AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE	OF	PAGES
	1		4

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. *(If applicable)*
0002	17 AUGUST 2001		

6. ISSUED BY	CODE	7. ADMINISTERED BY *(If other than Item 6)*	CODE
US ARMY ENGINEER DISTRICT, FORT WORTH ATTN: CESWF-CT (RM 2A19) PO BOX 17300 FORT WORTH, TX 76102-0300			

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, county, State and ZIP Code)*	(X)	9A. AMENDMENT OF SOLICIATION NO.
	☒	DACA63-01-R-0016
		9B. DATED *(SEE ITEM 11)* 26 JULY 2001
	☐	10A. MODIFICATION OF CONTRACT/ORDER NO.
		10B. DATED *(SEE ITEM 11)*
CODE / FACILITY CODE		

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☒ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☒ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a)By completing items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram 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 OFFER. If by virtue of this amendment your 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 ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

CHECK ONE	
	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 NUMBERED 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 FAR 43.103(b).
	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.)*

The Solicitation for RAIL DEPLOYMENT COMPLEX, FORT BLISS, TEXAS, is amended as follows:

See Continuation Sheets.

NOTE: The Receipt of Proposal date and time remain "28 August 2001, at 4 p.m. local time," as previously announced.

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 *(Signature of Contracting Officer)*	16C. DATE SIGNED

Item 14. Continued.

CHANGES TO BIDDING SCHEDULE

1. Replace the Bidding Schedule, pages 00010-3 through 00010-6, with the accompanying new Bidding Schedule, pages 00010-3 through 00010-7, bearing the notation "ACCOMPANYING AMENDMENT NO. 0002 TO SOLICITATION NO. DACA63-01-R-0016."

CHANGES TO SECTION 00150

2. Section 00150 – EVALUATION FACTORS FOR AWARD.- Delete Section 00150 in its entirety and replace with the accompanying new Section 00150, bearing the notation "Revised by Amendment 0002."

CHANGES TO SECTION 00700 CONTRACT CLAUSES

3. Page 00700-114.- Delete page 00700-114 in its entirety and replace with pages 00700-114 and 00700-115, bearing the notation "Revised by Amendment 0002."

CHANGES TO THE SPECIFICATIONS

4. Replacement Sections - Replace the following sections with the accompanying new sections of the same number and title, bearing the notation "ACCOMPANYING AMENDMENT NO. 0002 TO SOLICITATION NO. DACA63-01-R-0016:"

02731	AGGREGATE SURFACE COURSE
02741	HOT-MIX ASPHALT (HMA) FOR ROADS
03300	CAST-IN-PLACE STRUCTURAL CONCRETE
05650	RAILROADS
09915	COLOR SCHEDULE

CHANGES TO THE DRAWINGS

5. New Drawings.- The new drawing listed below which accompanies this amendment, bearing the notation "AM #0002" shall be added to and become a part of the contract documents:

c825.cal Seq 154 C825 STORM DRAIN DETAILS 4

6. Replacement Drawings.- Replace the drawings listed below with the attached new drawings of the same number, bearing the notation "AM #0002":

gi1.cal Seq GI1 GI1 INDEX SHEET VOL 1
c100.cal Seq 3 C100 DEMOLITION KEY PLAN
c101.cal Seq 4 C101 DEMOLITION PLAN 1
c102.cal Seq 5 C102 DEMOLITION PLAN 2
C200A.cal Seq 9 C200A OVERALL PLAN w/ KEY MAP
C202.cal Seq 12 C202 LAYOUT PLAN 2
C203.cal Seq 13 C203 LAYOUT PLAN 3
C220.cal Seq 32 C220 LAYOUT PLAN 20

C221.cal Seq 33 C221 LAYOUT PLAN 21
c301.cal Seq 39 C301 GRADING PLAN 1
c302.cal Seq 40 C302 GRADING PLAN 2
c303.cal Seq 41 C303 GRADING PLAN 3
c401.cal Seq 63 C401 STORM DRAIN PLAN 1
c402.cal Seq 64 C402 STORM DRAIN PLAN 2
c403.cal Seq 65 C403 STORM DRAIN PLAN 3
c404.cal Seq 66 C404 STORM DRAIN PLAN 15
c501.cal Seq 73 C501 JOINT PATTERN PLAN 11
c502.cal Seq 75 C502 JOINT PATTERN PLAN 12
c708.cal Seq 110 C708 TRACK PROFILES - TRACK H2, TRACK I2
c819.cal Seq 148 C819 UTILITY DETAILS 1
h01.cal Seq 186 h01 STORMWATER CONTROL PLAN 1
h02.cal Seq 187 h02 STORMWATER CONTROL PLAN 2
h03.cal Seq 188 h03 STORMWATER CONTROL PLAN 3
h04.cal Seq 189 h04 STORMWATER CONTROL PLAN 4
h05.cal Seq 190 h05 STORMWATER CONTROL PLAN 5
h06.cal Seq 191 h06 STORMWATER CONTROL PLAN 6
h07.cal Seq 192 h07 STORMWATER CONTROL PLAN 7
h08.cal Seq 193 h08 STORMWATER CONTROL PLAN 8
h09.cal Seq 194 h09 STORMWATER CONTROL PLAN 9
h10.cal Seq 195 h10 STORMWATER CONTROL PLAN 10
h11.cal Seq 196 h11 STORMWATER CONTROL PLAN 11
h12.cal Seq 197 h12 STORMWATER CONTROL PLAN 12
h13.cal Seq 198 h13 STORMWATER CONTROL PLAN 13
h14.cal Seq 199 h14 STORMWATER CONTROL PLAN 14
h15.cal Seq 200 h15 STORMWATER CONTROL PLAN 15
h16.cal Seq 201 h16 STORMWATER CONTROL PLAN 16
h17.cal Seq 202 h17 STORMWATER CONTROL PLAN 17
h18.cal Seq 203 h18 STORMWATER CONTROL PLAN 18
h19.cal Seq 204 H19 STORMWATER CONTROL PLAN 19
h20.cal Seq 205 h20 STORMWATER CONTROL PLAN 20
h21.cal Seq 206 h21 STORMWATER CONTROL PLAN 21
h22.cal Seq 207 h22 STORMWATER CONTROL PLAN 22
h23.cal Seq 208 h23 EROSION AND SEDIMENT CONTROL DETAILS
h24.cal Seq 209 h24 DOSING WET WELL DETAILS
h24A.cal Seq 209A h24a SEPTIC SYSTEM DETAILS
a205.cal Seq 235 A2.05 BUILDING ELEVATIONS
s101.cal Seq 268 S1.01 STRUCTURAL NOTES AND MISCELLANEOUS DETAILS
s104.cal Seq 271 S1.04 ROOF FRAMING PLAN
s201.cal Seq 276 S2.01 STRUCTURAL NOTES AND MISCELLANEOUS DETAILS
s301.cal Seq 284 S3.01 STRUCTURAL NOTES AND MISCELLANEOUS DETAILS
eu18.cal Seq 337 EU18 ELECTRICAL SITE PLAN 3
eu21.cal Seq 340 EU21 ELECTRICAL SITE PLAN 6
eu23.cal Seq 342 EU23 ELECTRICAL SITE PLAN 8
eu28.cal Seq 347 EU28 ELECTRICAL SITE PLAN 12
eu29.cal Seq 348 EU29 ELECTRICAL SITE PLAN 13
eu30.cal Seq 349 EU30 ELECTRICAL SITE PLAN 14
eu40.cal Seq 359 EU40 RAILROAD SIGNAL PLAN 1
eu41.cal Seq 360 EU41 RAILROAD SIGNAL PLAN 2
eu42.cal Seq 361 EU42 RAILROAD SIGNAL PLAN 3
eu63.cal Seq 382 EU63 PANEL SCHEDULES, SHEET 1
eu68.cal Seq 387 EU68 POLE DETAILS, SHEET 2
eu69.cal Seq 388 EU69 POLE DETAILS, SHEET 3

e12.cal Seq 414 E1.2 Administration Bldg. Interior Power Plan
e13.cal Seq 415 E1.3 Administration Bldg.Fire Alarm & Communications Plan
e14.cal Seq 416 E1.4 Administration Bldg. Panel Scheduleds &Riser Diagram
e22.cal Seq 419 E2.2 Engine Repair Bldg. Interior Power Plan
e23.cal Seq 420 E2.3 Engine Repair Bldg.Fire Alarm & Communications Plan
e24.cal Seq 421 E2.4 Engine Repair Bldg. Panel Scheduleds & Riser Diagram
e31.cal Seq 423 E3.1 Latrine & Scale Shack Lighting, Comm., & Power Plan
e41.cal Seq 424 E4.1 Scale Shack Power & Lighting

END OF AMENDMENT

RAIL DEPLOYMENT COMPLEX (Title)
FORT BLISS, TEXAS (Location)

Solicitation No.DACA63-01-R-0016

BIDDING SCHEDULE
(To be attached to SF 1442)

Item No.	Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
0001	Rail Deployment Complex buildings; complete including all utilities to the 1524 mm line of the building, and exclusive of separately listed items.	Job	Sum	***	$_____
0002	All Exterior Work outside the buildings' 1524mm (5-Ft) line (Including all utilities, earthwork, curb and gutter, demolition) and all other work not listed separately	Job	Sum	***	$_____
(am#1) 0003	**305**mm Concrete Pavement (Excluding Subbase and Subgrade)	4468	M3	$_____	$_____
0004	215mm Concrete Pavement (Excluding Subbase and Subgrade)	5357	M3	$_____	$_____
0005	290mm Concrete Pavement (Excluding Subbase and Subgrade)	2692	M3	$_____	$_____

Solicitation No.DACA63-01-R-0016

BIDDING SCHEDULE (cont)

Item No.	Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
(am#2) 0006	**Deleted Item**				
(am#1) 0007	**Deleted Item**				
0008	Final Record Drawings	Job	Sum	**	$107,250

TOTAL $_____

OPTION NO. 1: All work required by the plans and specifications for the construction of the Interchange Yard. Including work required for Tracks I1, I2, and I3, the modifications to the adjacent existing railroad track, storm drainage, and electrical work.

0009	Interchange Yard complete	Job	Sum	***	$_____

OPTION NO. 2: All work required by the plans and specifications for the construction of the Hot Load Bypass Road.

(am#2) 0010	**Deleted Item**				
(am#2) 0011	**Hot Load Bypass Road, complete**	**Job**	**Sum**	*******	**$_____**

Solicitation No.DACA63-01-R-0016

BIDDING SCHEDULE (cont)

Item No.	Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
	OPTION NO. 3: All work required by the plans and specifications for the construction of the concrete pavement at the Hot Load Container Loading Apron along Track H2.				
0012	290mm Concrete Pavement (Excluding Subbase and Subgrade)	2559	M3	$_____	$_____
(am#2)	**OPTION NO. 4: All work required by the plans and specifications for the construction of Track H2 (Sta 0+050 to 0+574.464), incl. rail, ties, ballast & subbase and Concrete End Ramp H2.**				
0013	**Track H2 and Concrete End Ramp H2**	**Job**	**Sum**	*******	**$**_____

TOTAL (BASE BID + OPTIONS NO. 1, 2, 3 AND 4 $_____

Solicitation No.No.DACA63-01-R-0016

BIDDING SCHEDULE (cont)

NOTES:

1. ARITHMETIC DISCREPANCIES (EFARS 14.407-2)

(a) For the purpose of initial evaluation of bids, the following will be utilized in resolving arithmetic discrepancies found on the face of the bidding schedule as submitted by bidders:

(1) Obviously misplaced decimal points will be corrected;

(2) In case of discrepancy between unit price and extended price, the unit price will govern;

(3) Apparent errors in extension of unit prices will be corrected; and

(4) Apparent errors in addition of lump-sum and extended prices will be corrected.

(b) For the purpose of bid evaluation, the Government will proceed on the assumption that the bidder intends his bid to be evaluated on the basis of the unit prices, the totals arrived at by resolution of arithmetic discrepancies as provided above and the bid will be so reflected on the abstract of bids.

(c) These correction procedures shall not be used to resolve any ambiguity concerning which bid is low.

2. If a modification to a bid based on unit prices is submitted, which provides for a lump sum adjustment to the total estimated cost, the application of the lump sum adjustment to each unit price in the bid schedule must be stated. If it is not stated, the bidder agrees that the lump sum adjustment shall be applied on a pro rata basis to every unit price in the bid schedule.

3. Bidders must bid on all items.

Solicitation No.No.DACA63-01-R-0016

BIDDING SCHEDULE (cont)

NOTES: (cont)

4. EXERCISE OF OPTIONS (SWDR 715-1-1 (16 January 1996))

The Government reserves the right to exercise the option(s) by written notice to the Contractor either singularly or in any combination for up to 90 calendar days after award of the Base Bid without an increase in the Offeror's Bid Price. Completion of added items shall continue at the same schedule as the Base Bid unless otherwise noted in Section 01000 CONSTRUCTION SCHEDULE, paragraph 1 entitled SCHEDULE.

5. ABBREVIATIONS

For the purpose of this solicitation, the units of measure are represented as follows:

a. EA (each)
b. GAL (gallons)
c. CF (cubic feet)
d. SF (square feet)
e. LS (lump sum)
f. MM (millimeters)
g. LM (length in linear meters)
h. M3 (cubic meters)
i. MT (metric ton)

END OF BIDDING SCHEDULE

SECTION 00150
EVALUATION FACTORS FOR AWARD

1.0 **BASIS FOR AWARD**. The Government intends to award one (1) contract, based upon initial offers received, without discussion of such offers. Each offer should contain the offeror's best terms. The Government will evaluate price, past performance, Small Disadvantaged Utilization Plans and Subcontracting Plans. When combined, all non-cost/price factors are approximately equal to cost or price. The Government reserves the right to conduct discussions if later it is determined by the Contracting Officer to be necessary. The right is reserved to accept other than the lowest offer and to reject any or all offers. As proposals become more equivalent, cost consideration becomes more significant and may become the determining factor for award. Any award price must be determined to be fair and reasonable.

2.0 PRICE/COST PROPOSAL

2.1 A price analysis will be completed of the offeror's ***price/cost*** proposal ***as submitted on the bidding schedule*** to determine price reasonableness. If adequate competition is not obtained, a detailed cost analysis will be used to evaluate for cost realism (allowability, allocability, and reasonableness).

3.0 PAST PERFORMANCE
(Weighted 75% of Non-Cost Factors)

3.1 For the purpose of evaluating the Past Performance Survey information submitted hereunder:

3.1.1 Past Performance Survey data will be evaluated and scored, as it relates to the probability of the offeror successfully accomplishing the proposed effort.

3.1.2 The Government will use the Past Performance Survey data provided by the offeror (as specified in Section 00120) and data obtained from other sources in addition to these Surveys to perform this assessment.

4.0 SMALL DISADVANTAGED BUSINESS UTILIZATION PLANS
(Weighted 25% of Non-Cost Factors)

4.1 Small Disadvantaged Business (SDB) Utilization Plans Applies to all offerors

NOTE: Each SDB includes Small Businesses (SB), Small Disadvantaged Businesses (SDB), Woman-Owned Small Businesses (WOSB), HUB Zone Businesses (HUBZone), Veteran-Owned Small Businesses (VOSB), and Historically Black Colleges & Universities/Minority Institutions (where applicable)

4.2 SDB Utilization Plans will be evaluated based on the following:

- The extent to which SDB concerns are specifically identified.
- The extent of commitment to use SDB concerns.
- The complexity and variety of the work SDB concerns are to perform

- Show the extent of participation of SDB concerns in terms of the value of the total acquisition.

5.0 SUBCONTRACTING PLANS
(Evaluated Seperately)

5.1 Subcontracting Plans will be evaluated in accordance with Appendix CC of the Army Federal Acquisition Regulation Supplement.

6.0 EVALUATION OF OPTIONS (JUL 1990)(FAR 52.217-5) Except when it is determined in accordance with FAR 17.206(b) not to be in the Government's best interests, the Government will evaluate offers for award purposes by adding the total price for all options to the total price for the basic requirement. Evaluation of options will not obligate the Government to exercise the option(s).

(End of Section 00150)

(2) If this contract is not a construction contract, in all subcontracts under this contract that are for--

(i) Noncommercial items; or

(ii) Commercial items that--

(A) The Contractor is reselling or distributing to the Government without adding value (generally, the Contractor does not add value to items that it subcontracts for f.o.b. destination shipment);

(B) Are shipped in direct support of U.S. military contingency operations, exercises, or forces deployed in humanitarian or peacekeeping operations; or

(C) Are commissary or exchange cargoes transported outside of the Defense Transportation System in accordance with 10 U.S.C. 2643.

(End of clause)

52.219-4 NOTICE OF PRICE EVALUATION PREFERENCE FOR HUBZone SMALL BUSINESS CONCERNS. (Jan 1999)

(a) *Definition*. "HUBZone small business concern," as used in this clause, means a small business concern that appears on the List of Qualified HUBZone Small Business Concerns maintained by the Small Business Administration.
(b) *Evaluation preference*. (1) Offers will be evaluated by adding a factor of 10 percent to the price of all offers, except--
(i) Offers from HUBZone small business concerns that have not waived the evaluation preference;
(ii) Otherwise successful offers from small business concerns;
(iii) Otherwise successful offers of eligible products under the Trade Agreements Act when the dollar threshold for application of the Act is exceeded (see 25.402 of the Federal Acquisition Regulation (FAR)); and
(iv) Otherwise successful offers where application of the factor would be inconsistent with a Memorandum of Understanding or other international agreement with a foreign government.
(2) The factor of 10 percent shall be applied on a line item basis or to any group of items on which award may be made. Other evaluation factors described in the solicitation shall be applied before application of the factor.
(3) A concern that is both a HUBZone small business concern and a small disadvantaged business concern will receive the benefit of both the HUBZone small business price evaluation preference and the small disadvantaged business price evaluation adjustment (see FAR clause 52.219-23). Each applicable price evaluation preference or adjustment shall be calculated independently against an offeror's base offer. These individual preference amounts shall be added together to arrive at the total evaluated price for that offer.
(c) *Waiver of evaluation preference*. A HUBZone small business concern may elect to waive the evaluation preference, in which case the factor will be added to its offer for evaluation purposes. The agreements in paragraph (d) of this clause do not apply if the offeror has waived the evaluation preference.
* Offeror elects to waive the evaluation preference.
(d) *Agreement*. A HUBZone small business concern agrees that in the performance of the contract, in the case of a contract for--
(1) Services (except construction), at least 50 percent of the cost of personnel for contract performance will be spent for employees of the concern or employees of other HUBZone small business concerns;
(2) Supplies (other than procurement from a nonmanufacturer of such supplies), at least 50 percent of the cost of manufacturing, excluding the cost of materials, will be performed by the concern or other HUBZone small business concerns;
(3) General construction, at least 15 percent of the cost of the contract performance incurred for personnel will be will be spent on the concern's employees or the employees of other HUBZone small business concerns; or

(4) Construction by special trade contractors, at least 25 percent of the cost of the contract performance incurred for personnel will be spent on the concern's employees or the employees of other HUBZone small business concerns.
(e) A HUBZone joint venture agrees that in the performance of the contract, the applicable percentage specified in paragraph (d) of this clause will be performed by the HUBZone small business participant or participants.
(f) A HUBZone small business concern nonmanufacturer agrees to furnish in performing this contract only end items manufactured or produced by HUBZone small business manufacturer concerns. This paragraph does not apply in connection with construction or service contracts.
(End of clause)

(End of Section 00700)

SECTION 02731

AGGREGATE SURFACE COURSE
01/98
Amendment #0002

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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
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 D 75	(1987; R 1997) Sampling Aggregates
ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996el) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D 3740	(1999c) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 4318	(1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

1.2 Not Used

1.3 DEGREE OF COMPACTION

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated herein as present laboratory maximum density.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment;

List of proposed equipment to be used in performance of construction work including descriptive data.

SD-06 Test Reports

Sampling and Testing;
Density Tests;

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Test results from samples, not less than 30 days before material is required for the work. Results of laboratory tests for quality control purposes, for approval, prior to using the material.

1.5 EQUIPMENT

All plant, equipment, and tools used in the performance of the work covered by this section will be subject to approval by the Contracting Officer before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, and meeting the grade controls, thickness controls, and smoothness requirements set forth herein.

1.6 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory or by the Contractor, subject to approval. If the Contractor elects to establish its own testing facilities, approval of such facilities will be based on compliance with ASTM D 3740. No work requiring testing will be permitted until the Contractor's facilities have been inspected and approved.

1.6.1 Sampling

Sampling for material gradation, liquid limit, and plastic limit tests shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.6.2 Testing

1.6.2.1 Gradation

Aggregate gradation shall be made in conformance with ASTM C 136 and ASTM D 422. Sieves shall conform to ASTM E 11.

1.6.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

1.6.3 Approval of Materials

The source of the material to be used for producing aggregates shall be selected 90 days prior to the time the material will be required in the work. Approval of sources not already approved by the Corps of Engineers will be based on an inspection by the Contracting Officer. Tentative approval of materials will be based on appropriate test results on the aggregate source. Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted surface course.

1.7 WEATHER LIMITATIONS

Aggregate surface courses shall not be constructed when the ambient temperatures is below 2 degrees C and on subgrades that are frozen or contain frost. It shall be the responsibility of the Contractor to protect, by approved method or methods, all areas of surfacing that have not been accepted by the Contracting Officer. Surfaces damaged by freeze, rainfall, or other weather conditions shall be brought to a satisfactory condition by the Contractor.

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregates shall consist of clean, sound, durable particles of natural gravel, crushed gravel, crushed stone, sand, soil, or other approved materials processed and blended or naturally combined. Aggregates shall be free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign materials. The Contractor shall be responsible for obtaining materials that meet the specification and can be used to meet the grade and smoothness requirements specified herein after all compaction and proof rolling operations have been completed.

2.1.1 Coarse Aggregates

The material retained on the 4.75 mm sieve shall be known as coarse aggregate. Coarse aggregates shall be reasonably uniform in density and quality. The coarse aggregate shall have a percentage of wear not to exceed 50 percent after 500 revolutions as determined by ASTM C 131. The amount of flat and/or elongated particles shall not exceed 20 percent. A flat particle is one having a ratio of width to thickness greater than three; an elongated particle is one having a ratio of length to width greater than three. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the requirements set forth herein.

2.1.2 Fine Aggregates

The material passing the 4.75 mm sieve shall be known as fine aggregate. Fine aggregate shall consist of screenings, sand, soil, or other finely divided mineral matter that is processed or naturally combined with the coarse aggregate.

2.1.3 Gradation Requirements

Gradation requirements specified in TABLE I shall apply to the completed aggregate surface. It shall be the responsibility of the Contractor to obtain materials that will meet the gradation requirements after mixing, placing, compacting, and other operations. TABLE I shows permissible gradings for granular material used in aggregate surface roads and airfields. Sieves shall conform to ASTM E 11.

TABLE I. GRADATION FOR AGGREGATE SURFACE COURSES

Sieve Designation	No. 1
25.0 mm	100
13.0 mm	40-70
4.75 mm	20-50
2.00 mm	15-40
0.425 mm	10-30
0.075 mm	5-20

[AM #2]

The table is based on aggregates of uniform specific gravity and the

percentages passing the various sieves are subject to appropriate corrections in accordance with ASTM C 127 and ASTM C 128 when aggregates of varying specific gravity are used.

2.2 LIQUID LIMIT AND PLASTICITY INDEX REQUIREMENTS

The portion of the completed aggregate surface course passing the 0.425 mm sieve shall have a maximum liquid limit of 35 and a plasticity index of 4 to [AM #2] 12.

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

Clearing, stripping, and excavating shall be the responsibility of the Contractor. The aggregate sources shall be operated to produce the quantity and quality of materials meeting these specification requirements in the specified time limit. Upon completion of the work, the aggregate sources on Government property shall be conditioned to drain readily and be left in a satisfactory condition. Aggregate sources on private lands shall be conditioned in agreement with local laws or authorities.

3.2 STOCKPILING MATERIALS

Prior to stockpiling the material, the storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled in such a manner that will prevent segregation. Aggregates and binders obtained from different sources shall be stockpiled separately.

3.3 PREPARATION OF UNDERLYING COURSE SUBGRADE

The underlying course, including shoulders, shall be cleaned of all foreign substances. At the time of surface course construction, the underlying course shall contain no frozen material. Ruts or soft yielding spots in the underlying course areas having inadequate compaction and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade and recompacting to density requirements specified in Section 02722 AGGREGATE BASE COURSE or Section 02721 SUBBASE COURSES, whichever is applicable. The completed underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the surface course is placed.

3.4 GRADE CONTROL

During construction, the lines and grades including crown and cross slope indicated for the aggregate surface course shall be maintained by means of line and grade stakes placed by the Contractor in accordance with the SPECIAL CONTRACT REQUIREMENTS.

3.5 MIXING AND PLACING MATERIALS

The materials shall be mixed and placed to obtain uniformity of the material and a uniform optimum water content for compaction. The Contractor shall make adjustments in mixing, placing procedures, or in equipment to obtain the true grades, to minimize segregation and degradation, to obtain the desired water content, and to ensure a satisfactory surface course.

3.6 LAYER THICKNESS

The aggregate material shall be placed on the underlying course in layers of uniform thickness. When a compacted layer of 150 mm or less is specified, the material may be placed in a single layer; when a compacted thickness of more than 150 mm is required, no layer shall exceed 150 mm nor be less than 75 mm when compacted.

3.7 COMPACTION

Each layer of the aggregate surface course shall be compacted with approved compaction equipment. The water content during the compaction procedure shall be maintained at optimum or at the percentage specified by the Contracting Officer. In locations not accessible to the rollers, the mixture shall be compacted with mechanical tampers. Compaction shall continue until each layer through the full depth is compacted to at least 100 percent of laboratory maximum density. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked to produce a satisfactory material.

3.8 Not Used

3.9 EDGES OF AGGREGATE-SURFACED ROAD

Approved material shall be placed along the edges of the aggregate surface course in such quantity as to compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, at least 300 mm of shoulder width shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the surface course.

3.10 SMOOTHNESS TEST

The surface of each layer shall not show any deviations in excess of 10 mm (3/8 inch) when tested with a 3 m (10 foot) straightedge applied both parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding this amount shall be corrected by the Contractor by removing material, replacing with new material, or reworking existing material and compacting, as directed. One smoothness test shall be performed for each 150 m of completed aggregate surface course.

3.11 THICKNESS CONTROL

The completed thickness of the aggregate surface course shall be within 13

mm (1/2 inch), plus or minus, of the thickness indicated on plans. The thickness of the aggregate surface course shall be measured at intervals in such manner that there will be a thickness measurement for at least each 500 square meters of the aggregate surface course. The thickness measurement shall be made by test holes at least 75 mm (3 inches) in diameter through the aggregate surface course. When the measured thickness of the aggregate surface course is more than 13 mm (1/2 inch) deficient in thickness, the Contractor, at no additional expense to the Government, shall correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompacting, as directed. Where the measured thickness of the aggregate surface course is more than 13 mm (1/2 inch) thicker than that indicated, it shall be considered as conforming with the specified thickness requirements plus 13 mm (1/2 inch). The average job thickness shall be the average of the job measurements determined as specified above, but shall be within 6 mm (1/4 inch) of the thickness indicated. When the average job thickness fails to meet this criterion, the Contractor shall, at no additional expense to the Government, make corrections by scarifying, adding or removing mixture of proper gradation, and reblading and recompacting, as directed.

3.12 DENSITY TESTS

Density shall be measured in the field in accordance with ASTM D 1556 or ASTM D 2922. For the method presented in ASTM D 2922 the calibration curves shall be checked and adjusted, if necessary, using only the sand cone method as described in paragraph Calibration of the ASTM publication. Tests performed in accordance with ASTM D 2922 result in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. In-place density tests shall be performed for each 100 square meters of completed aggregate surface course.

3.13 WEAR TEST

Wear tests shall be made in conformance with ASTM C 131. A minimum of one wear test shall be performed for each type of aggregate surface material proposed for use.

3.14 MAINTENANCE

The aggregate surface course shall be maintained in a condition that will meet all specification requirements until accepted.

-- End of Section --

SECTION 02741

HOT-MIX ASPHALT (HMA)
09/99
Amendment #0002

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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO MP 1	(1998)Provisional Specification for Performance Graded Asphalt Binder
AASHTO MP 2	(1998; Interim 1999) Superpave Volumetric Mix Design
AASHTO TP53	(1998; Interim 1999) Determining Asphalt Content of Hot Mix Asphalt by the Ignition Method

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29/C 29M	(1997) Bulk Density ("Unit Weight") and Voids in Aggregates
ASTM C 88	(1999a) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1995) Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
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 566	(1997) Evaporable Total Moisture Content of Aggregate by Drying
ASTM C 1252	(1998) Uncompacted Void Content of Fine

	Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)
ASTM D 140	(1998) Sampling Bituminous Materials
ASTM D 242	(1995) Mineral Filler for Bituminous Paving Mixtures
ASTM D 946	(1999) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 995	(1995b) Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
ASTM D 1461	(1985)) Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2041	(1995) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2419	(1995) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2489	(1984; R 1994el) Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D 2726	(1996el) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixture
ASTM D 2950	(1997) Density of Bituminous Concrete in Place by Nuclear Method
ASTM D 3381	(1999) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3665	(1999) Random Sampling of Construction Materials
ASTM D 3666	(1998) Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
ASTM D 4125	(1994el)Asphalt Content of Bituminous Mixtures by the Nuclear Method

ASTM D 4791	(1999) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D 4867/D 4867M	(1996) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D 5444	(1998) Mechanical Size Analysis of Extracted Aggregate
ASTM D 6307	(1998) Asphalt Content of Hot Mix Asphalt by Ignition Method

ASPHALT INSTITUTE (AI)

AI MS-2	(1997) Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types
AI MS-22	(1998; 2nd Edition) Construction of Hot-Mix Asphalt Pavements

[AM #2]_____

CORPS OF ENGINEERS (COE)

COE CRD-C 171	(1995) Test Method for Determining Percentage of Crushed Particles in Aggregate

1.2 DESCRIPTION OF WORK

The work shall consist of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. HMA designed and constructed in accordance with this section shall conform to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Mix Design; G, RE.

Proposed JMF.

Contractor Quality Control; G; RE.

Quality control plan.

Material Acceptance and Percent Payment;G, RE.

Acceptance test results and pay calculations.

SD-06 Test Reports

Aggregates; G, RE.
QC Monitoring; G, RE.

Aggregate and QC test results.

SD-07 Certificates

Asphalt Cement Binder; G, RE.

Copies of certified test data.

Testing Laboratory; G, RE.

Certification of compliance.

Plant Scale Calibration Certification

1.4 [AM #2] Not Used

1.5 [AM #2] Not Used

1.6 ASPHALT MIXING PLANT

Plants used for the preparation of hot-mix asphalt shall conform to the requirements of ASTM D 995 with the following changes:

a. Truck Scales. The asphalt mixture shall be weighed on approved certified scales at the Contractor's expense. Scales shall be inspected and sealed at least annually by an approved calibration laboratory.

b. Testing Facilities. The Contractor shall provide laboratory facilities at the plant for the use of the Government's acceptance testing and the Contractor's quality control testing.

c. Inspection of Plant. The Contracting Officer shall have access at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the

preparation of the mixtures and for taking samples. The Contractor shall provide assistance as requested, for the Government to procure any desired samples.

d. Storage Bins. Use of storage bins for temporary storage of hot-mix asphalt will be permitted as follows:

(1) The asphalt mixture may be stored in non-insulated storage bins for a period of time not exceeding 2 hours.

(2) The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 4 hours. The mix drawn from bins shall meet the same requirements as mix loaded directly into trucks.

1.7 HAULING EQUIPMENT

Trucks used for hauling hot-mix asphalt shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Petroleum based products shall not be used as a release agent. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers (tarps) shall be securely fastened.

1.8 ASPHALT PAVERS

Asphalt pavers shall be self-propelled, with an activated screed, heated as necessary, and shall be capable of spreading and finishing courses of hot-mix asphalt which will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

1.8.1 Receiving Hopper

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

1.8.2 Automatic Grade Controls

If an automatic grade control device is used, the paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. A transverse slope controller shall not be used to control grade.

The controls shall be capable of working in conjunction with any of the following attachments:

a. Ski-type device of not less than 9.14 m in length.

b. Taut stringline set to grade.

c. Short ski or shoe for joint matching.

d. Laser control.

1.9 ROLLERS

Rollers shall be in good condition and shall be operated at slow speeds to avoid displacement of the asphalt mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Equipment which causes excessive crushing of the aggregate shall not be used.

1.10 WEATHER LIMITATIONS

The hot-mix asphalt shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 1. The temperature requirements may be waived by the Contracting Officer, if requested; however, all other requirements, including compaction, shall be met.

Table 1. Surface Temperature Limitations of Underlying Course

Mat Thickness, mm	Degrees C
75 or greater	4
Less than 75	7

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregates shall consist of crushed stone, crushed gravel, crushed slag, screenings, natural sand and mineral filler, as required. The portion of material retained on the 4.75 mm sieve is coarse aggregate. The portion of material passing the 4.75 mm sieve and retained on the 0.075 mm sieve is fine aggregate. The portion passing the 0.075 mm sieve is defined as mineral filler. All aggregate test results and samples shall be submitted to the Contracting Officer at least 14 days prior to start of construction.

2.1.1 Coarse Aggregate

Coarse aggregate shall consist of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. All individual coarse aggregate sources shall meet the

following requirements:

a. The percentage of loss shall not be greater than 40 percent after 500 revolutions when tested in accordance with ASTM C 131.

b. At least 75 percent by weight of coarse aggregate shall have at least two or more fractured faces when tested in accordance with COE CRD-C 171. Fractured faces shall be produced by crushing.

c. The particle shape shall be essentially cubical and the aggregate shall not contain more than 20% percent, by weight, of flat and elongated particles (3:1 ratio of maximum to minimum) when tested in accordance with ASTM D 4791.

e. Slag shall be air-cooled, blast furnace slag, and shall have a compacted weight of not less than 1200 kg/cubic meter when tested in accordance with ASTM C 29/C 29M.

2.1.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, tough, durable particles. The aggregate particles shall be free from coatings of clay, clay balls, silt, or any objectionable material and shall contain no clay balls. All individual fine aggregate sources shall have a sand equivalent value not less than 45 when tested in accordance with ASTM D 2419.

The fine aggregate portion of the blended aggregate shall have an uncompacted void content not less than 45.0 percent when tested in accordance with ASTM C 1252 Method A.

2.1.3 Mineral Filler

Mineral filler shall be nonplastic material meeting the requirements of ASTM D 242.

2.1.4 Aggregate Gradation

The combined aggregate gradation shall conform to gradations specified in Table 2, when tested in accordance with ASTM C 136 and ASTM C 117, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

Table 2. Aggregate Gradations

Sieve Size, mm	Gradation 1 Percent Passing by Mass	Gradation 2 Percent Passing
25.0	---	---
19.0	100	---
12.5	76-96	100

Table 2. Aggregate Gradations

Sieve Size, mm	Gradation 1 Percent Passing by Mass	Gradation 2 Percent Passing
9.5	69-89	76-96
4.75	53-73	58-78
2.36	38-60	40-60
1.18	26-48	28-48
0.60	18-38	18-38
0.30	11-27	11-27
0.15	6-18	6-18
0.075	3-6	3-6

2.2 ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to [AM #2]_ASTM D 3381 Table 2, Viscosity Grade AC-20 _____ . Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting Officer. The supplier is defined as the last source of any modification to the binder. The Contracting Officer may sample and test the binder at the mix plant at any time before or during mix production. Samples for this verification testing shall be obtained by the Contractor in accordance with ASTM D 140 and in the presence of the Contracting Officer. These samples shall be furnished to the Contracting Officer for the verification testing, which shall be at no cost to the Contractor. Samples of the asphalt cement specified shall be submitted for approval not less than 14 days before start of the test section.

2.3 MIX DESIGN

The Contractor shall develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a JMF has been approved. The hot-mix asphalt shall be designed using procedures contained in AI MS-2 and the criteria shown in Table 3. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D 4867/D 4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost.

At the option of the contractor a currently used Texas Department of Transportation hot mix may be used in lieu of developing a new hot mix design study as described herein provided it meets all the requirements as statede herein. The Contractor shall submit all required testing data for review.

2.3.1 JMF Requirements

The job mix formula shall be submitted in writing by the Contractor for approval at least 14 days prior to the start of the test section and shall include as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt cement.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt viscosity grade, penetration grade, or performance grade.

e. Number of blows of hammer per side of molded specimen.

f. Laboratory mixing temperature.

g. Lab compaction temperature.

h. Temperature-viscosity relationship of the asphalt cement.

i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

j. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2.

k. Specific gravity and absorption of each aggregate.

l. Percent natural sand.

m. Percent particles with 2 or more fractured faces (in coarse aggregate).

n. Fine aggregate angularity.

o. Percent flat or elongated particles (in coarse aggregate).

p. Tensile Strength Ratio(TSR).

q. Antistrip agent (if required) and amount.

r. List of all modifiers and amount.

Table 3. Marshall Design Criteria

Test Property	75 Blow Mix	50 Blow Mix
Stability, newtons minimum	*8000	*4450
Flow, 0.25 mm	8-16	8-18
Air voids, percent	3-5	3-5
Percent Voids in mineral aggregate (VMA), (minimum)		
Gradation 1	14.0	14.0
Gradation 2	15.0	15.0
TSR, minimum percent	75	75

* This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.
** Calculate VMA in accordance with AI MS-2, based on ASTM D 2726 bulk specific gravity for the aggregate.

2.3.2 Adjustments to Field JMF

The Laboratory JMF for each mixture shall be in effect until a new formula is approved in writing by the Contracting Officer. Should a change in sources of any materials be made, a new laboratory jmf design shall be performed and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the Laboratory JMF within the limits specified below to optimize mix volumetric properties with the approval of the Contracting Officer. Adjustments to the Laboratory JMF shall be applied to the field (plant) established JMF and limited to those values as shown. Adjustments shall be targeted to produce or nearly produce 4 percent voids total mix (VTM).

TABLE 4. Field (Plant) Established JMF Tolerances

Sieves	Adjustments (plus or minus), percent
12.5 mm	3
4.75 mm	3
2.36 mm	3
0.075 mm	1
Binder Content	0.4

If adjustments are needed that exceed these limits, a new mix design shall

be developed. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table 2; while not desirable, this is acceptable.

[AM #2] _____

PART 3 EXECUTION

3.1 PREPARATION OF ASPHALT BINDER MATERIAL

The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 160 degrees C when added to the aggregates. Modified asphalts shall be no more than 174 degrees C when added to the aggregates.

3.2 PREPARATION OF MINERAL AGGREGATE

The aggregate for the mixture shall be heated and dried prior to mixing. No damage shall occur to the aggregates due to the maximum temperature and rate of heating used. The temperature of the aggregate and mineral filler shall not exceed 175 degrees C when the asphalt cement is added. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.3 PREPARATION OF HOT-MIX ASPHALT MIXTURE

The aggregates and the asphalt cement shall be weighed or metered and introduced into the mixer in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but no less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D 2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to at least achieve 95 percent of coated particles. The moisture content of all hot-mix asphalt upon discharge from the plant shall not exceed 0.5 percent by total weight of mixture as measured by ASTM D 1461.

3.4 PREPARATION OF THE UNDERLYING SURFACE

Immediately before placing the hot mix asphalt, the underlying course shall be cleaned of dust and debris. A prime coat and tack coat where applicable shall be applied in accordance with the contract specifications.

3.5 TEST SECTION

Prior to full production, the Contractor shall place a test section for each JMF used. The contractor shall construct a test section 75 - 150 m long and two paver passes wide placed for two lanes, with a longitudinal cold joint. The test section shall be of the same depth as the course

which it represents. 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 and personnel used in construction of the test section shall be the same equipment to be used on the remainder of the course represented by the test section. The test section shall be placed as part of the project pavement as approved by the Contracting Officer.

3.5.1 Sampling and Testing for Test Section

One random sample shall be taken at the plant, triplicate specimens compacted, and tested for stability, flow, and laboratory air voids. A portion of the same sample shall be tested for aggregate gradation and asphalt content. Four randomly selected cores shall be taken from the finished pavement mat, and four from the longitudinal joint, and tested for density. Random sampling shall be in accordance with procedures contained in ASTM D 3665. The test results shall be within the tolerances shown in Table 5 for work to continue. If all test results meet the specified requirements, the test section shall remain as part of the project pavement. If test results exceed the tolerances shown, the test section shall be removed and replaced at no cost to the Government and another test section shall be constructed. The test section shall be paid for with the first lot of paving

Table 5. Test Section Requirements for Material and Mixture Properties

Property	Specification Limit
Aggregate Gradation-Percent Passing (Individual Test Result)	
4.75 mm and larger	JMF plus or minus 8
2.36, 1.18, 0.60, and 0.30 mm	JMF plus or minus 6
0.15 and 0.075 mm	JMF plus or minus 2.0
Asphalt Content, Percent (Individual Test Result)	JMF plus or minus 0.5
Laboratory Air Voids, Percent (Average of 3 specimens)	JMF plus or minus 1.0
VMA, Percent (Average of 3 specimens)	
Gradation 1	14 minimum
Gradation 2	15 minimum
Stability, newtons (Average of 3 specimens)	[4450] [8000] minimum
Flow, 0.25 mm (Average of 3 specimens)	
High Stability	8 - 16
Low Stability	8 - 18
Mat Density, Percent of Marshall	

Table 5. Test Section Requirements for Material and Mixture Properties

Property	Specification Limit
(Average of 4 Random Cores)	97.0 - 100.5
Joint Density, Percent of Marshall (Average of 4 Random Cores)	95.5 - 100.5

3.5.2 Additional Test Sections

If the initial test section should prove to be unacceptable, 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. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Full production shall not begin until an acceptable section has been constructed and accepted.

3.6 TESTING LABORATORY

The laboratory used to develop the JMF shall meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The certification shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

3.7 TRANSPORTING AND PLACING

3.7.1 Transporting

The hot-mix asphalt shall be transported from the mixing plant to the site in clean, tight vehicles. Deliveries shall be scheduled so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Adequate artificial lighting shall be provided for night placements. Hauling over freshly placed material will not be permitted until the material has been compacted as specified, and allowed to cool to 60 degrees C.

3.7.2 Placing

The mix shall be placed and compacted at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, the mixture shall be placed to the full width by an asphalt

paver; it shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of 3 m. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 300 mm; however, the joint in the surface course shall be at the centerline of the pavement. Transverse joints in one course shall be offset by at least 3 m from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 3 m. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

3.8 COMPACTION OF MIXTURE

After placing, the mixture shall be thoroughly and uniformly compacted by rolling. The surface shall be compacted as soon as possible without causing displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once. Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened but excessive water will not be permitted. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers. Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective shall be removed full depth, replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching will not be allowed.

3.9 JOINTS

The formation of joints shall be made ensuring a continuous bond between the courses and to obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.9.1 Transverse Joints

The roller shall not pass over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing material at the joint . The cutback material shall be removed from

the project. In both methods, all contact surfaces shall be given a light tack coat of asphalt material before placing any fresh mixture against the joint.

3.9.2 Longitudinal Joints

Longitudinal joints which are irregular, damaged, uncompacted, cold (less than 80 degrees C at the time of placing adjacent lanes), or otherwise defective, shall be cut back a minimum of 50 mm from the edge with a cutting wheel to expose a clean, sound vertical surface for the full depth of the course. All cutback material shall be removed from the project. All contact surfaces shall be given a light tack coat of asphalt material prior to placing any fresh mixture against the joint. The Contractor will be allowed to use an alternate method if it can be demonstrated that density, smoothness, and texture can be met.

3.10 CONTRACTOR QUALITY CONTROL

3.10.1 General Quality Control Requirements

The Contractor shall develop an approved Quality Control Plan. Hot-mix asphalt for payment shall not be produced until the quality control plan has been approved. The plan shall address all elements which affect the quality of the pavement including, but not limited to:

a. Mix Design

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management

e. Proportioning

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction

l.Surface Smoothness

3.10.2 Testing Laboratory

The Contractor shall provide a fully equipped asphalt laboratory located at the plant or job site. The laboratory shall meet the requirements as required in ASTM D 3666. The effective working area of the laboratory

shall be a minimum of 14 square meters with a ceiling height of not less than 2.3 m. Lighting shall be adequate to illuminate all working areas. It shall be equipped with heating and air conditioning units to maintain a temperature of 24 degrees C plus or minus 2.3 degrees C. Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Contracting Officer shall be permitted unrestricted access to inspect the Contractor's laboratory facility, to witness quality control activities, and to perform any check testing desired. The Contracting Officer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are corrected.

3.10.3 Quality Control Testing

The Contractor shall perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, stability, flow, in-place density, grade and smoothness. A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

3.10.3.1 Asphalt Content

A minimum of two tests to determine asphalt content will be performed [AM #2] for every 2000 metric tons of material placed, or fraction thereof, by one of the following methods: the extraction method in accordance with ASTM D 2172, Method A or B, the ignition method in accordance with the AASHTO TP53or ASTM D 6307, or the nuclear method in accordance with ASTM D 4125, provided the nuclear gauge is calibrated for the specific mix being used. For the extraction method, the weight of ash, as described in ASTM D 2172, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture.

3.10.3.2 Gradation

[AM #2] A minimum of two aggregate gradations shall be determined [AM #2] for every 2000 metric tons of material placed from mechanical analysis of recovered aggregate in accordance with ASTM D 5444. When asphalt content is determined by the nuclear method, aggregate gradation shall be determined from hot bin samples on batch plants, or from the cold feed on drum mix plants. For batch plants, aggregates shall be tested in accordance with ASTM C 136 using actual batch weights to determine the combined aggregate gradation of the mixture.

3.10.3.3 Temperatures

Temperatures shall be checked at least four times per [AM #2] 2000 metric

tons placed, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.10.3.4 Aggregate Moisture

The moisture content of aggregate used for production shall be determined a minimum of once per [AM #2] 2000 metric tons placed in accordance with ASTM C 566.

3.10.3.5 Moisture Content of Mixture

The moisture content of the mixture shall be determined at least once per [AM #2] 2000 metric tons placed in accordance with ASTM D 1461 or an approved alternate procedure.

3.10.3.6 Laboratory Air Voids, Marshall Stability and Flow

Mixture samples shall be taken at least four times per [AM #2] 2000 metric tons placed and compacted into specimens, using 50 or 75 blows per side with the Marshall hammer as described in ASTM D 1559. After compaction, the laboratory air voids of each specimen shall be determined, as well as the Marshall stability and flow.

3.10.3.7 In-Place Density

The Contractor shall conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge may be used to monitor pavement density in accordance with ASTM D 2950.

3.10.3.8 Grade and Smoothness

The Contractor shall conduct the necessary checks to ensure the grade and smoothness requirements are met [AM #2] _____.

3.10.3.9 Additional Testing

Any additional testing, which the Contractor deems necessary to control the process, may be performed at the Contractor's option.

3.10.3.10 QC Monitoring

The Contractor shall submit all QC test results to the Contracting Officer on a daily basis as the tests are performed. The Contracting Officer reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.10.4 Sampling

When directed by the Contracting Officer, the Contractor shall sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in

accordance with standard procedures specified.

3.10.5 [AM #2]Not Used

3.11 MATERIAL ACCEPTANCE [AM #2]

Testing for acceptability of work will be performed by an independent laboratory hired by the Contractor. Test results [AM #2] _____ shall be forwarded daily to the Contracting Officer. Acceptance of the plant produced mix and in-place requirements will be on a lot to lot basis. A standard lot for all requirements will be equal to 2000 metric tons. [AM #2] _____
Grade and surface smoothness determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus grade and smoothness measurements for the entire lot cannot be made. In order to evaluate laboratory air voids and in-place (field) density, each lot will be divided into four equal sublots.

3.11.1 [AM #2] Not Used

3.11.2 [AM #2] Not Used

3.11.3 Additional Sampling and Testing

The Contracting Officer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Government. Testing in these areas will be in addition to the lot testing, and the requirements for these areas will be the same as those for a lot.

3.11.4 Laboratory Air Voids

Laboratory air voids will be calculated by determining the Marshall density of each lab compacted specimen using ASTM D 2726 and determining the theoretical maximum density of every other [AM #2] ___lot sample using ASTM D 2041. Laboratory air void calculations for each [AM #2] ___lot will use the latest theoretical maximum density values obtained [AM #2]_____. All laboratory air void tests will be completed and reported within 24 hours after completion of construction of each lot.

3.11.5 [AM #2] Not Used

3.11.6 In-place Density

3.11.6.1 General Density Requirements

For determining in-place density, one random core will be taken by the Government from the mat (interior of the lane) of [AM #2] every 500 metric tons placed, and one random core will be taken from the joint (immediately over joint) of [AM #2] every 500 metric tons placed. Each random core will be full thickness of the layer being placed. When the random core is less than 25 mm thick, it will not be included in the analysis. In this case, another random core will be taken. After air drying to a constant weight, cores obtained from the mat and from the joints will be used for in-place density determination.

3.11.6.2 Mat and Joint Densities

The average in-place mat and joint densities are expressed as a percentage of the average Marshall density for the lot. The Marshall density for each lot will be determined as the average Marshall density of the four random samples (3 specimens compacted per sample). [AM #2]

3.11.6.3 [AM #2] Not Used

3.11.7 Grade

The top of the surface course pavement shall conform to the elevations and cross sections shown and shall vary not more than 15 mm from the plan grade established and approved at site of work. Finished surfaces at juncture with other pavements shall coincide with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. The final wearing surface of the pavement will be tested for conformance with specified plan grade requirements. The grade will be determined by running lines of levels at intervals of 7.6 m , or less, longitudinally and transversely, to determine the elevation of the completed pavement surface. Within 5 working days, after the completion of a particular lot incorporating the final wearing surface, the Contracting Officer will inform the Contractor in writing, of the results of the grade-conformance tests. [AM #2] _____
In areas where the grade exceeds the tolerance [AM #2]_____, the Contractor shall remove the surface lift full depth; the Contractor shall then replace the lift with hot-mix asphalt to meet specification requirements, at no additional cost to the Government. Diamond grinding may be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted.

3.11.8 Surface Smoothness

The Contractor shall use the straightedge method to test and evaluate the surface course smoothness of the pavement. All testing shall be performed in the presence of the Contracting Officer. Detailed notes of the results of the testing shall be kept and a copy furnished to the Government

immediately after each day's testing. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), the surface shall be finished to meet the approval of the Contracting Officer.

3.11.8.1 Smoothness Requirements

a. Straightedge Testing: The finished surfaces of the pavements shall have no abrupt change of 6 mm or more, and all pavements shall be within the tolerances specified in Table 9 when checked with an approved 4 m straightedge.

Table 9. Straightedge Surface Smoothness--Pavements

Pavement Category	Direction of Testing	Tolerance, mm
All paved areas	Longitudinal	6
	Transverse	6

3.11.8.2 Testing Method

After the final rolling, but not later than 24 hours after placement, the surface of the pavement in each entire lot shall be tested by the Contractor in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. [AM #2]_____ If any pavement areas are ground, these areas shall be retested immediately after grinding. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines. The transverse lines shall be 8 m or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane for lines less than 6.1 m and at the third points for lanes 6.1 m or greater. Other areas having obvious deviations shall also be tested. Longitudinal testing lines shall be continuous across all joints.

a. Straightedge Testing. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.

3.11.8.3 [AM #2] Not Used

-- End of Section --

SECTION 03300

CAST-IN-PLACE STRUCTURAL CONCRETE
09/95

AMENDMENT 0002

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 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.2	(1998) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 213R	(1987) Guide for Structural Lightweight Aggregate Concrete
ACI 214.3R	(1988) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 301	(1996) Standard Specifications for Structural Concrete
ACI 303R	(1991) Guide to Cast-In-Place Architectural Concrete Practice
ACI 305R	(1991) Hot Weather Concreting
ACI 318/318R	(1999) Building Code Requirements for Structural Concrete and Commentary

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991; R 1996) Burlap Cloth Made From Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31/C 31M	(1998) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(19999a) Concrete Aggregates
ASTM C 39	(1996) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	(1999) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 78	(1994) Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
ASTM C 94	(1999) Ready-Mixed Concrete
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 143	(1998) Slump of Hydraulic Cement Concrete
ASTM C 150	(1998a) Portland Cement
ASTM C 171	(1997a)

Sheet Materials for Curing Concrete

ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 173	(1994ael) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192/C 192M	(1998) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1997el) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1998) Air-Entraining Admixtures for Concrete
ASTM C 309	(1998a) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 330	(1999) Lightweight Aggregates for Structural Concrete
ASTM C 494	(1999) Chemical Admixtures for Concrete
ASTM C 496	(1996) Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 567	(1999a) Unit Weight of Structural Lightweight Concrete
ASTM C 578	(1995) Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(1994) Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 595	(1998) Blended Hydraulic Cements
ASTM C 595M	(1997) Blended Hydraulic Cements (Metric)
ASTM C 618	(1999) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 685	(1998a) Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C 881	(1999) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 937	(1997) Grout Fluidifier for Preplaced-Aggregate Concrete

ASTM C 940	(1998a) Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C 989	(1999) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1017	(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 1116	(1995) Fiber-Reinforced Concrete and Shotcrete
ASTM C 1240	(1999) Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar and Grout
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM D 1751	(1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996el) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E 96	(1995) Water Vapor Transmission of Materials
ASTM E 1155	(1996) Determining Floor Flatness and Levelness Using the F-Number System
ASTM E 1155M	(1996) Determing Floor Flatness and Levelness Using the F-Number System (Metric)

CORPS OF ENGINEERS (COE)

COE CRD-C 94	(1995) Surface Retarders
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
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
COE CRD-C 540	(1971; R 1981) Standard Specification for Nonbituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

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
NRMCA TMMB 100	(1994) Truck Mixer Agitator and Front Discharge Concrete Carrier Standards
NRMCA QC 3	(1984) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

1.2 UNIT PRICE CONTRACT

1.2.1 Measurement

Measurement of concrete for payment will be made on the basis of the actual volume within the pay lines of the structure as indicated on the contract drawings. Measurement for payment of concrete placed against the sides of any excavation without intervening forms will be made only within the pay lines of the structure as shown on the contract drawings. No deductions will be made for rounded or beveled edges, for space occupied by metal work, for conduits, for voids, or for embedded items which are less than 0.15 cubic meters in volume or 0.09 square meters in cross section.

1.2.2 Payment

Unless otherwise specified, payment for concrete will be made at the respective unit prices per cubic meter for the various items of the schedule, measured as specified above, which price shall include the cost of all labor, materials, and the use of equipment and tools required to complete the concrete work, except for any reinforcement and embedded parts specified to be paid separately. Unit price payment will not be made for concrete placed in structures for which payment is made as a lump sum.

1.3 LUMP SUM CONTRACT

Under this type of contract concrete items will be paid for by lump sum and will not be measured. The work covered by these items consists of furnishing all concrete materials, reinforcement, miscellaneous embedded materials, and equipment, and performing all labor for the forming, manufacture, transporting, placing, finishing, curing, and protection of concrete in these structures.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Mixture Proportions; G, FIO

The results of trial mixture design studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of ingredients that will be used in the manufacture of each strength or class of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an approved independent commercial testing laboratory, showing that mixture design studies have been made with materials proposed for the project and that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the mixture design studies without additional tests to show that the quality of the concrete is satisfactory.

Lightweight Aggregate Concrete; FIO,

Written recommendations from lightweight aggregate supplier on batching and mixing cycles.

Dry Shake Finish; FIO,

Manufacturer's written instructions on application of dry shake material 15 days prior to start of construction.

SD-04 Samples

Surface Retarder; FIO,

Sample of surface retarder material with manufacturer's instructions for application in conjunction with air-water cutting.

SD-06 Test Reports

Testing and Inspection for Contractor Quality Control; G, FIO

Certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.

SD-07 Certificates

Qualifications; FIO,

Written documentation for Contractor Quality Control personnel.

1.5 QUALIFICATIONS

Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the following grades or shall have written evidence of having completed similar qualification programs:

Concrete Field Testing Technician, Grade I
Concrete Laboratory Testing Technician, Grade I or II
Concrete Construction Inspector, Level II

Concrete Transportation Construction Inspector or
Reinforced Concrete Special Inspector, Jointly certified by American Concrete Institute (ACI), Building Official and Code Administrators International (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International (SBCCI).

The foreman or lead journeyman of the flatwork finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher or equal, with written documentation.

1.6 FIELD TEST PANELS

Field test panels shall be constructed prior to beginning of work using the materials and procedures proposed for use on the job, to demonstrate the results to be attained. The quality and appearance of each panel shall be subject to the approval of the Contracting Officer, and, if not judged satisfactory, additional panels shall be constructed until approval is attained. Formed or finished surfaces in the completed structure shall match the quality and appearance of the approved field example.

1.6.1 Sample Wall Panels

One sample panel at least 1220 mm by 1525 mm and 150 mm thick shall be constructed to demonstrate Class A formed finish and a similar one for Class B formed finish. Panels shall be located in an area approved by the Contracting Officer. Each panel shall include a full length and full width joint line and shall have at least two voids each at least 300 mm by 300 mm by 75 mm deep either impressed in the concrete as placed or chipped in the hardened concrete. After the concrete is 7 days old, the voids shall be patched to demonstrate the effectiveness and the appearance of the Contractor's repair procedures.

1.6.2 Slab Panels

A slab panel at least 1220 mm by 1525 mm and 100 mm thick shall be constructed to demonstrate exposed aggregate slab finish and a similar panel for extra high class slab finish. Panels shall be located in an area approved by the Contracting Officer. Each panel shall have a full length joint line.

1.7 SPECIAL REQUIREMENTS

A pre-installation meeting with the Contracting Officer will be required at least 10 days prior to start of construction on any concrete work. The Contractor shall be responsible for calling the meeting; the Project Superintendent and active installation personnel shall be present.

1.8 GENERAL REQUIREMENTS

1.8.1 Tolerances

Except as otherwise specified herein, tolerances for concrete batching, mixture properties, and construction as well as definition of terms and application practices shall be in accordance with 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.

1.8.1.1 Floors

For the purpose of this Section the following terminology correlation between ACI 117/117R and this Section shall apply:

Floor Profile Quality Classification From ACI 117/117R	This Section
Conventional Bullfloated	Same
Conventional Straightedged	Same
Flat	Float Finish or Trowel Finish
Very Flat	Same. Use only with F-system

Levelness tolerance shall not apply where design requires floors to be

sloped to drains or sloped for other reasons.

1.8.1.2 Floors by the F-Number System

The flatness and levelness of floors shall be carefully controlled and the tolerances shall be measured by the F-Number system of Paragraph 4.5.6 and 4.5.6.1 of ACI 117/117R. The Contractor shall furnish an approved floor profilograph or other equipment capable of measuring the floor flatness (FF) number and the floor levelness (FL) number in accordance with ASTM E 1155M . The Contractor shall perform the tolerance measurements within 72 hours after floor slab construction while being observed by the Contracting Officer. The tolerances of surfaces beyond the limits of ASTM E 1155M (the areas within 600 mm of embedments and construction joints) shall be acceptable to the Contracting Officer. Tolerances of the following areas shall meet the requirements for the listed surfaces as specified in paragraphs 4.5.6 and 4.5.6.1 of ACI 117/117R.

Bullfloated-	Areas ALL
Straightedged-	Areas ALL
Float Finish-	Areas ALL
Trowel Finish-	Areas ALL
Very Flat-	Areas NONE

1.8.1.3 Floors by the Straightedge System

The flatness of the floors shall be carefully controlled and the tolerances shall be measured by the straightedge system as specified in paragraph 4.5.7 of ACI 117/117R, using a 3 m straightedge, within 72 hours after floor slab installation and before shores and/or forms are removed. The listed tolerances shall be met at any and every location at which the straightedge can be placed.

Bullfloated	13
Straightedged	8
Float Finish	5
Trowel Finish	3

1.8.2 Strength Requirements and w/c Ratio

1.8.2.1 Strength Requirements

Specified compressive strength (f'c) shall be as follows:

COMPRESSIVE STRENGTH	STRUCTURE OR PORTION OF STRUCTURE
(AM 0002) 28 MPa at 28 days	for concrete for maintenance pit.
21 MPa at 28 days	for all other concrete except concrete at vehicular slabs.

(

Concrete slabs on-grade shall have a 28-day flexural strength of 4.5 MPa. Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II

portland cement. Compressive strength shall be determined in accordance with ASTM C 39. Flexural strength shall be determined in accordance with ASTM C 78.

a. Evaluation of Concrete Compressive Strength. Compressive strength specimens (152 by 305 mm cylinders) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31/C 31M 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 3.5 MPa. 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 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.

b. Investigation of Low-Strength Compressive Test Results. When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 3.5 MPa 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. 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 strength 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. Non-destructive tests (tests other than test cylinders or cores) shall not be used as a basis for acceptance or rejection. The Contractor shall perform the coring and repair the holes. Cores will be tested by the Government.

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 as being understrength shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed by and at the expense of the Contractor and must be approved by the Contracting Officer, except that if all concrete is found to be in compliance with the drawings and specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.

d. Evaluation of Concrete Flexural Strength. Flexural strength specimens (beams) shall be fabricated by the Contractor and laboratory cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 78. 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 flexural strength and no individual test result falls below the specified flexural strength by more than 350 kPa.A "test" is defined as the average of two companion beams. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the slab is considered potentially deficient.

1.8.2.2 Water-Cement Ratio

Maximum water-cement ratio (w/c) for normal weight concrete shall be as follows:

WATER-CEMENT RATIO, BY WEIGHT	STRUCTURE OR PORTION OF STRUCTURE
0.50	All areas unless noted otherwise.

These w/c's may cause higher strengths than that required above for compressive or flexural strength. The maximum w/c required will be the equivalent w/c as determined by conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast furnace slag (GGBF slag) by the weight equivalency method as described in ACI 211.1. In the case where silica fume or GGBF slag is used, the weight of the silica fume and GGBF slag shall be included in the equations of ACI 211.1 for the term P which is used to denote the weight of pozzolan.

1.8.3 Air Entrainment

Except as otherwise specified for lightweight concrete, all normal weight concrete shall be air entrained to contain between 4 and 7 percent total air, except that when the nominal maximum size coarse aggregate is 19 mm or smaller it shall be between 4.5 and 7.5 percent. Concrete with specified strength over 35 MPa may have 1.0 percent less air than specified above. Specified air content shall be attained at point of placement into the forms. Air content for normal weight concrete shall be determined in accordance with ASTM C 231. .

1.8.4 Slump

Slump of the concrete, as delivered to the point of placement into the forms, shall be within the following limits. Slump shall be determined in accordance with ASTM C 143.

Structural Element	Slump Minimum	Slump Maximum
Walls, columns and beams	50 mm	100 mm
Foundation walls, substructure walls, footings, slabs	25 mm	75 mm
Any structural concrete approved for placement by pumping:		
At pump	50 mm	150 mm
At discharge of line	25 mm	100 mm

When use of a plasticizing admixture conforming to ASTM C 1017 or when a Type F or G high range water reducing admixture conforming to ASTM C 494 is permitted to increase the slump of concrete, concrete shall have a slump of 50 to 100 mm before the admixture is added and a maximum slump of 200 mm at the point of delivery after the admixture is added.

1.8.5 Concrete Temperature

The temperature of the concrete as delivered shall not exceed 32 degrees C. When the ambient temperature during placing is 5 degrees C or less, or is expected to be at any time within 6 hours after placing, the temperature of the concrete as delivered shall be between 12 and 25 degrees C.

1.8.6 Size of Coarse Aggregate

The largest feasible nominal maximum size aggregate (NMSA) specified in paragraph AGGREGATES shall be used in each placement. However, nominal maximum size of aggregate shall not exceed any of the following: three-fourths of the minimum cover for reinforcing bars, three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

1.8.7 Special Properties and Products

Concrete may contain admixtures other than air entraining agents, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if specified or approved. Any of these materials to be used on the project shall be used in the mix design studies.

1.8.8 Technical Service for Specialized Concrete

The services of a factory trained technical representative shall be obtained to oversee proportioning, batching, mixing, placing, consolidating, and finishing of specialized structural concrete, such as the use of admixtures in concrete. The technical representative shall be on the job full time until the Contracting Officer is satisfied that field controls indicate concrete of specified quality is furnished and that the Contractor's crews are capable of continued satisfactory work. The

technical representative shall be available for consultation with, and advice to, Government forces.

1.9 MIXTURE PROPORTIONS

Concrete shall be composed of portland cement, other cementitious and pozzolanic materials as specified, aggregates, water and admixtures as specified.

1.9.1 Proportioning Studies for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified shall be the responsibility of the Contractor. Except as specified for flexural strength concrete, mixture proportions shall be based on compressive strength as determined by test specimens fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 39. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use in the project and shall be accompanied by the manufacturer's or producer's test reports indicating compliance with these specifications. 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 for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratios required in subparagraph Water-Cement Ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast furnace slag (GGBF slag) by the weight equivalency method as described in ACI 211.1. In the case where silica fume or GGBF slag is used, the weight of the silica fume and GGBF slag shall be included in the equations in ACI 211.1 for the term P, which is used to denote the weight of pozzolan. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent by weight of the total cementitious material, and the maximum shall be 35 percent. Laboratory trial mixtures shall be designed for maximum permitted slump and air content. Separate sets of trial mixture studies shall be made for each combination of cementitious materials and each combination of admixtures proposed for use. No combination of either shall be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerator or a retarder may be used without separate trial mixture study. Separate trial mixture studies shall also be made for concrete for any conveying or placing method proposed which requires special properties and for concrete to be placed in unusually difficult placing locations. 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 withASTM C 192/C 192M. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, a curve shall be plotted showing the relationship between 7 day and 28 day strengths. Each mixture shall be designed to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding.

1.9.2 Proportioning Studies for Flexural Strength Concrete

Trial design batches, mixture proportioning studies, and testing requirements shall conform to the requirements specified in paragraph Proportioning Studies for Normal Weight Concrete, except that proportions shall be based on flexural strength as determined by test specimens (beams) fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 78. Procedures given in ACI 211.1 shall be modified as necessary to accommodate flexural strength.

1.9.3 Proportioning Studies for Lightweight Aggregate Structural Concrete

Trial design batches, mixture proportioning studies, and testing requirements shall conform to the requirements specified in paragraph Proportioning Studies for Normal Weight Concrete, except as follows. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 211.2, using at least three different cement contents. Trial mixes shall be proportioned to produce air dry unit weight and concrete strengths specified in paragraph GENERAL REQUIREMENTS. Trial mixtures shall be proportioned for maximum permitted slump and air content. Test specimens and testing shall be as specified for normal weight concrete except that shall be determined from test cylinders that have been air dried at 50 percent relative humidity for the last 21 days. Air dry unit weight shall be determined in accordance with ASTM C 567 and shall be designed to be at least 32 kg per cubic meter less than the maximum specified air dry unit weight in paragraph GENERAL REQUIREMENTS. Curves shall be plotted using these results showing the relationship between cement factor and strength and air dry unit weight. Normal weight fine aggregate may be substituted for part or all of the lightweight fine aggregate, provided the concrete meets the strength and unit weight. A correlation shall also be developed showing the ratio between air dry unit weight and fresh concrete unit weight for each mix.

1.9.4 Average Compressive Strength Required for Mixtures

The mixture proportions selected during mixture design studies shall produce a required average compressive strength (f'cr) exceeding the specified compressive strength (f'c) by the amount indicated below. This required average compressive strength, f'cr, will not be a required acceptance criteria during concrete production. However, whenever the daily average compressive strength at 28 days drops below f'cr during concrete production, or daily average 7-day strength drops below a strength correlated with the 28-day f'cr, the mixture shall be adjusted, as approved, to bring the daily average back up to f'cr. During production, the required f'cr shall be adjusted, as appropriate, based on the standard deviation being attained on the job.

1.9.4.1 Computations 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 214.3R. 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 7 MPa 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. 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 where units are in MPa

f'cr = f'c + 2.33S - 3.45 where units are in MPa

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
15	1.16
20	1.08
25	1.03
30 or more	1.00

1.9.4.2 Computations 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 f'cr shall be determined as follows:

a. If the specified compressive strength f'c is less than 20 MPa,

f'cr = f'c + 6.9 MPa

b. If the specified compressive strength f'c is 20 to 35 MPa,

f'cr = f'c + 8.3 MPa

c. If the specified compressive strength f'c is over 35 MPa,

f'cr = f'c + 9.7 MPa

1.9.5 Average Flexural Strength Required for Mixtures

The mixture proportions selected during mixture design studies for flexural strength mixtures and the mixture used during concrete production shall be designed and adjusted during concrete production as approved, except that the overdesign for average flexural strength shall simply be 15 percent greater than the specified flexural strength at all times.

1.9.6 Mix Design for Bonded Topping for Heavy Duty Floors

The concrete mix design for bonded topping for heavy duty floors shall contain the greatest practical proportion of coarse aggregate within the specified proportion limits. The mix shall be designed to produce concrete having a 28-day strength of at least 34.5 MPa. Concrete for the topping shall consist of the following proportions, by weight:

1.00 part portland cement
1.15 to 1.25 parts fine aggregate
1.80 to 2.00 parts coarse aggregate

Maximum w/c shall be 0.33. The topping concrete shall not be air-entrained. The concrete shall be mixed so as to produce a mixture of the driest consistency possible to work with a sawing motion of the strike-off and which can be floated and compacted as specified without producing water or excess cement at the surface. In no case shall slump exceed 25 mm as determined by ASTM C 143.

1.10 STORAGE OF MATERIALS

Cement and other cementitious materials shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants and keep each material completely separated. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. Materials shall be capable of being accurately identified after bundles or containers are opened.

1.11 GOVERNMENT ASSURANCE INSPECTION AND TESTING

Day-to day inspection and testing shall be the responsibility of the Contractor Quality Control (CQC) staff. However, representatives of the Contracting Officer can and will inspect construction as considered appropriate and will monitor operations of the Contractor's CQC staff. Government inspection or testing will not relieve the Contractor of any of his CQC responsibilities.

1.11.1 Materials

The Government will sample and test aggregates, cementitious materials,

other materials, and concrete to determine compliance with the specifications as considered appropriate. 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. Other materials will be sampled from storage at the jobsite or from other locations as considered appropriate. Samples may be placed in storage for later testing when appropriate.

1.11.2 Fresh Concrete

Fresh concrete will be sampled as delivered in accordance with ASTM C 172 and tested in accordance with these specifications, as considered necessary.

1.11.3 Hardened Concrete

Tests on hardened concrete will be performed by the Government when such tests are considered necessary.

1.11.4 Inspection

Concrete operations may be tested and inspected by the Government as the project progresses. Failure to detect defective work or material will not prevent rejection later when a defect is discovered nor will it obligate the Government for final acceptance.

PART 2 PRODUCTS

2.1 CEMENTITIOUS MATERIALS

Cementitious Materials shall be portland cement, portland-pozzolan cement, or portland cement in combination with pozzolan and shall conform to appropriate specifications listed below. Use of cementitious materials in concrete which will have surfaces exposed in the completed structure shall be restricted so there is no change in color, source, or type of cementitious material.

2.1.1 Portland Cement

ASTM C 150, Type I low alkali with a maximum 15 percent amount of tricalcium aluminate, or Type II low alkali including false set requirements or Type V. White portland cement shall meet the above requirements except that it may be Type I, Type II or Type III low alkali. White Type III shall be used only in specific areas of the structure, when approved in writing.

2.1.2 High-Early-Strength Portland Cement

ASTM C 150, Type III with tricalcium aluminate limited to 5 percent, low alkali. Type III cement shall be used only in isolated instances and only when approved in writing.

2.1.3 Blended Cements

ASTM C 595M , Type IP IS .

2.1.4 Pozzolan (Fly Ash)

ASTM C 618, Class F with the optional requirements for multiple factor, drying shrinkage, and uniformity from Table 2A of ASTM C 618. Requirement for maximum alkalies from Table 1A of ASTM C 618 shall apply. If pozzolan is used, it shall never be less than 15 percent nor more than 35 percent by weight of the total cementitious material.

2.1.5 Ground Granulated Blast-Furnace (GGBF) Slag

ASTM C 989, Grade 120.

2.1.6 Silica Fume

Silica fume shall conform to ASTM C 1240. Available alkalies shall conform to the optimal limit given in Table 2 of ASTM C 1240. Silica fume may be furnished as a dry, densified material or as a slurry. In accordance with paragraph Technical Service for Specialized Concrete, the Contractor shall provide at no cost to the Government the services of a manufacturer's technical representative experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume.

2.2 AGGREGATES

Aggregates shall conform to the following.

2.2.1 Fine Aggregate

Fine aggregate shall conform to the quality and gradation requirements of ASTM C 33.

2.2.2 Coarse Aggregate

(AM 0002) Coarse aggregate shall conform to ASTM C 33, Class 3S, size designation 57.

2.2.3 Materials for Bonded Topping for Heavy Duty Floors

In addition to the requirements specified above, coarse aggregate used for this purpose shall be a well graded, hard, sound diabase, trap rock, emery, granite or other natural or manufactured aggregate having equivalent hardness and wearing qualities and shall have a percentage of loss not to exceed 30 after 500 revolutions when tested in accordance with ASTM C 131. Gradation of the aggregates when tested in accordance with ASTM C 136 shall be as follows:

Coarse Aggregate

Sieve Size	Cumulative Percent By Weight Passing
19 mm	100
12.5 mm	50-100
9.5 mm	25-50
4.75 mm	0-15
2.36 mm	0-8

Fine Aggregate

Sieve Size	Cumulative Percent By Weight Passing
9.5 mm	100
4.75 mm	95-100
2.36 mm	65-80
1.18 mm	45-65
0.600 mm	25-45
0.300 mm	5-15
0.150 mm	0-5

2.3 CHEMICAL ADMIXTURES

Chemical admixtures, when required or permitted, shall conform to the appropriate specification listed. Admixtures shall be furnished in liquid form and of suitable concentration for easy, accurate control of dispensing.

2.3.1 Air-Entraining Admixture

ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions.

2.3.2 Accelerating Admixture

ASTM C 494, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

2.3.3 Water-Reducing or Retarding Admixture

ASTM C 494, Type A, B, or D, except that the 6-month and 1-year compressive and flexural strength tests are waived.

2.3.4 High-Range Water Reducer

ASTM C 494, Type F or G, except that the 6-month and 1-year strength requirements are waived. The admixture shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of

separate mixture design studies.

2.3.5 Surface Retarder

COE CRD-C 94.

2.3.6 Expanding Admixture

Aluminum powder type expanding admixture conforming to ASTM C 937.

2.3.7 Other Chemical Admixtures

Chemical admixtures for use in producing flowing concrete shall comply with ASTM C 1017, Type I or II. These admixtures shall be used only when approved in writing, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan and upon performance of separate mixture design studies.

2.4 CURING MATERIALS

2.4.1 Impervious-Sheet

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

2.4.2 Membrane-Forming Compound

Membrane-Forming curing compound shall conform to ASTM C 309, Type 1-D or 2, except that only 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, waterproofing, or flooring specified. Nonpigmented compound shall contain a fugitive dye, and shall have the reflective requirements in ASTM C 309 waived.

2.4.3 Burlap and Cotton Mat

Burlap and cotton mat used for curing shall conform to AASHTO M 182.

2.5 WATER

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

2.6 NONSHRINK GROUT

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

2.7 NONSLIP SURFACING MATERIAL

Nonslip surfacing material shall consist of 55 percent, minimum, aluminum oxide or silicon-dioxide abrasive ceramically bonded together to form a homogeneous material sufficiently porous to provide a good bond with portland cement paste; or factory-graded emery aggregate consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. The aggregate shall be well graded from particles retained on the 0.6 mm sieve to particles passing the 2.36 mm sieve.

2.8 LATEX BONDING AGENT

Latex agents for bonding fresh to hardened concrete shall conform to ASTM C 1059.

2.9 EPOXY RESIN

Epoxy resins for use in repairs shall conform to ASTM C 881, Type V, Grade 2. Class as appropriate to the existing ambient and surface temperatures.

2.10 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application. Dovetail slots shall be galvanized steel. Hangers for suspended ceilings shall be as specified in Section 09510 ACOUSTICAL CEILINGS. Inserts for shelf angles and bolt hangers shall be of malleable iron or cast or wrought steel.

2.11 FLOOR HARDENER

Floor hardener shall be a colorless aqueous solution containing zinc silicofluoride, magnesium silicofluoride, or sodium silicofluoride. These silicofluorides can be used individually or in combination. Proprietary hardeners may be used if approved in writing by the Contracting Officer.

2.12 PERIMETER INSULATION

Perimeter insulation shall be polystyrene conforming to ASTM C 578, Type II; polyurethane conforming to ASTM C 591, Type II; or cellular glass conforming to ASTM C 552, Type I or IV.

2.13 VAPOR BARRIER

Vapor barrier shall be polyethylene sheeting with a minimum thickness of 0.15 mm (6 mils) or other equivalent material having a vapor permeance rating not exceeding 30 nanograms per Pascal per second per square meter (0.5 perms) as determined in accordance with ASTM E 96.

2.14 JOINT MATERIALS

2.14.1 Joint Fillers, Sealers, and Waterstops

Expansion joint fillers shall be preformed materials conforming to ASTM D 1751 . Materials for waterstops shall be in accordance with Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS. Materials for and sealing of joints shall conform to the requirements of Section 02760 FIELD

MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS .

2.14.2 Contraction Joints in Slabs

Sawable type contraction joint inserts shall conform to COE CRD-C 540. Nonsawable joint inserts shall have sufficient stiffness to permit placement in plastic concrete without undue deviation from a straight line and shall conform to the physical requirements of COE CRD-C 540, with the exception of Section 3.4 "Resistance to Sawing". Plastic inserts shall be polyvinyl chloride conforming to the materials requirements of COE CRD-C 572.

2.15 SYNTHETIC FIBERS FOR REINFORCING

Synthetic fibers shall conform to ASTM C 1116, Type III, Synthetic Fiber, and as follows. Fibers shall be 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials. Fibers shall have a specific gravity of 0.9, a minimum tensile strength of 480 MPa graded per manufacturer, and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement.

2.16 DRY SHAKE FLOOR TOPPING MATERIAL

Dry shake floor topping material shall be a premixed ready-to-use dry shake. It shall be proportioned, mixed and packaged at the factory, and delivered to the jobsite in sealed, moisture resistant bags, ready to apply, finish and cure. The manufacturer of the dry shake material shall have at least 10 years experience in the manufacture of such material. Any material from a manufacturer who makes any disclaimer of the materials performance shall not be used.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

Before commencing concrete placement, the following shall be performed. Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Forms shall be in place, cleaned, coated, and adequately supported, in accordance with Section 03100 STRUCTURAL CONCRETE FORMWORK. Reinforcing steel shall be in place, cleaned, tied, and adequately supported, in accordance with Section 03200 CONCRETE REINFORCEMENT. Transporting and conveying equipment shall be in-place, ready for use, clean, and free of hardened concrete and foreign material. Equipment for consolidating concrete shall be at the placing site and in proper working order. Equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the placing site, in proper working condition and in sufficient amount for the entire placement. When hot, windy conditions during concreting appear probable, equipment and material shall be at the placing site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

3.1.1 Foundations

3.1.1.1 Concrete on Earth Foundations

Earth (subgrade, base, or subbase courses) 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 foundation shall be well drained and shall be satisfactorily graded and uniformly compacted.

3.1.1.2 Preparation of Rock

Rock surfaces upon which concrete is to be placed shall be 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, rock surfaces shall be cleaned thoroughly by the use of air-water jets or sandblasting as specified below for Previously Placed Concrete. Rock surfaces shall be kept continuously moist for at least 24 hours immediately prior to placing concrete thereon. All horizontal and 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. Concrete shall be placed before the mortar stiffens.

3.1.1.3 Excavated Surfaces in Lieu of Forms

Concrete for footings may be placed directly against the soil provided the earth or rock has been carefully trimmed, is uniform and stable, and meets the compaction requirements of Section 02315EXCAVATION, FILLING, AND BACKFILLING FOR BUILDINGS. The concrete shall be placed without becoming contaminated by loose material, and the outline of the concrete shall be within the specified tolerances.

3.1.2 Previously Placed Concrete

Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next horizontal lift by cleaning the construction joint surface with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Concrete at the side of vertical construction joints shall be prepared as approved by the Contracting Officer. Air-water cutting shall not be used 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 surfaces of well bonded coarse aggregate are exposed and make up at least 10-percent of the surface area, distributed uniformly throughout the surface. The edges of the coarse aggregate shall not be undercut. The surface of horizontal construction joints shall be kept continuously wet for the first 12 hours during the 24-hour period prior to placing fresh concrete. The surface shall be washed completely clean as the last operation prior to placing the next lift. For heavy duty floors and two-course floors a thin coat of neat cement grout of about the consistency of thick cream shall be thoroughly scrubbed into the existing surface immediately ahead of the topping placing. The grout shall be a 1:1 mixture of portland cement and sand passing the 2.36 mm sieve. The topping concrete shall be deposited before the grout coat has had time to stiffen.

3.1.2.1 Air-Water Cutting

Air-water cutting of a fresh concrete surface shall be performed at the proper time and only on horizontal construction joints. The air pressure used in the jet shall be 700 kPa plus or minus, 70 kPa, 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 surface retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift in order to prolong the period of time during which air-water cutting is effective. 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 waterjet or sandblasting shall be used as the last operation before placing the next lift.

3.1.2.2 High-Pressure Water Jet

A stream of water under a pressure of not less than 20 MPa shall be used for cutting and 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 waterjet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

3.1.2.3 Wet Sandblasting

Wet sandblasting shall be used after the concrete has reached sufficient strength to prevent undercutting of the coarse aggregate particles. After wet sandblasting, the surface of the concrete shall then be washed thoroughly to remove all loose materials.

3.1.2.4 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.

3.1.2.5 Preparation of Previously Placed Concrete

Concrete surfaces to which other concrete is to be bonded shall be abraded in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be thoroughly washed and shall be moist but without free water when concrete is placed.

3.1.3 Vapor Barrier

Vapor barrier shall be provided beneath the interior on-grade concrete floor slabs. The greatest widths and lengths practicable shall be used to eliminate joints wherever possible. Joints shall be lapped a minimum of

300 mm. Torn, punctured, or damaged vapor barrier material shall be removed and new vapor barrier shall be provided prior to placing concrete. For minor repairs, patches may be made using laps of at least 300 mm. Lapped joints shall be sealed and edges patched with pressure-sensitive adhesive or tape not less than 50 mm wide and compatible with the membrane. Vapor barrier shall be placed directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular material which could puncture the vapor barrier. In this case, the surface shall be choked with a light layer of sand, as approved, before placing the vapor barrier. A 50 mm layer of compacted, clean concrete sand (fine aggregate) shall be placed on top of the vapor barrier before placing concrete. Concrete placement shall be controlled so as to prevent damage to the vapor barrier, or any covering sand.

3.1.4 Perimeter Insulation

Perimeter insulation shall be installed at locations indicated. Adhesive shall be used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

3.1.5 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. Conduit and other embedded items shall be clean and 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 shall not be performed on embedded metals within 300 mm of the surface of the concrete. Tack welding shall not be performed on or to embedded items.

3.2 CONCRETE PRODUCTION

3.2.1 Batching, Mixing, and Transporting Concrete

Concrete shall be batched and mixed onsite, or close to onsite, and shall conform to the following subparagraphs.

3.2.1.1 General

The batching plant shall be located on site in the general area indicated on the drawings . The batching, mixing and placing system shall have a capacity of at least 50 cubic meters per hour. The batching plant shall conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required.

3.2.1.2 Batching Equipment

The batching controls shall be semiautomatic or automatic, as defined in NRMCA CPMB 100. A 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 accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. The weight of water and admixtures shall be recorded if batched by weight. Separate bins or compartments shall be provided for each size group of aggregate and type of cementitious material, to prevent intermingling at any time. Aggregates shall be weighed either in separate weigh batchers with individual scales or, provided the smallest size is batched first, cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cementitious material. If both portland cement and other cementitious material are used, they may be batched cumulatively, provided that the portland cement is batched first, except that silica fume shall always be batched separately. Water may be measured by weight or volume. Water shall not be weighed or measured cumulatively with another ingredient. Filling and discharging valves for the water metering or batching system shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. Piping for water and for admixtures shall be free from leaks and shall be properly valved to prevent backflow or siphoning. Admixtures shall be furnished as a liquid of suitable concentration for easy control of dispensing. An adjustable, accurate, mechanical device for measuring and dispensing each admixture shall be provided. Each admixture dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and individually discharged automatically in a manner to obtain uniform distribution throughout the water as it is added to the batch in the specified mixing period. When use of truck mixers makes this requirement impractical, the admixture dispensers shall be interlocked with the sand batchers. Different admixtures shall not be combined prior to introduction in water and shall not be allowed to intermingle until in contact with the cement. Admixture dispensers shall have suitable devices to detect and indicate flow during dispensing or have a means for visual observation. 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, and for sampling and calibrating the dispensing of cementitious material, water, and admixtures. Filling ports for cementitious materials bins or silos shall be clearly marked with a permanent sign stating the contents.

3.2.1.3 Scales

The weighing equipment shall conform to the applicable requirements of CPMB Concrete Plant Standard, and 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. The tests shall be made at the specified frequency in the presence of a Government inspector. The weighing equipment shall be arranged so that the plant operator can conveniently observe all dials or indicators.

3.2.1.4 Batching Tolerances

(A) Tolerances with Weighing Equipment

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

(B) Tolerances with Volumetric Equipment

For volumetric batching equipment used for water and admixtures, the following tolerances shall apply to the required volume of material being batched:

MATERIAL	PERCENT OF REQUIRED MATERIAL
Water:	plus or minus 1 percent
Chemical admixtures:	0 to plus 6 percent

3.2.1.5 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the weights of the materials being batched.

3.2.1.6 Concrete Mixers

Mixers shall be stationary mixers or truck mixers. Mixers shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The 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.

3.2.1.7 Stationary Mixers

Concrete plant mixers shall be drum-type mixers of tilting, nontilting, horizontal-shaft, or vertical-shaft type, or shall be pug mill type 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 applicable to central-mixed concrete.

3.2.1.8 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity shall conform to the requirements of ASTM C 94. 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 is possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed. Water shall not be added at the placing site unless specifically approved; and in no case shall it exceed the specified w/c. Any such water shall be injected at the base of the mixer, not at the discharge end.

3.3 CONCRETE PRODUCTION, SMALL PROJECTS

Batch-type equipment shall be used for producing concrete. Ready-mixed concrete shall be batched, mixed, and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and nonagitating transporting units shall comply with NRMCA TMMB 100. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Approved batch tickets shall be furnished for each load of ready-mixed concrete. Site-mixed concrete shall be produced in accordance with ACI 301, and plant shall conform to NRMCA CPMB 100.

3.4 LIGHTWEIGHT AGGREGATE CONCRETE

In addition to the requirements specified for normal weight concrete, lightweight aggregate concrete shall conform to the following. The batching and mixing cycle shall be as directed based on written recommendations from the aggregate supplier which the Contractor shall furnish. Unless otherwise directed, the mixer shall be charged with approximately 2/3 of the total mixing water and all of the aggregate. This shall be mixed for at least 1-1/2 minutes in a stationary mixer or 15 revolutions at mixing speed in a truck mixer. The remaining ingredients shall then be added and mixing continued as specified for normal weight concrete. Lightweight aggregate concrete shall not be vibrated to the extent that large particles of aggregate float to the surface. During finishing, lightweight aggregate concrete shall not be worked to the extent that mortar is driven down and lightweight coarse aggregate appears at the surface. Lightweight aggregate concrete to be pumped shall have a cement content of at least 335 kg per cubic meter. A field trial run of lightweight aggregate concrete placement and finishing shall be made in accordance with ACI 213R.

3.5 FIBER REINFORCED CONCRETE

Fiber reinforced concrete shall conform to ASTM C 1116 and as follows, using the fibers specified in PART 2. A minimum of 0.9 kg of fibers per cubic m of concrete shall be used. Fibers shall be added at the batch plant. The services of a qualified technical representative shall be provided to instruct the concrete supplier in proper batching and mixing of materials to be provided.

3.6 TRANSPORTING CONCRETE TO PROJECT SITE

Concrete shall be transported to the placing site in truck mixers, or by approved pumping equipment . Nonagitating equipment, other than pumps, shall not be used for transporting lightweight aggregate concrete.

3.7 CONVEYING CONCRETE ON SITE

Concrete shall be conveyed from mixer or transporting unit to forms as rapidly as possible and within the time interval specified by methods which will prevent segregation or loss of ingredients using following equipment. Conveying equipment shall be cleaned before each placement.

3.7.1 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 5 times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 0.2 square meters.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 1.5 cubic meters 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.

3.7.2 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 shall 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.

3.7.3 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. Nonagitating equipment shall be used only for transporting plant-mixed concrete over a smooth road and 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.

3.7.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes normally 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.

3.7.5 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, such as discharge baffle or hopper , 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 900 mm. The belt speed shall be a minimum of 90 meters per minute and a maximum of 225 meters 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 truck that is long enough to extend through the reinforcing bars.

3.7.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure type; pneumatic placing equipment shall not be used. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least 3 times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 100 mm. Aluminum pipe shall not be used.

3.8 PLACING CONCRETE

Mixed concrete shall be discharged within 1-1/2 hours or before the mixer drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. When the concrete temperature exceeds 30 degrees C, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the transporting unit. Concrete shall be handled from mixer or transporting unit to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Sufficient placing capacity shall be provided so that concrete can be kept free of cold joints.

3.8.1 Depositing Concrete

Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 1.5 meters except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 300 mm thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level. Concrete shall be deposited continuously in one layer or in layers so that fresh concrete is deposited on in-place concrete that is still plastic. Fresh concrete shall not be deposited on concrete that has hardened sufficiently to cause formation of seams or planes of weakness within the section. Concrete that has surface dried, partially hardened, or contains foreign material shall not be used. When temporary spreaders are used in the forms, the spreaders shall be removed as their service becomes unnecessary. Concrete shall not be placed in slabs over columns and walls until concrete in columns and walls has been in-place at least two hours or until the concrete begins to lose its plasticity. Concrete

for beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as concrete for adjoining slabs.

3.8.2 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 100 mm thick or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 10,000 vibrations per minute, an amplitude of at least 0.6 mm, and the head diameter shall be appropriate for the structural member and the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a reasonable amount. The vibrator shall penetrate rapidly to the bottom of the layer and at least 150 mm into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then vertically withdrawn slowly while operating. Form vibrators shall not be used unless specifically approved and unless forms are constructed to withstand their use. Vibrators shall not be used to move concrete within the forms. Slabs 100 mm and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique. Excessive vibration of lightweight concrete resulting in segration or flotation of coarse aggregate shall be prevented. Frequency and amplitude of vibrators shall be determined in accordance with COE CRD-C 521. Grate tampers ("jitterbugs") shall not be used.

3.8.3 Cold Weather Requirements

Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 5 degrees C. The temperature of the concrete when placed shall be not less than 10 degrees C nor more than 25 degrees C. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, an accelerating admixture conforming to ASTM C 494, Type C or E may be used, provided it contains no calcium chloride. Calcium chloride shall not be used.

3.8.4 Hot Weather Requirements

When the ambient temperature during concrete placing is expected to exceed 30 degrees C, the concrete shall be placed and finished with procedures previously submitted and as specified herein. The concrete temperature at time of delivery to the forms shall not exceed the temperature shown in the table below when measured in accordance with ASTM C 1064/C 1064M. Cooling of the mixing water or aggregates or placing concrete in the cooler part of the day may be required to obtain an adequate placing temperature. A

retarder may be used, as approved, to facilitate placing and finishing. Steel forms and reinforcements shall be cooled as approved prior to concrete placement when steel temperatures are greater than 49 degrees C. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature Degrees
Greater than 60	33 C
40-60	30 C
Less than 40	27 C

3.8.5 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, as well as interior placements when space heaters produce low humidity, the Contractor shall be alert to the tendency for plastic shrinkage cracks to develop and shall institute measures to prevent this. Particular care shall be taken if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Fig. 2.1.5 of ACI 305R. In addition the concrete placement shall be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding or wet covering. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin as directed, after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

3.8.6 Placing Concrete Underwater

Concrete shall be deposited in water by a tremie or concrete pump. The methods and equipment used shall be subject to approval. Concrete buckets shall not be used 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 concrete shall be deposited so that it enters the mass of the previously placed concrete from within, displacing water with a minimum disturbance to the surface of the concrete. The discharge end of the pump line or tremie shaft shall be kept continuously submerged in the concrete. The underwater seal at start of placing shall 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 of concrete will be limited to 5 m. Concrete shall not be deposited in running water or in water with a temperature below 2 degrees C.

3.8.7 Placing Concrete in Congested Areas

Special care shall be used to ensure complete filling of the forms, elimination of all voids, and complete consolidation of the concrete when placing concrete in areas congested with reinforcing bars, embedded items, waterstops and other tight spacing. An appropriate concrete mixture shall be used, and the nominal maximum size of aggregate (NMSA) shall meet the specified criteria when evaluated for the congested area. Vibrators with heads of a size appropriate for the clearances available shall be used, and the consolidation operation shall be closely supervised to ensure complete and thorough consolidation at all points. Where necessary, splices of reinforcing bars shall be alternated to reduce congestion. Where two mats of closely spaced reinforcing are required, the bars in each mat shall be placed in matching alignment to reduce congestion. Reinforcing bars may be temporarily crowded to one side during concrete placement provided they are returned to exact required location before concrete placement and consolidation are completed.

3.8.8 Placing Flowable Concrete

If a plasticizing admixture conforming to ASTM C 1017 is used or if a Type F or G high range water reducing admixture is permitted to increase the slump, the concrete shall meet all requirements of paragraph GENERAL REQUIREMENTS in PART 1. Extreme care shall be used in conveying and placing the concrete to avoid segregation. Consolidation and finishing shall meet all requirements of paragraphs Placing Concrete, Finishing Formed Surfaces, and Finishing Unformed Surfaces. No relaxation of requirements to accommodate flowable concrete will be permitted.

3.9 JOINTS

Joints shall be located and constructed as indicated or approved. Joints not indicated on the drawings shall be located and constructed to minimize the impact on the strength of the structure. In general, such joints shall be located near the middle of the spans of supported slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs, unless otherwise approved. Joints shall be perpendicular to the main reinforcement. All reinforcement shall be continued across joints; except that reinforcement or other fixed metal items shall not be continuous through expansion joints, or through construction or contraction joints in slabs on grade. Reinforcement shall be 50 mm clear from each joint. Except where otherwise indicated, construction joints between interior slabs on grade and vertical surfaces shall consist of 1.5 kg per square meter asphalt-saturated felt, extending for the full depth of the slab. The perimeters of the slabs shall be free of fins, rough edges, spalling, or other unsightly appearance. Reservoir for sealant for construction and contraction joints in slabs shall be formed to the dimensions shown on the drawings by removing snap-out joint-forming inserts, by sawing sawable inserts, or by sawing to widen the top portion of sawed joints. Joints to be sealed shall be cleaned and sealed as indicated and in accordance with Section 07900 JOINT SEALING.

3.9.1 Construction Joints

For concrete other than slabs on grade, construction joints shall be located so that the unit of operation does not exceed 18 meters. Concrete shall be placed continuously so that each unit is monolithic in construction. Fresh concrete shall not be placed against adjacent hardened concrete until it is at least 24 hours old. Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown. Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete begins to lose its plasticity, before placing concrete for beams, girders, or slabs thereon. In walls having door or window openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints in walls or columns are required, a strip of 25 mm square-edge lumber, bevelled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 25 mm above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph Previously Placed Concrete.

3.9.2 Contraction Joints in Slabs on Grade

Contraction joints shall be located and detailed as shown on the drawings. Contraction Joints shall be produced by forming a weakened plane in the concrete slab by use of rigid inserts impressed in the concrete during placing operations or sawing a continuous slot with a concrete saw. Regardless of method used to produce the weakened plane, it shall be 1/4 the depth of the slab thickness and between 3 and 5 mm wide. For saw-cut joints, cutting shall be timed properly with the set of the concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent ravelling of the edges of the saw cut. Cutting shall be completed before shrinkage stresses become sufficient to produce cracking. Reservoir for joint sealant shall be formed as previously specified.

3.9.3 Expansion Joints

Installation of expansion joints and sealing of these joints shall conform to the requirements of Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS and Section 07900 JOINT SEALING.

3.9.4 Waterstops

Waterstops shall be installed in conformance with the locations and details shown on the drawings using materials and procedures specified in Section 03150 EXPANSION JOINTS, CONTRACTION JOINTS, AND WATERSTOPS.

3.9.5 Dowels and Tie Bars

Dowels and tie bars shall be installed at the locations shown on the drawings and to the details shown, using materials and procedures specified in Section 03200 CONCRETE REINFORCEMENT and herein. Conventional smooth "paving" dowels shall be installed in slabs using approved methods to hold the dowel in place during concreting within a maximum alignment tolerance of 1 mm in 100 mm. "Structural" type deformed bar dowels, or tie bars, shall be installed to meet the specified tolerances. Care shall be taken during placing adjacent to and around dowels and tie bars to ensure there is no displacement of the dowel or tie bar and that the concrete completely embeds the dowel or tie bar and is thoroughly consolidated.

3.10 FINISHING FORMED SURFACES

Forms, form materials, and form construction are specified in Section 03100 STRUCTURAL CONCRETE FORMWORK. Finishing of formed surfaces shall be as specified herein. Unless another type of architectural or special finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired. 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 requires a Class A or B finish. Except for major defects, as defined hereinafter, surface defects shall be repaired as specified herein within 24 hours after forms are removed. Repairs of the so-called "plaster-type" will not be permitted in any location. Tolerances of formed surfaces shall conform to the requirements of ACI 117/117R. These tolerances apply to the finished concrete surface, not to the forms themselves; forms shall be set true to line and grade. Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter shall be repaired as specified in paragraph Damp-Pack Mortar Repair. Defects whose surface diameter is greater than their depth shall be repaired as specified in paragraph Repair of Major Defects. Repairs shall be finished flush with adjacent surfaces and with the same surface texture. The cement used for all repairs shall be a blend of job cement with white cement proportioned so that the final color after curing and aging will be the same as the adjacent concrete. Concrete with excessive honeycomb, or other defects which affect the strength of the member, will be rejected. Repairs shall be demonstrated to be acceptable and free from cracks or loose or drummy areas at the completion of the contract and, for Class A and B Finishes, shall be inconspicuous. Repairs not meeting these requirements will be rejected and shall be replaced.

3.10.1 Class A Finish and Class B Finish

Class A finish is required in the following areas, formed surfaces that will be permanently exposed to view. Class B finish is required in the following areas, formed surfaces that will not be exposed or backfilled against. Fins, ravelings, and loose material shall be removed, all surface defects over 12 mm in diameter or more than 12 mm deep, shall be repaired and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be

reamed and filled. Defects more than 12 mm in diameter shall be cut back to sound concrete, but in all cases at least 25 mm deep. The Contractor shall prepare a sample panel for approval (as specified in PART 1) before commencing repair, showing that the surface texture and color match will be attained. Metal tools shall not be used to finish repairs in Class A surfaces.

3.10.2 Class C and Class D Finish

Class C finish is required in the following areas, formed surfaces that will have soil backfill placed against it. Class D finish is required in the following areas, formed surfaces that will be permanently buried. Fins, ravelings, and loose material shall be removed, and, except as otherwise indicated or as specified in Section 03100 STRUCTURAL CONCRETE FORMWORK, holes left by removal of form ties shall be reamed and filled. Honeycomb and other defects more than 12 mm deep or more than 50 mm in diameter shall be repaired. Defects more than 50 mm in diameter shall be cut back to sound concrete, but in all cases at least 25 mm deep.

3.11 REPAIRS

3.11.1 Damp-Pack Mortar Repair

Form tie holes requiring repair and other defects whose depth is at least as great as their surface diameter but not over 100 mm shall be repaired by the damp-pack mortar method. Form tie holes shall be reamed and other similar defects shall be cut out to sound concrete. The void shall then be thoroughly cleaned, thoroughly wetted, brush-coated with a thin coat of neat cement grout and filled with mortar. Mortar shall be a stiff mix of 1 part portland cement to 2 parts fine aggregate passing the 1.18 mm sieve, and minimum amount of water. Only sufficient water shall be used to produce a mortar which, when used, will stick together on being molded into a ball by a slight pressure of the hands and will not exude water but will leave the hands damp. Mortar shall be mixed and allowed to stand for 30 to 45 minutes before use with remixing performed immediately prior to use. Mortar shall be thoroughly tamped in place in thin layers using a hammer and hardwood block. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. All holes shall be packed full. Damp-pack repairs shall be moist cured for at least 48 hours.

3.11.2 Repair of Major Defects

Major defects will be considered to be those more than 12 mm deep or, for Class A and B finishes, more than 12 mm in diameter and, for Class C and D finishes, more than 50 mm in diameter. Also included are any defects of any kind whose depth is over 100 mm or whose surface diameter is greater than their depth. Major defects shall be repaired as specified below.

3.11.2.1 Surface Application of Mortar Repair

Defective concrete shall be removed, and removal shall extend into completely sound concrete. Approved equipment and procedures which will not cause cracking or microcracking of the sound concrete shall be used.

If reinforcement is encountered, concrete shall be removed so as to expose the reinforcement for at least 50 mm on all sides. All such defective areas greater than 7800 square mm shall be outlined by saw cuts at least 25 mm deep. Defective areas less than 7800 square mm shall be outlined by a 25 mm deep cut with a core drill in lieu of sawing. All saw cuts shall be straight lines in a rectangular pattern in line with the formwork panels. After concrete removal, the surface shall be thoroughly cleaned by high pressure washing to remove all loose material. Surfaces shall be kept continually saturated for the first 12 of the 24 hours immediately before placing mortar and shall be damp but not wet at the time of commencing mortar placement. The Contractor, at his option, may use either hand-placed mortar or mortar placed with a mortar gun. If hand-placed mortar is used, the edges of the cut shall be perpendicular to the surface of the concrete. The prepared area shall be brush-coated with a thin coat of neat cement grout. The repair shall then be made using a stiff mortar, preshrunk by allowing the mixed mortar to stand for 30 to 45 minutes and then remixed, thoroughly tamped into place in thin layers. If hand-placed mortar is used, the Contractor shall test each repair area for drumminess by firm tapping with a hammer and shall inspect for cracks, both in the presence of the Contracting Officer's representative, immediately before completion of the contract, and shall replace any showing drumminess or cracking. If mortar placed with a mortar gun is used, the gun shall be a small compressed air-operated gun to which the mortar is slowly hand fed and which applies the mortar to the surface as a high-pressure stream, as approved. Repairs made using shotcrete equipment will not be accepted. The mortar used shall be the same mortar as specified for damp-pack mortar repair. If gun-placed mortar is used, the edges of the cut shall be beveled toward the center at a slope of 1:1. All surface applied mortar repairs shall be continuously moist cured for at least 7 days. Moist curing shall consist of several layers of saturated burlap applied to the surface immediately after placement is complete and covered with polyethylene sheeting, all held closely in place by a sheet of plywood or similar material rigidly braced against it. Burlap shall be kept continually wet.

3.11.2.2 Repair of Deep and Large Defects

Deep and large defects will be those that are more than 150 mm deep and also have an average diameter at the surface more than 450 mm or that are otherwise so identified by the Project Office. Such defects shall be repaired as specified herein or directed, except that defects which affect the strength of the structure shall not be repaired and that portion of the structure shall be completely removed and replaced. Deep and large defects shall be repaired by procedures approved in advance including forming and placing special concrete using applied pressure during hardening. Preparation of the repair area shall be as specified for surface application of mortar. In addition, the top edge (surface) of the repair area shall be sloped at approximately 20 degrees from the horizontal, upward toward the side from which concrete will be placed. The special concrete shall be a concrete mixture with low water content and low slump, and shall be allowed to age 30 to 60 minutes before use. Concrete containing a specified expanding admixture may be used in lieu of the above mixture; the paste portion of such concrete mixture shall be designed to have an expansion between 2.0 and 4.0 percent when tested in accordance

with ASTM C 940. A full width "chimney" shall be provided at the top of the form on the placing side to ensure filling to the top of the opening. A pressure cap shall be used on the concrete in the chimney with simultaneous tightening and revibrating the form during hardening to ensure a tight fit for the repair. The form shall be removed after 24 hours and immediately the chimney shall be carefully chipped away to avoid breaking concrete out of the repair; the surface of the repair concrete shall be dressed as required.

3.11.3 Resinous and Latex Material Repair

In lieu of the portland cement bonding coats specified above, an epoxy resin or a latex bonding agent may be used. .

3.12 FINISHING UNFORMED SURFACES

The finish of all unformed surfaces shall meet the requirements of paragraph Tolerances in PART 1, when tested as specified herein.

3.12.1 General

The ambient temperature of spaces adjacent to unformed surfaces being finished and of the base on which concrete will be placed shall be not less than 10 degrees C. In hot weather all requirements of paragraphs Hot Weather Requirements and Prevention of Plastic Shrinkage Cracking shall be met. Unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, with additional finishing as specified below, and shall be true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings, properly consolidated, and left true and regular. Unless otherwise shown on the drawings, exterior surfaces shall be sloped for drainage, as directed. Where drains are provided, interior floors shall be evenly sloped to the drains. 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 for any surfaces. The dusting of surfaces with dry cement or other materials or the addition of any water during finishing shall not be permitted. If bleedwater is present prior to finishing, the excess water shall be carefully dragged off or removed by absorption with porous materials such as burlap. During finishing operations, extreme care shall be taken to prevent over finishing or working water into the surface; this can cause "crazing" (surface shrinkage cracks which appear after hardening) of the surface. Any slabs with surfaces which exhibit significant crazing shall be removed and replaced. During finishing operations, surfaces shall be checked with a 10 foot straightedge, applied in both directions at regular intervals while the concrete is still plastic, to detect high or low areas.

3.12.2 Rough Slab Finish

As a first finishing operation for unformed surfaces and as final finish for slabs to receive mortar setting beds, the surface shall receive a rough slab finish prepared as follows. The concrete shall be uniformly placed across the slab area, consolidated as previously specified, and then

screeded with straightedge strikeoffs immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible. Side forms and screed rails shall be provided, rigidly supported, and set to exact line and grade. Allowable tolerances for finished surfaces apply only to the hardened concrete, not to forms or screed rails. Forms and screed rails shall be set true to line and grade. "Wet screeds" shall not be used.

3.12.3 Floated Finish

Slabs to receive more than a rough slab finish shall next be given a wood float finish. The screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. Then, after the concrete has stiffened so that it will withstand a man's weight without imprint of more than 6 mm and the water sheen has disappeared, it shall be floated to a true and even plane free of ridges. Floating shall be performed by use of suitable hand floats or power driven equipment. Sufficient pressure shall be used on the floats to bring a film of moisture to the surface. Hand floats shall be made of wood, magnesium, or aluminum. Lightweight concrete or concrete that exhibits stickiness shall be floated with a magnesium float. Care shall be taken to prevent over-finishing or incorporating water into the surface.

3.12.4 Troweled Finish

The following areas all building slabs shall be given a trowel finish. After floating is complete and after the surface moisture has disappeared, unformed surfaces shall be steel-troweled to a smooth, even, dense finish, free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. Additional trowelings shall be performed, either by hand or machine until the surface has been troweled 3 times, with waiting period between each. Care shall be taken to prevent blistering and if such occurs, troweling shall immediately be stopped and operations and surfaces corrected. A final hard steel troweling shall be done by hand, with the trowel tipped, and using hard pressure, when the surface is at a point that the trowel will produce a ringing sound. The finished surface shall be thoroughly consolidated and shall be essentially free of trowel marks and be uniform in texture and appearance. The concrete mixture used for troweled finished areas shall be adjusted, if necessary, in order to provide sufficient fines (cementitious material and fine sand) to finish properly.

3.12.5 Superflat Finish

None of the building slabs shall be constructed as superflat floors. Extreme care shall be taken to meet specified tolerances. If necessary, special heavy duty, laser guided machines built especially for this work shall be used and shall have experienced, factory-trained operators. Finishing operations shall include use of long-handled 3 meter "highway type" cutting straightedges plus any other tools necessary to meet the surface tolerance requirements.

3.12.6 Non-Slip Finish

Non-slip floors shall be constructed in accordance with the following subparagraphs.

3.12.6.1 Broomed

All permanently exposed slab surfaces on the exterior of the building shall be given a broomed finish. After floating, the surface shall be lightly steel troweled, and then carefully scored by pulling a coarse fiber push-type broom across the surface. Brooming shall be transverse to traffic or at right angles to the slope of the slab. After the end of the curing period, the surface shall be vigorously broomed with a coarse fiber broom to remove all loose or semi-detached particles.

3.12.6.2 Abrasive Aggregate

Areas as indicated on the drawings shall be given an abrasive aggregate finish. The concrete surface shall be given a float finish. Abrasive aggregate shall then immediately be uniformly sprinkled over the floated surface at a total rate of not less than 1.25 kg per square meter spread in two applications at right angles to each other. The surface shall then be troweled to a smooth, even finish that is uniform in texture and appearance and free from blemishes including trowels marks. Immediately after curing, cement paste and laitance covering the abrasive aggregate shall be removed by steel brushing, rubbing with abrasive stone, or sandblasting to expose the abrasive particles.

3.12.7 Dry Shake Finish

Areas as indicated on the drawings shall be constructed with a dry shake finish. Dry shake floor armoring topping shall be used to surface the floor. The base slab shall be constructed and the dry shake material applied in accordance with the manufacturer's written instructions, which shall be furnished by the Contractor. The dry shake material shall be applied in a two-stage application. Total application shall be at the rate recommended by the manufacturer but at a rate not less than 7.5 kg per square meter. The first application shall be at the rate of two-thirds of the total and shall be applied immediately following floating of total area. The dry shake material shall first be applied to the floated concrete adjacent to forms, entryways, columns, and walls where moisture will be lost first. Dry shake material shall be distributed evenly using an approved mechanical spreader. The material shall not be hand thrown on the surface. Finishing machines with float shoes shall be used as soon as dry shake has absorbed moisture (indicated by darkening of surface); floating shall be done just sufficiently to bring moisture from base slab through the shake. Immediately following floating of the first shake, the remaining one-third of the total specified shake shall be applied in the same manner and machine floated. Surface shall be further compacted by a third mechanical floating if time and setting characteristics will allow. At no time shall water be added to the surface. As surface further stiffens, indicated by loss of sheen, it shall be hand or mechanically troweled with blades relatively flat. All marks and pinholes shall be removed in the final raised trowel operation. Floors finished with dry shake material shall be cured using a curing compound recommended by the

manufacturer of the dry shake material. Membrane curing compound shall be applied immediately after the floor surface has hardened sufficiently so surface will not be marred by the application. Compound shall be applied uniformly over the entire surface at a coverage which will provide moisture retention in excess of the requirements of ASTM C 309. When dry, the coating shall be protected from droppings of plaster, paint, dirt, and other debris by a covering of scuffproof, non-staining building paper. Floor shall remain covered and be kept free of traffic and loads for at least 10 days after completion. Adequate provision shall be made for maintaining the concrete temperature at 10 degrees C or above during the curing period. The curing compound shall remain in place for not less than 30 days. The curing compound shall be removed by a manufacturer recommended method prior to turning the facility over to the Government.

3.12.8 Heavy Duty Floors

Areas as indicated on the drawings shall have heavy duty floors constructed as follows:

3.12.8.1 General

Heavy duty floor shall be constructed by placing a heavy duty bonded topping on a base slab which has had a rough slab finish left 50 mm below final grade. Concrete in the base slab shall be thoroughly hardened but not more than 30 hours old. The temperature of the fresh concrete topping shall not vary more than 5 degrees C plus or minus from the temperature of the base slab. The ambient temperature of the space adjacent to the concrete placement and of the base slab shall be between 10 and 30 degrees C.

3.12.8.2 Preparation of Base Slab

The base slab shall be kept continuously damp until topping is placed. The surface of the base slab shall be thoroughly cleaned with an air-water jet immediately before placing the topping. A thin coat of neat cement grout of about the consistency of thick cream shall be thoroughly scrubbed into the existing surface immediately ahead of the overlay placing. At the time the neat cement grout is placed, the existing concrete surface shall be damp but shall have no free water present. The overlay concrete shall be deposited before the grout coat has had time to stiffen.

3.12.8.3 Placing and Finishing

Concrete shall be placed, as nearly as practicable in final position, in a uniform layer. The overlay shall be placed and screeded slightly above the required finished grade, compacted by rolling with rollers weighing not less than 4.5 kg per linear 25 mm of roller width or by approved tamping equipment and finish screeded to established grade. Grid type tampers shall not be used. The concrete, while still green but sufficiently hardened to bear a person's weight without deep imprint, shall be floated to a true even plane with no coarse aggregate visible. Floating shall be performed with an approved disc-type mechanical float which has integral impact mechanism. The surface of the overlay shall then be left undisturbed until the concrete has hardened enough to prevent excess fines

from being worked to the top. Joints shall be formed to match those in the base slab.

3.12.8.4 Curing and Protection

Concrete shall be maintained in a moist condition and shall be protected against rapid temperature change, mechanical injury, and injury from rain or flowing water, for a curing period of not less than 10 days. Concrete shall be maintained in a moist condition at temperatures above 10 and below 30 degrees C throughout the specified curing period. Concrete shall be protected from a temperature change greater than 3 degrees C per hour and from rapid drying for the first 24 hours following the removal of temperature protection. Curing activities shall begin as soon as free water has disappeared from the concrete surface after placing and finishing. Curing shall be moist curing accomplished by the following method. Surfaces shall be covered with a double layer of burlap, wetted before placing, and overlapped at least 150 mm. Burlap shall be kept continually wet and in intimate contact with the surface. Burlap shall be kept covered with a polyethylene sheeting at least 0.1 mm thick. All traffic shall be kept from the floor during the curing period and heavy traffic shall be kept off till 28-day age.

3.12.9 Two-Course Floor Construction

Areas as indicated on the drawings shall have floors constructed with two-course construction. Two-course floor shall be constructed by placing a bonded topping on the thoroughly hardened concrete base slab which has been left with a rough slab finish left 50 mm below final grade as shown on the drawings. Topping shall be applied at an approved time late in the contract period. The floor topping mixture shall have a specified compressive strength of 34.5 MPa at 28 days, a 50 mm maximum slump, 12.5 mm maximum size coarse aggregate, and shall be proportioned to obtain required finishability. The surface of the base slab shall be thoroughly cleaned by sandblasting or high-pressure waterjet immediately before placing topping. The temperature of the fresh concrete topping shall not vary more than 5 degrees C plus or minus from the temperature of the base slab. The ambient temperature of the space adjacent to the concrete placement and of the base slab shall be between 10 and 30 degrees C. The base slab shall be kept continuously wet for the first 12 hours during the 24 hour period immediately prior to placing the finished floor. After all free water has evaporated or has been removed from the surface, a grout shall be scrubbed in. The grout shall be a 1:1 mixture of portland cement and sand passing the 2.36 mm sieve mixed to a creamlike consistency. The grout shall be scrubbed into the surface just ahead of the concrete topping placing operation. While the grout is still damp, the top course shall be spread and screeded and darbied or bull floated. When the surface moisture has disappeared, the surface shall then be floated with disc-type power float with integral impact mechanism followed by a minimum of two power trowelings. Trowel marks left by the machine shall be removed by a final, hard steel troweling by hand. Joints shall be formed to match those in the base slab. Concrete shall be maintained in a moist condition and shall be protected against rapid temperature change, mechanical injury, and injury from rain or water, for a curing period of not less than 10 days. Concrete shall be maintained in a moist condition at temperatures above 10 and below

30 degrees F throughout the specified curing period. Concrete shall be protected from a temperature change greater than 3 degrees C per hour and from rapid drying for the first 24 hours following the removal of temperature protection. Curing activities shall be started immediately as soon as free water has disappeared from the surface of the concrete after placing and finishing. Curing shall be moist curing accomplished by the following method. Surfaces shall be covered with a double layer of burlap, wetted before placing, and overlapped at least 150 mm. Burlap shall be kept continually wet and in intimate contact with the surface. Burlap shall be kept covered with a polyethylene sheeting at least 0.1 mm thick. All traffic shall be kept from the topping during the curing period.

3.13 FLOOR HARDENER

Areas as indicated on the drawings shall be treated with floor hardener. Floor hardener shall be applied after the concrete has been cured and then air dried for 14 days. Three coats shall be applied, each the day after the preceding coat was applied. For the first application, 0.5 kg of the silocofluoride shall be dissolved in 4 liters of water. For subsequent applications, the solution shall be 1.0 kg of silicofluoride to each 4 liters of water. Floor should be mopped with clear water shortly after the preceding application has dried to remove encrusted salts. Proprietary hardeners shall be applied in accordance with the manufacturer's instructions. During application, area should be well ventilated. Precautions shall be taken when applying silicofluorides due to the toxicity of the salts. Any compound that contacts glass or aluminum should be immediately removed with clear water.

3.14 EXTERIOR SLAB AND RELATED ITEMS

3.14.1 Pavements

Pavements shall be constructed where shown on the drawings. After forms are set and underlying material prepared as specified, the concrete shall be placed uniformly throughout the area and thoroughly vibrated. As soon as placed and vibrated, the concrete shall be struck off and screeded to the crown and cross section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. The entire surface shall be tamped with the strike off, or consolidated with a vibrating screed, and this operation continued until the required compaction and reduction of internal and surface voids are accomplished. Care shall be taken to prevent bringing excess paste to the surface. Immediately following the final consolidation of the surface, the pavement shall be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete shall be placed and screeded, and the float operated until a satisfactory surface has been produced. The floating operation shall be advanced not more than half the length of the float and then continued over the new and previously floated surfaces. After finishing is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of long-handled cutting straightedges. Straightedges shall be 3.75 m in length and shall be operated from the sides of the pavement and from bridges. A straightedge operated from the side of the pavement shall be

equipped with a handle 1 m longer than one-half the width of the pavement. The surface shall then be tested for trueness with a 3.75 straightedge held in successive positions parallel and at right angles to the center line of the pavement, and the whole area covered as necessary to detect variations. The straightedge shall be advanced along the pavement in successive stages of not more than one-half the length of the straightedge. Depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. Projections above the required elevation shall also be struck off and refinished. The straightedge testing and finishing shall continue until the entire surface of the concrete is true. Before the surface sheen has disappeared and well before the concrete becomes nonplastic, the surface of the pavement shall be given a nonslip sandy surface texture by use of a burlap drag. A strip of clean, wet burlap from 1.0 to 1.5 m wide and 0.7 m longer than the pavement width shall be carefully pulled across the surface. Edges and joints shall be rounded with an edger having a radius of 3 mm. Curing shall be as specified.

3.14.2 Sidewalks

Concrete shall be 100 mm minimum thickness. Contraction joints shall be provided at 1.75 m spaces unless otherwise indicated. Contraction joints shall be cut 25 mm deep with a jointing tool after the surface has been finished. Transverse expansion joints 12 mm thick shall be provided at changes in direction and where sidewalk abuts curbs, steps, rigid pavement, or other similar structures. Sidewalks shall be given a lightly broomed finish. A transverse slope of 1 mm per 50 mm shall be provided, unless otherwise indicated. Variations in cross section shall be limited to 1 mm per 250 mm.

3.14.3 Curbs and Gutters

Concrete shall be formed, placed, and finished by hand using a properly shaped "mule" or constructed using a slipform machine specially designed for this work. Contraction joints shall be cut 75 mm deep with a jointing tool after the surface has been finished. Expansion joints (12 mm wide) shall be provided at 35 m maximum spacing unless otherwise indicated. Exposed surfaces shall be finished using a stiff bristled brush.

3.14.4 Pits and Trenches

Pits and trenches shall be constructed as indicated on the drawings. Bottoms and walls shall be placed monolithically or waterstops and keys, shall be provided as approved.

3.15 CURING AND PROTECTION

3.15.1 General

Concrete shall be cured by an approved method for the period of time given below:

Concrete with Type III cement	3 days
All other concrete	7 days

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and damage from rain and flowing water for the duration of the curing period. Air and forms in contact with concrete shall be maintained at a temperature above 10 degrees C for the first 3 days and at a temperature above 0 degrees C for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure, and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. Materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat, including welding, shall be permitted near or in direct contact with the concrete at any time. Except as otherwise permitted by paragraph Membrane Forming Curing Compounds, moist curing shall be provided for any areas to receive floor hardener, any paint or other applied coating, or to which other concrete is to be bonded. Concrete containing silica fume shall be initially cured by fog misting during finishing, followed immediately by continuous moist curing. Except for plastic coated burlap, impervious sheeting alone shall not be used for curing.

3.15.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, commencing immediately after finishing. If water or curing materials used stain or discolor concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned as approved. When wooden forms are left in place during curing, they shall be kept wet at all times. If steel forms are used in hot weather, nonsupporting vertical forms shall be broken loose from the concrete soon after the concrete hardens and curing water continually applied in this void. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Burlap and mats shall be clean and free from any contamination and shall be completely saturated before being placed on the concrete. The Contractor shall have an approved work system to ensure that moist curing is continuous 24 hours per day.

3.15.3 Membrane Forming Curing Compounds

Membrane forming curing compounds shall be used only on surfaces in the following areas, areas that will not receive any additional floor covering. Concrete in the following areas Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete, including surfaces to which a smooth finish is to be applied or other concrete to be bonded. However, a styrene acrylate or chlorinated rubber compound meeting ASTM C 309, Class B requirements, may be used for surfaces which 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, waterproofing or flooring

specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. 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. All surfaces shall be thoroughly moistened with water. Curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 500 kPa, at a uniform coverage of not more than 10 cubic meters per L for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces which 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. Surfaces on which clear compound is used shall be shaded from direct rays of the sun for the first 3 days. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.15.4 Impervious Sheeting

The following concrete surfaces may be cured using impervious sheets: all. However, except for plastic coated burlap, impervious sheeting alone shall not be used for curing. Impervious-sheet curing shall only be used on horizontal or nearly horizontal surfaces. Surfaces shall be thoroughly wetted and be completely covered with the sheeting. Sheeting shall be at least 450 mm wider than the concrete surface to be covered. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 300 mm and securely weighted down or shall be lapped not less than 100 mm 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.

3.15.5 Ponding or Immersion

Concrete shall be continually immersed throughout the curing period. Water shall not be more than 10 degrees C less than the temperature of the concrete.

3.15.6 Cold Weather Curing and Protection

When the daily ambient low temperature is less than 0 degrees C the temperature of the concrete shall be maintained above 5 degrees C for the first seven days after placing. 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 13 degrees C as determined by suitable temperature measuring devices furnished by the Contractor, as required, and installed adjacent to the concrete surface and 50 mm inside the surface of the concrete. The installation of the thermometers shall be made by the

Contractor as directed.

3.16 SETTING BASE PLATES AND BEARING PLATES

After being properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be set to the proper line and elevation with damp-pack bedding mortar, except where nonshrink grout is indicated. The thickness of the mortar or grout shall be approximately 1/24 the width of the plate, but not less than 20 mm. Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed. Nonshrink grout shall be used for base plates.

3.16.1 Damp-Pack Bedding Mortar

Damp-pack bedding mortar shall consist of 1 part cement and 2-1/2 parts fine aggregate having water content such that a mass of mortar tightly squeezed in the hand will retain its shape but will crumble when disturbed. The space between the top of the concrete and bottom of the bearing plate or base shall be packed with the bedding mortar by tamping or ramming with a bar or rod until it is completely filled.

3.16.2 Nonshrink Grout

Nonshrink grout shall be a ready-mixed material requiring only the addition of water. Water content shall be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.16.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. 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 machinery-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for completely retaining the grout on all sides and on top and shall be removed after the grout has set. The placed grout shall be carefully worked by rodding or other means 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 18 to 30 degrees C until after setting.

3.16.2.2 Treatment of Exposed Surfaces

For metal-oxidizing nonshrink grout, exposed surfaces shall be cut back 25 mm and immediately covered with a parge coat of mortar consisting of 1 part portland cement and 2-1/2 parts fine aggregate by weight, with

sufficient water to make a plastic mixture. The parge coat shall have a smooth finish. For other mortars or grouts, exposed surfaces shall have a smooth-dense finish and be left untreated. Curing shall comply with paragraph CURING AND PROTECTION.

3.17 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and shall submit specified reports. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease and the operation shall be corrected. The laboratory performing the tests shall be onsite and shall conform with ASTM C 1077. Materials may be subjected to check testing by the Government from samples obtained at the manufacturer, at transfer points, or at the project site. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per week thereafter for conformance with ASTM C 1077.

3.17.1 Grading and Corrective Action

3.17.1.1 Fine Aggregate

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 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. 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 reported to the Contracting Officer, concreting shall be stopped, and immediate steps taken to correct the grading.

3.17.1.2 Coarse Aggregate

At least once during each shift 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 control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. 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 5 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.

3.17.2 Quality of Aggregates

Thirty days prior to the start of concrete placement, the Contractor shall perform all tests for aggregate quality required by ASTM C 33. In addition, after the start of concrete placement, the Contractor shall perform tests for aggregate quality at least every three months, and when the source of aggregate or aggregate quality changes. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

3.17.3 Scales, Batching and Recording

The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every three months. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors. 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. At the same time, the Contractor shall test and ensure that the devices for dispensing admixtures are operating properly and accurately. 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.

3.17.4 Batch-Plant Control

The measurement of concrete 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 meter, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic meter for each class of concrete batched during each day's plant operation.

3.17.5 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 inspector. Tests shall be made in accordance with ASTM C 231 for normal weight concrete and ASTM C 173 for lightweight concrete. Test results shall be plotted on

control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews 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 air content and the control chart for range, and for determining need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate control chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph Air Entrainment. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line, respectively. 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 secondary control chart for range where an upper warning limit is set at 2.0 percentage points and an 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 practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the secondary control chart for 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.

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 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 inspector. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews 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. 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 charts for slump and the chart for range, and for determining need for any remedial action. Limits shall be set on separate control charts for slump for each type of mixture. The upper warning limit shall be set at 12.5 mm below the maximum allowable slump specified in paragraph Slump in PART 1 for each type of concrete 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 50 mm. 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 the 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 charts for slump reach the upper warning limit, an adjustment shall immediately be 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 ratio specified, based on 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 individual 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. Additional slump tests shall be made as directed.

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.

f. Strength Specimens. At least one set of test specimens shall be made, for compressive or flexural strength as appropriate, on each different concrete mixture placed during the day for each 380 cubic meters or portion thereof of that concrete mixture placed each day. Additional sets of test specimens shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A truly random (not haphazard) 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 Strength Requirements in PART 1 shall consist of four specimens, two to be tested 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 for test cylinders and ASTM C 78 for test beams. Results of all strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength "tests", ("test" as defined in paragraph Strength Requirements in PART 1) moving average of last 3 "tests" for strength, and moving average for range for the last 3 "tests" for each mixture. The charts shall be similar to those found in ACI 214.3R.

3.17.6 Inspection Before Placing

Foundations, construction joints, forms, and embedded items shall be inspected by the Contractor in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.17.7 Placing

The placing foreman shall supervise placing operations, shall determine that the correct quality of concrete or grout is placed in each location as specified and as directed by the Contracting Officer, and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume placed, and method of placement. The placing foreman shall not permit batching and placing to begin until it has been 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.

3.17.8 Vibrators

The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior 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 while the vibrator is operating in concrete with the tachometer being 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. Any vibrator not meeting the requirements of paragraph Consolidation, shall be immediately

removed from service and repaired or replaced.

3.17.9 Curing Inspection

a. Moist Curing Inspections. At least once each shift, and not less than twice per day on both work and non-work 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 those areas shall be extended by 1 day.

c. Membrane Curing Inspection. No curing compound shall be applied until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each operation, the Contractor shall estimate the quantity of compound used by measurement of the container and the area of concrete surface covered, shall compute the rate of coverage in square meters per Liter, and 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 non-work days, an inspection shall be made of all areas being cured using impervious 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 1 day.

3.17.10 Cold-Weather Protection

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

3.17.11 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 60,000 cubic meters of concrete placed, whichever results in the shortest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94.

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 mixing shall be determined in accordance with ASTM C 94. 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.

c. Mixer Uniformity Corrective Action. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

3.17.12 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 contractor quality control records.

-- End of Section --

SECTION 05650

RAILROADS
12/99
Amendment #0002

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.

AMERICAN RAILWAY ENGINEEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Manual	(1999) Manual for Railway Engineering (4 Vol.)
AREMA Track Plans	(1999) Portfolio of Track Work Plans

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ASNT CP-189	(1995) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(1997) High-Strength Bolts for Structural Steel Joints (Metric)
ASTM A 490	(1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 490M	(1993) High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM C 88	(1999a) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C 127	(1988; R 1993el) Specific Gravity and Absorption of Coarse 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 535	(1996el) Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 702	(1998) Reducing Samples of Aggregate to Testing Size
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM D 217	(1997) Cone Penetration of Lubricating Grease (IP50/88)
ASTM D 402	(1997) Distillation of Cut-Back Asphaltic (Bituminous) Products
ASTM D 445	(1997) Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)
ASTM D 566	(1997) Dropping Point of Lubricating Grease
ASTM D 1241	(1968; R 1994el) Materials for Soil-Aggregate Subbase, Base, and Surface Courses
ASTM D 1310	(1986; R 1997el) Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus
ASTM D 1556	(1990; R 1996el) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1683	(1990a) Failure in Sewn Seams of Woven Fabrics
ASTM D 2171	(1994) Viscosity of Asphalts by Vacuum Capillary Viscometer

ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(1999b) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 3776	(1996) Mass Per Unit Area (Weight) of Woven Fabric
ASTM D 4354	(1996) Sampling of Geosynthetics for Testing
ASTM D 4355	(1992) Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D 4491	(1999) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	(1986; R 1994) Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4632	(1991; R 1996) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4716	(1995) Determining the (In plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D 4751	(1999) Determining Apparent Opening Size of a Geotextile
ASTM D 4759	(1988; R 1996) Determining the Specification Conformance of Geosynthetics
ASTM D 4791	(1999) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D 4833	(1988; R 1996el) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes
ASTM F 405	(1997) Corrugated Polyethylene (PE) Tubing and Fittings
ASTM F 512	(1995) Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C2	(1995) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA C6	(1997) Cross Ties and Switch Ties Preservative Treatment by Pressure Processes
AWPA M2	(1997) Standard for Inspection of Treated Timber Products
AWPA M6	(1997) Brands Used on Forest Products
AWPA P2	(1995) Standard for Creosote Solutions

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA SA-89-006	(1988) Manual on Uniform Traffic Control Devices for Streets and Highways

CORPS OF ENGINEERS (COE)

COE CRD-C 119	(1991) Standard Test Method for Flat or Elongated Particles in Course Aggregate

1.2 Not Used.
1.2.1 [Enter Appropriate Subpart Title Here]
1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

As-Built Drawings; G, RE

One set of reproducible originals of the final as-built drawings for each automatic crossing protection installation prior to final acceptance by the Contracting Officer. The materials and methods used to produce these drawings shall meet the requirements of this specification and shall result in drawings which are easy to revise without damage to the drawing.

SD-03 Product Data

Wood Ties;

Name of the tie manufacturer, Rail Tie Association membership, the wood species proposed, the quantities of ties for each specie proposed, and product data for the ties to be furnished, including the type of seasoning to be utilized, prior to ordering the ties.

New Jointed Rail; G, RE
Relay Rail; G, RE
Joint Bars; ,
Compromise Joint Bars; , .

Manufacturer's data on new rail including: rail weight, rail section, drilling, rail length, date rolled, and the name of the mill where the rail was rolled. For relay rail the required information shall include weight, section, lengths, and the name of the supplier. The maximum allowable vertical wear on the rail head and the maximum allowable horizontal wear on the side of the rail shall be provided. The design of the joint bars and compromise joint bars proposed to be furnished with each rail section shall also be provided.

Miscellaneous Track Materials; ,

Manufacturer's data for all track materials to be furnished.

Crossing Material or Surface; ,

Within 30 days of the Notice to Proceed, the brand name of the premanufactured crossing material or crossing surface material proposed for use along with manufacturer's literature concerning the product; and for built-in-place crossings, the type of materials to be used along with manufacturer's literature.

Components or Products; G, ED

Performance data for components or products proposed as an equivalent to those specified. The Contracting Officer's written approval is required for any such equivalent type component or product proposed to be used.

Traffic Maintenance and Detour Plans; G, RE

Traffic maintenance and detour plans for approval.

Crossing Material or Surface; ,

Detailed installation procedure for the premanufactured crossing material or crossing surface material proposed for use within 30 days of the notice to proceed.

Thermite Welding Procedures; G, RE

A detailed statement covering the step-by-step procedures to be employed in making the welds, including a complete description of each of the following items, as applicable, and any other essential characteristics included in the welding procedures:

a. The manufacturer's trade name for the welding process.

b. The method used for cutting and cleaning the rail ends. Flame cutting of rail ends will not be allowed.

c. The minimum and maximum spacing between rail ends.

d. The method used for maintaining the rails in alignment during welding.

e. The method used for preheating, including time and temperature.

f. The tapping procedure, including the minimum time required to cool the weld under the mold insulation.

g. The method used, including a description of special tools and equipment, for removing the upset metal and finishing the weld to the final contour.

h. Quality control procedures to be followed.

i. The contractual agreements with any subcontractor employed by the Contractor in doing the work.

Electric Arc Welding; G, RE

A detailed specification covering the step-by-step procedures to be employed in making the electric arc welds. A complete description of each of the following items as applicable and any other essential characteristics shall be included in the procedure specifications.

a. Type, size, and capacity of electric welding machine (250 amp minimum), grinder and other equipment. Also, type and size of material (welding rod or wire).

b. The method to be used to remove defective and excess metal prior to welding (arcair or grinding).

c. The method to be used to prevent warping.

d. The method used for preheating, including time and temperature.

e. The method of applying metal buildup and slag removal.

f. The method of securing original contour of items welded.

g. Quality control procedures to be followed.

h. Welding materials (rod or wire), name and manufacturer of materials (low carbon steel) for welding rail, rail frogs, guard rails, switch point protectors, and switch points without manganese inserts and materials (manganese alloy) for welding manganese frogs, RBM frogs, manganese switch point inserts and manganese railroad crossing inserts or castings.

Materials and Equipment;

A complete schedule of the materials proposed for installation within 60 days of receipt of notice to proceed, and before installation of the materials; the schedule shall include a list of equipment proposed for the work.

Tie Plates; G.
Turnouts; G.
Rail Bonding and Grounding; G.

SD-04 Samples

Geotextile;

Geotextile samples for testing. Samples shall be submitted a minimum of 30 days prior to the beginning of installation of the geotextiles. One sample shall be provided for each 20 units (rolls, panels, etc.) of geotextile to be used in the contract. All samples shall be from the same production lot as will be supplied for the contract. Samples shall be identified by the manufacturer's name, brand name, lot designation, and project name. The minimum size of sample submitted for testing shall be the full width of the geotextile by 1.7 m .

Ballast;

Samples of the ballast material for testing. Samples shall be submitted a minimum of 60 days prior to the installation of the material. Samples shall be obtained from the quarry, supplier, or other source that will be used to provide the ballast materials for this project using the methods described in ASTM D 75. One

representative sample of not less than 90.6 kg of ballast material shall be submitted for each 9070 MT of ballast to be installed.

SD-06 Test Reports

Sampling and Testing;

One certified copy of Test Reports for each test performed on the ballast within 2 working days of the test completion.

Wood Ties;

Certified test and inspection reports for crossties and switch ties subsequent to treatment, a minimum of seven calendar days prior to any ties being installed in track. Test and inspection reports shall contain the information required by Part 7 of AWPA M2.

Geotextiles;

Independent testing laboratory's certified test reports for geotextiles, including necessary analysis and interpretation. These reports shall provide results of the laboratory testing performed on samples of the geotextile material delivered to the jobsite. Test reports shall be submitted at least 30 working days prior to the installation of the geotextile.

Ultrasonic Test;

Results of the ultrasonic rail testing. Results shall list defects and rail stationing.

SD-07 Certificates

Wood Ties;

Certificates of compliance prior to any ties being installed in track.

Ballast;

Certificates of Compliance for the ballast materials to be installed in this project.

Materials and Equipment;

Manufacturer's certificates of conformance for the following materials:

a. Rail.
b. Tie plates.
c. Track bolts, nuts, and spring washers.
d. Joint bars.

e. Rail anchors.
f. Track spikes.
g. Turnouts.
h. Rail welding process.
i. Premanufactured car bumpers.
j. Premanufactured road crossings and/or crossing surfaces.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Materials and Samples

The Contracting Officer will notify the Contractor of the materials approved or disapproved. Disapproved materials that have already been delivered to the project site, shall be promptly segregated from the approved materials and removed from the premises. If materials are disapproved, acceptable replacement materials shall be provided at no additional cost to the Government. Initial approval by the Contracting Officer will not prevent the removal and replacement of materials that are materially defective or materials not meeting this specification that are discovered during construction and/or routine quality control/quality assurance operations.

1.4.2 Geotextiles

Geotextiles shall be shipped and stored in their original ultraviolet resistant cover until the day of installation. Geotextiles shall be protected from vandalism, temperatures greater than 60 degrees C, dirt, dust, mud, debris, moisture, sunlight, and ultraviolet rays. Geotextiles delivered to the project site shall be clearly labeled on the material cover to show the manufacturer's name, brand name, fabric type, location and date manufactured, lot identification, width, and length.

1.5 QUALIFICATIONS

1.5.1 Track Construction

Track construction shall be performed under the direction of qualified and competent supervisory personnel experienced in railroad construction.

1.5.2 Welding

Welding shall be performed under the direct supervision of an experienced welding supervisor or foreman.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Temporary Work

During construction, suitable roads and crossings with all necessary lights, signs, drainage, and other appurtenances required for safe public and local travel shall be provided. Suitable temporary fences shall be erected and maintained where required to prevent trespass upon work or damage to adjoining property. Drainage shall be maintained, and the accumulation of water that might affect the stability of the roadbed will

not be permitted.

1.6.2 Traffic Control

Traffic control devices shall comply with FHWA SA-89-006. Suitable warning signs shall be placed near the beginning of the work site and well ahead of the work site for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

1.6.3 Welding

Welding shall not be performed in rain, snow, or other inclement weather without adequately protecting the weld from the elements.

1.6.4 [Enter Appropriate Subpart Title Here]1.6.4.1 [Enter Appropriate Subpart Title Here]

PART 2 PRODUCTS

2.1 BALLAST

Prepared ballast shall be crushed stone, Size No. 4, or 5 conforming to Chapter 1, Part 2, of AREMA Manual for quality, soundness and gradation. In the portion retained on each sieve specified, the crushed stone shall contain at least 90 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the plane. When two fractures are contiguous, the angle between planes of the fractures shall be at least 30 degrees in order to count as two fractured faces. Flat and elongated particle dimension ratio used in ASTM D 4791 shall be 1:3. Ballast materials shall meet the property requirements shown in TABLE I.

TABLE I. MINIMUM PROPERTY REQUIREMENTS - BALLAST

Property	Maximum Value	Minimum Value	Test Method
Percent passing 0.075 sieve (No. 200 Sieve)	--		ASTM C 117
Granite	1.0%	--	
Traprock	1.0%	--	
Quartzite	1.0%	--	
Dolomitic Limestone	1.0%	--	
Bulk specific gravity			ASTM C 127
Granite	--	2.55	
Traprock	--	2.60	

TABLE I. MINIMUM PROPERTY REQUIREMENTS - BALLAST

Property	Maximum Value	Minimum Value	Test Method
Quartzite	--	2.60	
Dolomitic Limestone	--	2.65	
Absorption			ASTM C 127
Granite	1.0%	--	
Traprock	1.0%	--	
Quartzite	1.0%	--	
Dolomitic Limestone	2.0%	--	
Clay lumps and friable particles			ASTM C 142
Granite	0.5%	--	
Traprock	0.5%	--	
Quartzite	0.5%	--	
Dolomitic Limestone	0.5%	--	
Degradation Soundness			See Note 1
Granite	40%	--	
Traprock	25%	--	
Quartzite	30%	--	
Dolomitic Limestone	35%	--	
Sodium sulfate - 5 cycles			ASTM C 88
Granite	5%	--	
Traprock	5%	--	
Quartzite	5%	--	
Dolomitic Limestone	5%	--	
Flat or elongated particles			CRD-C-119
Granite	10%	--	
Traprock	5%	--	
Quartzite	5%	--	
Dolomitic Limestone	10%	--	

Note 1 - Materials having gradations containing particles retained on the 25mm sieve shall be tested by ASTM C535. Materials having gradations with 100% passing the 25mm sieve shall be tested by ASTM C131.

Note 2 - The limit for bulk specific gravity is a minimum value. Limits for the remainder of the tests are maximum values.

2.2 Not Used

2.3 GEOTEXTILE

2.3.1 Physical Property Requirements

The geotextile shall be a nonwoven, needle-punched material. The geotextile's fiber shall consist of at least 85 percent by weight polyamide, polypropylene, or polyethylene. The geotextile shall contain stabilizers and/or inhibitors as necessary to make the filaments resistant to deterioration from ultraviolet light and heat exposure, particularly prior to placement and coverage. The fibers shall be formed into a network which will be dimensionally stable. The edges of the geotextile shall be finished in a way to prevent the outer fibers from being pulled away from the geotextile. The geotextile shall exceed the applicability property requirements stated in TABLE II.

TABLE II - PROPERTY REQUIREMENTS-GEOTEXTILE

PROPERTY	MINIMUM REQUIREMENTS*	TEST METHOD
Weight**	0.57 kg/0.836 sq m (15 oz/sq yd)	ASTM D 3776 Option B
Color	Grey or tinted	--
Grab tensile strength	158.6 kg (350 lbs)	ASTM D 4632
Puncture strength	83.8 kg (185 lbs)	ASTM D 4833
Trapezoidal tear strength	68 kg (150 lbs)	ASTM D 4533
Apparent opening size (AOS) (maximum required valve)	Less than 0.22 mm (No. 70 sieve)	ASTM D 4751
Normal permeability (k)	0.1 cm/sec	ASTM D 4491
Permittivity	0.2 per sec	ASTM D 4491
Planar water flow/ transmissivity at i = 1 and normal stress = 1.6 kg per sq cm (3.5 psi)	5.53 sq cm/min (0.006 sq ft/min)	ASTM D 4716
Ultraviolet degradation at 150 hours	70 percent strength retained	ASTM D 4355
Seam strength	158.6 kg (350 lbs)	ASTM D 1683

TABLE II - PROPERTY REQUIREMENTS-GEOTEXTILE

PROPERTY	MINIMUM REQUIREMENTS*	TEST METHOD

*These property requirements are Minimum Average Roll Values in the weaker principal direction.

**Geotextile selection shall not be limited by the minimum weight shown. Selection shall be based on the other property requirements listed. Heavier geotextiles have shown greater resistance to abrasion.

2.3.2 Dimensional Requirements

Each roll of geotextile shall be at least 3 m wide and 6 m long.

2.3.3 [Enter Appropriate Subpart Title Here]

2.4 JOINT BARS

Joint bars shall be of the size, shape, and punching pattern to fit the rail being joined.

2.4.1 New Joint Bars

New joint bars shall be used with new rail, and shall be of the "toeless" and "head free design" to match rail section. New joint bars shall conform to the requirements of "Specifications For High-Carbon Steel Joint Bars" or "Specifications For Quenched Carbon-Steel Joint Bars and Forged Compromise Joint Bars" found in Chapter 4, Part 2 of AREMA Manual for the joint bar and assemblies recommended in Chapter 4, Part 1 of AREMA Manual.

2.4.2 Used Joint Bars

Used joint bars in good condition shall be used with relay rail only. The type of joint bar shall be "toeless" . The "long toe" type of joint bar shall not be used. Used joint bars shall be straight, free from cracks, breaks, and other visual defects. Excessive rust, dirt, and other foreign materials on the joint bars are not permitted. Used joint bars shall be of the proper size to make good contact with the underside of the rail head and the top of the rail base on the rails being joined. Joint bars shall have alternating round and oval bolt holes. Bolt holes shall not show excessive wear that would prevent use of the oval neck track bolt normally used with that joint bar. Joint bars that have been flame-gouged, flame cut, or otherwise altered shall be considered scrap and shall not be used.

2.4.3 Compromise Joint Bars

Compromise joint bars shall be of the size, shape, and punching pattern to fit the rail sizes and sections being joined. Only factory designed and constructed (forged or cast) compromise joint bars shall be used to join rails of different sizes.

2.4.3.1 New Compromise Joint Bars

Compromise joint bars shall conform to the requirements of "Specifications For Quenched Carbon-Steel Joint Bars and Forged Compromise Joint Bars" found in Chapter 4, Part 2 of AREMA Manual.

2.4.3.2 Used Compromise Joint Bars

Requirements for joint bars in paragraph Used Joint Bars shall also apply to used compromise joint bars.

2.5 GREASE

Grease for lubricating moving parts in turnouts and other trackwork shall have the following typical characteristics:

Calcium Soap, percent	9.0
Solid Additive (Graphite),percent	11.5
Penetration, ASTM D 217 at 25 degrees C worked	340
Dropping Point ASTM D 566 at 25 degrees C	101/214
Oil Viscosity, square mm/record at 40 degrees C	81.8
ASTM D 445 SUS at 38 degrees C	379

Other types of grease or lubricating oil may be used provided that the grease or oil has been used successfully by local commercial railroads and has the approval of the Contracting Officer.

2.6 OIL FOR CORROSION PROTECTION

Oil for protecting rail and other track materials from corrosion, except joints, shall conform to the following general specification:

Asphalt, 100 penetration minimum 45 percent	ASTM D 402
Flash point, minimum 55 degrees C	ASTM D 1310
Viscosity, kinematic, 60 degrees C 480 to 700 sq mm/s	ASTM D 2171

2.7 RAIL

2.7.1 New Jointed Rail

New jointed rail shall comply with the following:

a. Rail Lengths: New rail shall be a 57 kg/m (115 lbs/yd), 65 kg/m (132 lbs/yd), 66 kg/m (133 lbs/yd) or 67 kg/m (136 lbs/yd) section and shall conform to the specifications in Chapter 4, Parts 1 and 2 of AREMA Manual that were in effect at the time of its manufacture. New rail shall be provided in 11.9 or 24.4 m lengths.

b. Rail Drilling: New rail shall be provided with the rail ends drilled. Drilling shall be uniform and to the patterns specified.

RAIL	DRILLING
115RE	89-152-152 mm (3-1/2, 6, 6 inch)
132RE	89-152-152 mm (3-1/2, 6, 6 inch)
133RE	89-152-152 mm (3-1/2, 6, 6 inch)
136RE	89-152-152 mm (3-1/2, 6, 6 inch)

2.7.2 Used Jointed Rail

2.7.2.1 Relief Rail

Used rail for spot rail replacement of defective rails (relief rail) shall be the same weight, section, drilling, and length as the rail being replaced. Relief rail shall meet the requirements specified for relay rail.

2.7.2.2 Relay Rail

Relay rail shall be control cooled. Used rail provided by the Contractor for out of face replacement and new construction shall be 57 kg/m or heavier and shall have the same section and drilling pattern for each rail weight. Acceptable rail weights and sections for material provided by the Contractor are: 115 AREA, 132 AREA, 133 AREA, and 136 AREA. All relay rail provided shall be the same section. Rail sections 90 ARA-A, 90 ARA-B, and 110 AREA that are removed as part of the track demolition in this project and meet the requirements of this specification may be reused where indicated

a. Rail Drilling: Relay rail shall be provided with the rail ends drilled. Drilling shall be uniform and to the patterns specified.

RAIL	DRILLING
115RE	89-152-152 mm (3-1/2, 6, 6 inch)
132RE	89-152-152 mm (3-1/2, 6, 6 inch)
133RE	89-152-152 mm (3-1/2, 6, 6 inch)
136RE	89-152-152 mm (3-1/2, 6, 6 inch)

b. Length: Relay rail shall be standard 11.9 m lengths. Not more than 10 percent of the lot may be shorts. No rail shorter than 8.2 m will be accepted.

c. Maximum Allowable Wear: For each rail, the average top wear shall meet the requirements on Table IV, except rail in turnouts which shall conform to paragraph Maximum Wear Used Rails Installed in Turnouts. Side wear shall be measured 16 mm below the original top of rail.

d. Condition and Appearance: Relay rail shall be free from obvious defects and clean in appearance. Rail that has severe pitting and corrosion or has been flame-gouged, or spike nipped will not be

accepted. Rail shall be straight from line and surface and free from any kinks or bends. Rail bases shall be solid and free from visual defects such as plate wear, spike notching, pitting, and flame-gouging.

(1) Maximum Allowable Lip: Lip or overflow shall not exceed 3 mm on either side of the rail head.

(2) Engine Burns: Engine burns shall not be greater than 13 mm diameter and 0.8 mm deep. A maximum of 6 engine burns is allowed per rail and engine burns shall not affect more than 25 percent of the total order.

(3) End Batter and Chipping: Rail end batter shall not exceed a maximum of 3 mm when measured 13 mm from the rail end with a 460 mm straightedge laid only on the rail being measured. Chipped or broken rail ends will not be accepted.

(4) Running Surface Damage: Running surface damage shall not exceed 6 mm long by 13 mm wide, and shall be not greater than 1.5 mm deep. Flat spots are not permitted on the rail head.

(5) Defects Not Permitted: Relay rail having any of the following defects shall not be accepted: bolt hole cracks or breaks, broken base, breaks, crushed head, detail fracture, engine burn fracture, head-web separation, piped rail, horizontal split head, vertical split head, torch cut rail ends, torch cut bolt holes, and compound or transverse fissures. The presence of any of these defects in the rail render that rail as scrap.

Nominal Rail	Maximum Allowable Wear, mm	
Weight, kg/m	Top	Side
57.0 or less	3.2	6.4
Greater than 57.0	6.4	9.5

2.7.3 Welded Rail

Welded rail will not be permitted. The welding of rail joints will not be permitted, except as stated in this specification.

2.8 TIE PLATES

2.8.1 General

Tie plates shall be of the dimensions and punching pattern (A or B) to fit the rail. New tie plates conforming to Chapter 5, Part 1 of AREMA Manual shall be used with new rail. Used tie plates in good condition may be used with relay rail. The used tie plates shall not be smaller than 190.5 by 279 mm double-shoulder for use with relay rail having nominal weights of 49.6 kg/m and greater. Both flat and canted plates will be required to match the existing tie plates that are in track. Canted tie plates shall

be used in all new rail and relay out-of-face rail replacements.

2.8.2 Used Tie Plates

Used tie plates shall be free from excessive rust, pitting, mechanical damage, and dirt and other foreign materials. Cracked or broken plates shall be considered as scrap and shall not be used. Shoulders on the tie plates shall project a minimum of 6 mm above the plane of the rail seat. The thickness of the tie plate shall be at least 13 mm when measured anywhere in the rail seat area. Spike holes shall be square and not corroded, worn, or mechanically enlarged.

2.9 WOOD TIES

Species shall be Ash, Beech, Red and White Oak. Switch ties shall be Ash or Oak. Conditioning and seasoning shall conform to the requirements of AWPA C6 for the individual wood species. Ties shall be well seasoned. Prior to preservative treatment, wood ties shall be dried to the oven dry moisture content, or less, as specified in paragraph 3.14 of AWPA C6. The wood may be air dried, vapor dried, or boultonized. Ties which are to be dried by artificial means shall be conditioned and treated as soon as possible after sawing, but no more than 30 days later. The temperature used for boultonizing shall be as high as possible but in no case less than 94 degrees C. Vapor dried ties shall be transferred from drying cylinders to treatment cylinders as quickly as possible to avoid loss of heat from the seasoned ties. Ties shall be pressure treated in accordance with Chapter 3, Part 6 of AREMA Manual by the empty cell process with a 60/40 creosote/coal tar solution (Grade C) in accordance with AWPA P2 to a minimum retention of 3.6 kg/0.28 cu m of wood. The Contractor shall record treatment as specified in AWPA M2. Treated ties shall be permanently marked or branded by the producer in accordance with AWPA M6. Ties shall be produced by a member of the Railway Tie Association. All ties shall be incised on all four sides in the pattern specified in AREMA Manual, Chapter 3, Part 6, prior to treatment. Splits shall not be longer than 100 mm and not wider than 5 mm at either end. Splits longer than 100 mm but not longer than the width of the face in which the split appears, will be acceptable if specified anti-splitting devices are installed with the splits compressed. Any required adzing and drilling for spikes shall be performed prior to treatment. The Contractor shall notify the Contracting Officer at least 15 days prior to the shipment of any treated ties or timbers from the manufacturer's plant, to provide the Government the opportunity to inspect the materials before shipment. When inspections of onsite materials result in product rejection, the Contractor shall promptly segregate and remove rejected material from the premises. The Government may also charge the Contractor any additional cost of inspection or test when prior rejection makes reinspection or retesting necessary.

2.9.1 Crossties

Wood crossties shall conform to Chapter 3, Part 1 of AREMA Manual.

a. Wood crossties except at road crossings: Wood ties shall be sawed and shall be not less than 178 mm thick and 229 mm wide. The length shall be 2.6 m.

b. Wood crossties at road crossings: Wood ties shall be sawed and shall not be less than 178 mm thick and 229 mm wide. The length shall be 2.75 m, unless recommended otherwise by the manufacturer of crossing surface materials.

2.9.2 Switch Ties

Switch ties shall conform to Chapter 3, Part 2 of AREMA Manual and shall be sawed 178 mm thick and 229 mm wide. The length and quantities shall be as shown.

2.9.3 Not Used

2.9.3.1 [Enter Appropriate Subpart Title Here]

2.9.4 Tie Plugs

Tie plugs shall fit holes from which spikes are drawn. The plugs shall comply with Chapter 3, Part 1 of AREMA Manual and shall be treated in accordance with Chapter 3, Part 6 of AREMA Manual.

2.10 Not Used

2.11 Not Used

2.12 Not Used

2.13 ANTI-SPLITTING DEVICES

Crossties and switch ties shall be equipped on each end with gang nail end plates anti-splitting devices of the type specified, regardless of whether or not the wood has shown any tendency to split. Products used shall conform to Chapter 3, Part 1 of AREMA Manual. Anti-splitting devices shall be applied in accordance with Chapter 3, Part 1, Section 10 of AREMA Manual.

2.14 Not Used

2.15 TURNOUTS

The component parts of the turnouts to be furnished shall be the products of manufacturers regularly engaged in the manufacture of such products, and shall essentially duplicate items that have been in satisfactory use at least 2 years prior to bid opening. The parts need not all be made by the same manufacturer, but each turnout shall be the product of a single firm.

Switch assemblies, stands, frogs, and guardrails assemblies shall conform to the requirements of AREMA Track Plans.

2.15.1 Rail and Joint Bars

Rail, joint bars, and miscellaneous track materials used in turnout construction shall be furnished and installed as part of the complete turnout. Rail and miscellaneous track materials used in turnout construction shall be the weight and section as specified in Paragraph NEW JOINTED RAIL.

2.15.2 Maximum Wear Used Rails Installed in Turnouts

The average top (vertical) wear shall be 3 mm or less. Gage side head wear shall not exceed 3 mm

2.15.3 Frogs, Switches, Guardrails and Appurtenances

Frogs, switches, guardrails and appurtenances shall be materials suitable for use in heavy tonnage main track. Used turnout materials shall have been fully reconditioned and shall be within plus or minus 3 mm of the original specification for that turnout design. Materials used in the turnout shall be of the same weight and section. Materials shall be in good condition and free from excessive rust, dirt, and other foreign materials. The rail weight and section shall be as specified.

2.15.3.1 Switches

Switches for new turnout construction or complete turnout replacement shall be 5029 mm reinforced straight split switches with graduated risers generally conforming to AREMA Track Plans, Plan Number 112.

a. Switch points shall be new. Switch point detail shall be AREMA Track Plans, Plan No. 221, Detail 4000 or 6100.

b. Switch rods and connecting rods shall be new.

c. Gage plates, switch plates, slide plates, and heel plates shall either be new or used and in good condition and not worn or corroded. Rail braces shall be either rigid or adjustable. For a given turnout all rail braces shall be of the same design.

d. Heel blocks shall be either cast or forged steel and be either new or used and in good condition. New heel block bolt assemblies shall be provided and shall be heat treated. The heel joint bars shall be either new or used in good condition and manufactured for the purpose.

2.15.3.2 Frogs

Frogs shall be railbound manganese, as shown in AREMA Plan 600, or solid manganese self-guarded, as shown in AREMA Plans 641 and 691 (Section B-B) in the sizes indicated. Self-guarded frogs shall not be used in turnouts on the Yard Lead Track or Tracks I1, I2, and I3.

a. Frogs shall be new or remanufactured. Cracked or broken used frog castings shall not be used. Cracked or broken frog castings that have been repaired by welding are not acceptable and shall not be used. Remanufactured frogs shall meet the following wear requirements:

(1) Frog points shall be in good condition and not be worn, chipped, or broken.

(2) Maximum allowable wear on used or reconditioned frogs shall be:

Frog Point:	3 mm
Top Surface:	3 mm
Raised Guarding Face (Self-Guarded)	3 mm
All Wear Surfaces	3 mm

(3) Minimum flangeway depth for used frogs shall be 45 mm . Minimum flangeway width shall be 48 mm .

b. Frog bolts, nuts, lock washers, and headlocks shall all be new.

2.15.3.3 New or Replacement Guard Rails

New or replacement guard rails shall be a minimum of 4.6 m in length and shall be new or used in good condition. Guard rails shall be of any of the following designs: Tee rail per AREMA Track Plans, Plan No. 504, solid manganese steel per AREMA Track Plans, Plan No. 510, or an acceptable hook flange design. For used guard rails the guard face shall be smooth and not worn more than 3 mm from its new condition. Guard rails bolted to the running rails shall be equipped with fillers. When fillers are installed or repaired new bolt assemblies shall be used. All bolts, nuts, and associated hardware shall be new. Clamped guard rails shall be equipped with block wedges, filler wedges, and cotter keys. Guard rail plates shall be new or acceptable replacements. Single-shoulder tie plates used with guard rails shall be installed with the shoulder on the inside flush against the base of the guard rail.

2.15.3.4 Hook Plates

Hook plates shall be new or acceptable used material and shall be of the designs and lengths indicated on AREMA Track Plans, Plan Nos. 112 and 241.

2.15.3.5 Switch Stands

a. New or replacement switch stands shall conform to AREMA Track Plans, Plan 251-64 and shall be new or fully reconditioned, low-stand type. Switch stand shall be positive-action (rigid)] with adjustment from the top with shims through a moveable cover.

b. Existing switch stands, staffs and targets, if reused, shall be fully reconditioned.

c. Each stand shall be equipped with one of the following switch lamps

:

(1) Reflecting Type: Approved reflecting switch lamps fitted with standard commercial-type double red and white reflecting lenses but without day signal targets.

(2) Reflecting Type with Daylight Disk: Approved reflecting switch lamps fitted with standard commercial-type double red and white reflecting lenses, and with day signal targets. This lamp type shall be located at all turnouts on the Yard Lead Track and the turnouts at the juncture of Track I3 and the existing track.

2.15.4 Not Used

2.15.5 Rail Braces

Rail braces shall be adjustable type and shall be of standard manufacture.

2.16 GRADE CROSSINGS

2.16.1 Crossing Material or Surface

Roadway width shall be as indicated in the contract drawings. Crossing material or surface shall comply with the following:

Premanufactured, precast concrete panels for grade crossings shall be constructed of reinforced concrete having a minimum 28-day compressive strength of 34.5 MPa. Precast crossing panels shall be the product of a company regularly engaged in the manufacture of such panels, and whose products have been successfully used in the commercial railroad industry for at least 2 years. Panels removed from existing crossings may be reused in the yard track crossings. New panels shall be used on all paved road and tank trail crossings.

2.16.2 Rail

Rail within the road crossing and for at least 6 m on either side of the crossing shall be 115RE as specified in paragraph Rail and Joint Bars. Rail joints shall not be located within the crossing or for at least 6 meters on either side od the crossing.

2.16.3 Ties

Ties within the road crossing and for at least 6 m on either side of the crossing shall be hardwood and shall be as specified in paragraphs Crossties and Switch Ties.

2.16.4 Track Materials

Tie plates, spikes or other rail fasteners, rail anchors, and other track materials shall conform to the manufacturer's recommendations. Unless specified by the crossing manufacturer, track materials shall be as specified in paragraph MISCELLANEOUS TRACK MATERIALS.

2.16.5 Threaded Fasteners and Screw Spikes

Threaded fasteners for use in grade crossings shall be of the sizes and lengths specified by the grade crossing manufacturer or as indicated for built-in-place crossings. Screw spikes shall have a minimum ultimate tensile strength of 414 MPa and shall be galvanized for corrosion protection.

2.16.6 Pipe for Subdrains

Pipe for subdrains shall be 152 mm diameter corrugated, perforated polyethylene complying with ASTM F 405, or bituminous coated galvanized corrugated steel.

2.16.7 Cable Conduit

Cable conduit under grade crossings shall be PVC pipe conforming to ASTM F 512, size as indicated, and shall be a minimum of Schedule 80.

2.17 MISCELLANEOUS TRACK MATERIALS

Miscellaneous track materials shall be as follows:

2.17.1 Spikes

2.17.1.1 Track Spikes

Track spikes shall be new and shall conform to Chapter 5, Part 2 of AREMA Manual. Track spikes size 152 by 16 mm shall be used with 49.6 kg/m or heavier rail. Track spikes 140 by 14 mm shall be used with 44.6 kg/m and under rail.

2.17.1.2 [Enter Appropriate Subpart Title Here]

2.17.2 Bolts, Nuts, and Spring Washers

New track bolts, nuts, and spring washers shall be used throughout the project for both new and relay rail.

2.17.2.1 Bolts and Nuts

The various rail, joint bars, and rail drillings require various lengths and diameters of bolt assemblies. The Contractor shall determine the number of bolt assemblies of each size required. All bolt diameters shall be the largest possible for a given rail drilling and joint bar punching. Track bolts and nuts shall conform to Chapter 4, Part 2 of AREMA Manual.

Track bolts shall be long enough to leave at least two threads exposed after the nut is tightened.

2.17.2.2 Spring Washers

Spring washers and nuts shall be sized to ensure that the spring washer develops its full reactive force and does not jam into the joint bar hole. Spring washers shall be of the size to fit the bolt and nut used and shall conform to Chapter 4, Part 2 of AREMA Manual, and Section M12 of AREMA Track Plans.

2.17.3 Rail Anchors

Where special tools are required to install or remove anchors, the Contractor shall furnish a minimum of one tool for each 5,000 anchors, or fraction thereof, not to exceed 5 tools per job.

2.17.3.1 New Installation

Rail anchors for new installations shall be new. Sizes shall conform to the various sizes of rail on the project and conform to "Specifications for Rail Anchors" in Chapter 5, Part 7 of AREMA Manual. Anchors may be either drive-on or spring type.

2.17.3.2 Salvaged Rail Anchors

Rail anchors salvaged from the track being removed shall become the property of the Contractor and shall be removed from the site. No used anchors shall be reinstalled.

2.17.4 Insulated Joints

Insulated joints shall conform to applicable portions of Chapter 4, Part 2 of AREMA Manual. Conventional continuous insulated joints with fibre insulation shall not be used. Unless otherwise directed by the Contracting Officer, insulated joints shall be for the rail sections and rail drilling specified in Paragraph RAIL JOINT BARS. Location of insulated joints shall be as indicated on the Electrical Plans.

2.17.5 Bumping Posts, Cushion Heads and Wheelstops

Bumping posts, and cushion heads shall be new and shall be of a standard design that has been in use by commercial railroad industry for at least 5 years. Bumping posts, and cushion heads shall be manufactured by a company regularly engaged in the manufacture of these products.

2.17.5.1 Bumping Posts

Bumping posts shall be of all-steel construction, shall bolt firmly onto the rail, and shall be of a type designed for general service. Bumping posts shall have tension and compression members with a moment of inertia not less than 435×10^4 mm^4 .

2.17.5.2 Cushion Heads

Cushion heads shall be of all steel construction, shall firmly bolt, attach, or clamp onto the bumper or end dock (platform or ramp). Cushion heads shall resist 36,240 kg of compression.

2.17.5.3 [Enter Appropriate Subpart Title Here]

2.17.6 Used Bumping Posts

Used bumping posts shall not be furnished by the Contractor. The Contractor shall furnish new fastening materials conforming to the applicable sections of this specification.

2.17.7 Inner Guard Rail

Inner guard rail shall be Class IV or better used rails as indicated in Part 2, Chapter 4, "Inspection Classification of Second Hand Rail for Welding", of AREMA Manual. Rail shall be 36.2 kg or greater. All rails used at any one inner guard rail location shall be the same weight and section. Joint bars shall match the rail provided and shall be in good condition.

2.17.8 Gage Rods

2.17.8.1 New Gage Rods

New gage rods shall be the double-clamp style manufactured in conformance with "Specifications for Special Trackwork" of AREMA Track Plans. The double clamp style gage rods shall be threaded on both ends and shall be equipped with four malleable steel casting clamps to rigidly hold both sides of the base of both rails.

2.17.8.2 Used Gage Rods

Used gage rods shall not be furnished by the Contractor. Salvaged gage rods shall not be used.

2.17.9 Derails

2.17.9.1 New Derails

New double switch point derails shall be of a standard design that has been in use by the commercial railroad industry for at least 5 years. When the type of derail indicated requires a derail stand, connecting rod, and operating mechanism for proper operation, the derail and all necessary components shall be provided as a unit. The locations, sizes, and directions of the derails shall be as indicated on the contract drawings.

2.17.9.2 Used Derails

Used derails shall not be furnished by the Contractor. Used derails shall be salvaged from existing tracks that are removed and turned over to the Government.

2.18 SALVAGED MATERIALS

2.18.1 Dunnage

Pallets, sills, and other material used for packaging and stacking salvaged track items shall be clean, free of decay or other defect, and sufficiently sturdy for the service intended.

2.18.2 Marking Paint

Marking paint shall be a good quality oil-based spray marking paint or a good quality oil-based paint marker.

2.18.3 Salvaging Rail

The Contractor shall salvage rail as directed; the Government will make available salvaged rail to the Contractor subject to the following:

a. Nondefective and reclaimable rails salvaged from existing tracks may be used to execute rail replacement work and new work at other locations of the project, subject to review and approval of the materials by the Contracting Officer.

b. Reclaimable defective rails may be used to construct inner guard rails provided all defects can be cropped off. Detailed inspection shall be made of such rails to ensure that rails which contain critical defects such as transverse defects, head-web separations, vertical split heads, pipe, split webs, etc., are not incorporated in the work.

2.18.4 Joint Bars

Nondefective joint bars salvaged from existing tracks may be used to execute spot replacement work and new work at other locations of the project, subject to review and approval of the material by the Contracting Officer. Government furnished joint bars may only be used with Government furnished rail from track demolition.

2.18.5 Tie Plates

Tie plates salvaged from existing tracks, which are not either broken, cracked, or severely corroded or worn, may be used to execute the work subject to review and approval of the material by the Contracting Officer. Government furnished tie plates, from track demolition, may be used with Contractor furnished rail of the appropriate rail section for which the plates were manufactured. The "mixing" of different tie plate designs on the same section of track will not be permitted.

2.19 RAIL BONDING AND GROUNDING

2.19.1 Rail Bonds

Rail bonds shall be exothermic type ("Cadweld") bonds applied to the field side of the rail head (signalized grade crossings only), or 1154 mm bonds welded to the rail web. The bond cables shall be flexible bare copper stranded 1/0 AWG cables with preformed ends. Bond cables shall be flexible

bare copper stranded cables with preformed ends and shall conform to applicable requirements of AREMA Manual Vol. 3.

2.19.2 Grounding Rods

Grounding rods shall be 19 mm diameter copper clad steel rods. The minimum length of ground rods shall be 2.5 m .

2.19.3 Ground Connection Cables

Connections between the grounding system or ground rods and rails shall be made with a bare flexible copper stranded 1/0 AWG cable.

2.19.4 Electrical Connecting Hardware

Electrical connecting hardware shall be bronze pressure bar type materials having no rotating parts coming in direct contact with conductors.

2.20 WELDING

2.20.1 Rail Welding Kits

Kits for thermite type rail welds shall be approved by the Contracting Officer before use.

2.20.2 Rail

Rail for welding includes Contractor furnished material. The Contractor shall provide welding kits for all rail sections used.

PART 3 EXECUTION

3.1 REMOVAL, SALVAGE, AND DISPOSITION OF MATERIALS

Tracks and segments of track shall not be dismantled until approved to do so by the Contracting Officer. The following materials shall be salvaged by the Contractor for later use by the Government. Some of these items will be used in the construction of new tracks as indicated.

3.1.1 Materials To Be Salvaged

Materials to be salvaged for later use by the Government are:

a. 90RA rail, tie plates, and joint bars required to construct EMF Track.

b. 110RE rail, tie plates and joint bars.

c. 115RE rail, tie plates and joint bars.

d. Grade crossing signals and controllers as indicated.

[AM #2]
e. 112RE rail, tie plates, and joint bars

Other materials shall become the property of the Contractor and shall be removed from the project.

3.1.2 Methods and Procedures

The Contractor may use any methods to dismantle the track, provided proper measures are taken to ensure the safety of the laborers and the general public, and no damage is caused to track components to be salvaged or other tracks and structures which are indicated to remain. Methods of removal of existing tracks shall not cause damage to adjacent sidewalks or paved roadways. Damage to these facilities caused by the Contractor shall be restored at Contractor's expense.

3.1.3 Inventory of Track Materials

The Contractor shall keep a detailed inventory of excess and salvaged track materials stockpiled for the Government. Detailed inventory shall be recorded in appropriate format and furnished to the Contracting Officer.

3.1.4 Inspection and Reconditioning of Used Track Materials

Salvaged track materials shall be cleaned and inspected for defects to determine their suitability for further use.

3.1.4.1 Cleaning By Hand or Mechanical Means

Rail, joint bars, tie plates, and other materials shall be cleaned by hand or mechanical means to remove all adhering dirt and heavy rusting so that the [AM #2]_____ steel can be examined.

3.1.4.2 Visual Examination of Rails

Rails shall be visually examined for evidence of defects such as those illustrated on Form 402-A found in Part 3 of AREMA Manual. Such defects shall be brought to the attention of the Contracting Officer who will be the final judge as to the serviceability of the rail. Rails having bolt hole cracks or end batter under paragraph TRACK REPAIR that can be reconditioned for use by cropping and redrilling shall be marked at the location of the defect with yellow paint. Rails with other defects or which cannot be reconditioned shall be rejected as scrap and shall be marked with bright red paint and stacked separately.

3.1.4.3 Visual Examination of Joint Bars

Existing joint bars and compromise joint bars which are removed and no longer required at that location due to rail replacement or other work may be cleaned and reused at other locations, subject to review and approval of the Contracting Officer. Joint bars and compromise joints that are not reused shall be salvaged or scrapped. Joint bars shall be visually examined for defects and wear. Joint bars with bolt hole or spike slot cracks shall be scrapped. Bars which do not fit tightly against the rail or bars in which the bolt holes are excessively corroded or worn shall be scrapped. The Contracting Officer will be the final judge of the

serviceability of joint bars. Scrapped bars shall be marked with bright red paint and stacked separately.

3.1.4.4 Not Used

3.1.4.5 Visual Examination of Tie Plates

Tie plates shall be visually examined for cracks, breaks, excessive wear, and excessive corrosion. Track material with these defects shall be considered scrap, marked with bright red paint and stacked separately.

3.1.4.6 Not Used

3.1.4.7 Grade Crossing Materials

Existing premanufactured grade crossing panels, rail and other track materials shall be salvaged as indicated, or as designated by the Contracting Officer. All salvaged materials shall remain the property of the Government, and shall be reinstalled as indicated or shall be transported to the military installation storage yard. Grade crossing materials to be salvaged shall be removed, cleaned as required for proper reinstallation, marked or labeled as necessary for proper reinstallation, and transported to the reinstallation location or to the storage yard.

3.1.5 Transport and Stack Excess and Salvaged Materials

3.1.5.1 Material Not Used In Track Work

Excess and salvaged materials which are not used in track work shall be stacked at a site on the military installation designated by the Contracting Officer.

3.1.5.2 Stacking of Rails

Rails shall be stacked on approved sills a minimum of 152 mm above the ground. Rails shall be stacked with the heads up and with the ends even. Each layer shall be separated by at least three 50 by 100 mm wood strips evenly spaced along the length of the rail. Rail shall be grouped by weight, section, drilling, condition, length, and amount of wear. The weight, section, drilling, and length shall be marked on one of the rails near the mid-height of the stack. These markings shall be painted neatly near one end of the rail.

3.1.5.3 Stacking of Joint Bars and Tie Plates

Joint bars and tie plates shall be sorted by section, punching and condition and shall be stacked on pallets. Each pallet stack shall be steel banded for forklift handling. The maximum weight on any pallet shall be 679.5 kg. Compromise joint bars shall be wired together in pairs and stacked on pallets, separate from other bars.

3.1.5.4 Not Used

3.1.5.5 Stacking of Special Trackwork Materials

Special trackwork materials shall be palletized and stacked as directed by the Contracting Officer.

3.1.6 Material to be Scrapped

All materials not specified to be salvaged shall be scrapped and shall become the property of the Contractor.

3.2 PLACEMENT OF BALLAST

Ballast shall be placed to the lines and grades indicated. The average thickness shall be within 6mm of the thickness shown on the drawings. Subbase shall conform to the requirements of Section 02721 SUBBASE COURSES. Subgrade shall conform to the requirements of Section 02300 EARTHWORK. Ballast shall not be placed on soft, muddy, or frozen areas. Where the prepared subbase course (roadbed) is soft, muddy, rutted, exhibits severe depressions, or is otherwise damaged, the ballast shall not be placed until the damaged subbase course has been repaired and the area has been approved by the Contracting Officer.

3.2.1 Not Used

3.2.1.1 [Enter Appropriate Subpart Title Here]
3.2.2 Ballast

3.2.2.1 Ballast Placement

Number 5 AREMA ballast shall be placed in the tracks where indicated; 100 mm of Number 5 ballast shall be used near turnouts and for 10 M each side of the switch stand to provide a smooth walking surface for railroad employees. All other areas shall require size AREMA Number 4 ballast.

3.2.2.2 Ballast Distribution

Ballast shall not be distributed until the subbase course has been approved by the Contracting Officer. No payment will be made for ballast which is distributed without the Contracting Officer's approval.

a. Ballast distribution shall be to the depth indicated and may be from either trucks or railroad cars. [A government locomotive is not available for unloading ballast.

b. Forming of ruts that would impair proper roadway drainage shall be prevented when distributing ballast from trucks and off track equipment. Any ruts formed greater than 25 mm shall be leveled and graded to drain.

c. Ballast shall be unloaded as close as possible to the point of use

so that unnecessary handling is prevented. Excess ballast shall be picked up and redistributed at the Contractor's expense. If additional ballast is required for dressing, it shall be added by the Contractor at no increase in unit price.

d. Ballast cars shall not be released until they have been inspected. Ballast cars may be weighed by the Government before and after dumping the ballast at no cost to the Contractor.

3.2.2.3 Ballast Below Ties

For new construction, the last 100 mm ballast below the tie, the shoulder ballast and the ballast in the tie cribs shall be placed subsequent to the rail and tie installation. For surfacing existing track, the ballast shall be placed subsequent to rail and tie replacements.

3.3 TRACK CONSTRUCTION AND OUT-OF-FACE RELAY

Track construction not covered specifically herein shall be in accordance with AREMA recommendations and recommended practices.

3.3.1 Roadbed Preparation

Clearing and grubbing, grading, excavation, embankment preparation, subgrade preparation, and subbase preparation shall be performed in accordance with Section 02230 CLEARING AND GRUBBING, Section 02300 EARTHWORK, and 02721 SUBBASE COURSES. Roadbed surface, grade, and drainage shall be approved prior to any distribution of construction material. Where the subgrade or roadbed is damaged during distribution of materials, ruts and depressions shall be filled and compacted and the roadbed surface reapproved prior to track construction.

3.3.2 Not Used

3.3.3 Unloading the Materials

The use of picks in the handling of ties will not be permitted. Rails shall be unloaded from cars with an approved derrick or crane and placed with the head up without dropping and with sufficient support under the base. Rails of proper length shall be distributed as necessary for road crossings, switches, joint spacing, and other special conditions.

3.3.4 Ties

Standard center-to-center spacing of crossties shall be 560 mm . Switch ties shall be spaced as indicated on the drawings. Ties shall be laid perpendicular to the center line of the track with the grain up (heartwood side down). The best ties shall be used at the rail joints. The ends of ties on one side of the track shall be parallel to the rail and the center of the tie shall be on the approximate center line of the track. The ends shall be aligned on the inside of curves and shall continue on that side until reaching a curve in the opposite direction. On double tracks, the

ties shall be aligned on the outside ends. The top surface of ties shall provide full bearing for the tie plates. Adzing shall be restricted to that necessary to provide a sound true bearing for the tie plate. Adzing in excess of 5 mm will not be permitted. Where adzing is necessary, the cut surface shall be completely saturated with creosote or other approved preservatives.

3.3.5 Tie Plates

Tracks shall be fully tie-plated. Tie plates shall be free of dirt and other foreign material when installed. Tie plates shall be placed so that the rails will have full bearing on the plate, and the plate will have full bearing on the tie. Tie plates shall be set at right angles to the rail with the outside shoulder against the base of the rail, and centered on the tie. Canted tie plates shall be installed to cant the rail inward.

3.3.6 Rail

The base of the rail and the surface of the tie and tie plate shall be free of dirt and other foreign materials prior to laying rail.

3.3.6.1 Laying Rail

Rail shall be laid without bumping or striking, to standard gage (1.435 m between points 16 mm below the top of the rail) on tangents and on curves up to 12 degrees. For curves 12 degrees and greater, the gage shall be widened 3.2 mm for each increment of 2 degrees to a maximum of 1.448 m, in accordance with TABLE V. The track shall be gauged at every third tie as spikes are being driven.

TABLE V. TRACK GAGE FOR HIGH DEGREE OF CURVATURE

Degree of Curvature (per 30.5 m (100-ft) chord)		
Equal to or Greater Than (Deg - Min)	But Less Than (Deg - Min)	Track Gage m (Ft - In.)
0 - 00	12 - 00	1.435 (4 - 8-1/2)
12 - 01	14 - 00	1.438 (4 - 8-5/8)
14 - 01	16 - 00	1.441 (4 - 8-3/4)
16 - 01	18 - 00	1.445 (4 - 8-7/8)
18 - 01	20 - 00	1.448 (4 - 9)

a. Jointed rails shall be laid, one at a time, with space allowance for expansion being provided between rail ends in accordance with TABLE VI.

b. Gaps between rail ends in insulated joints shall only be sufficient to permit insertion of standard end posts.

c. A standard rail thermometer shall be used to determine the rail

temperature. The thermometer shall be laid close to the web on the side of the rail base which is shaded from the sun's rays in advance of the laying operation and left there long enough to accurately record the temperature. The contractor quality control representative shall see that rail temperature is checked frequently and that proper rail expansion shims are used. All thermometers shall be calibrated against the Contracting Officer's rail thermometer which will have been accurately calibrated and will be considered as the standard.

d. Except through turnouts and at insulated joints, the staggering of the joints on one side shall not vary more than 460 mm in either direction from the center of the opposite rail.

e. Rails less than 10 m in length shall not be used in out-of-face rail relay. However, rails not less than 4 m long may be used for final connections to existing rails to prevent joints from occurring at prohibited locations or to provide the specified joint stagger in curves.

f. Rail joints shall not occur in or within 6 m of a road crossing, alongside of or within 1.5 m of the end of any switch or turnout guard rail.

3.3.6.2 Joints

The joints in opposite rails shall be staggered one-half the rail length but not less than 3.5 m apart, except closer joints may be required at turnouts and insulated joints. Rail less than 4 m in length shall not be installed in track. No joint shall be less than 2 m from the ends of open-deck bridges, or less than 1 m from switch points. No joint shall be installed within 6 m of a road crossing, outer perimeter of any structure, or any location which restricts access to the joint. Where joints are required in these areas, the joints shall be welded.

3.3.6.3 Expansion Allowance

Allowance for expansion shall be provided at rail joints by using rail-expansion metal shims. Shims shall be removed to within 12 rails of the laying. Shims shall be of the thickness shown in TABLE VI. The temperature of the rail shall be determined by use of a thermometer placed on the rail base on the side away from the sun. Typical rail gap gauges are as shown.

TABLE VI. SHIM THICKNESS

10.1 m (33 Ft) Rail 99 Joints per km		11.9 m (39-Ft) Rail 84 Joints per km		24.4 m (78-Ft) Rail 42 Joints per km	
Rail Temperature (degrees C)	Shim Thickness (mm)	Rail Temperature (degrees C)	Shim Thickness (mm)	Rail Temperature degrees C)	Shim Thickness (mm)
Below -23	8	Below -14	8	Below 2	8
-23 to -10	6	-14 to -4	6	2 to 8	6
-9 to 1	5	-3 to 7	5	9 to 16	5
2 to 15	3	8 to 18	3	17 to 23	3
over 16	2	over 19	2	over 24	2

3.3.6.4 Cutting Rail

Only rail saws or track chisels shall be used to cut rail. New holes shall be drilled using a standard template. Holes shall not be burned in rail. Holes cut with a torch will not be accepted. When drilling of rail is necessary, all chips and burrs shall be removed before applying joints.

3.3.6.5 Matching Rails

Where relay rail is used, matching adjacent rails shall not cause lipped or uneven joints. Any mismatched rail ends shall be welded to provide proper match. Rail end mismatch shall not exceed 3 mm on gage or tread portions of rail.

3.3.6.6 Rail Replacement

The following procedures apply to rail replacement work:

a. Spot rail replacement is defined as replacement of 30 m or less of contiguous rails, usually with rails of the same section. Installation of relief rail in place of defective rail is considered spot rail replacement. Replacement of more than 30 m of contiguous rails shall be considered to be out-of-face rail relay.

b. If spikes are withdrawn, the holes shall be plugged with treated tie plugs of proper size to fit the hole, prior to replacement of rail. If spikes are withdrawn and spikes are to be redriven in existing spike holes, the holes shall be plugged with treated tie plugs prior to redriving the spike. Tie plugs shall not be installed in prebored holes unless spikes have been driven and withdrawn.

c. All ties shall be spiked with new spikes in accordance with paragraph Spot Tie Replacement.

d. The Contractor shall ensure that rail ends at joints are not lipped or uneven. Tread portion (vertical) or gage side (horizontal) rail end mismatch shall be no greater than 2 mm. Rail end mismatch greater than 2 mm shall be corrected by welding and grinding on the smaller rail. Grinding the larger rail is not permitted unless approved by the Contracting Officer. Welded transitions shall be made at a rate of 1 to 80.

e. Rails removed from track will be designated by the Contracting Officer as relay (for use on project), reclaimer (to be salvaged and stockpiled), or scrap. Joint bars removed from track will be designated as relay, reclaimer, or scrap. The Contractor shall mark scrap materials as scrap using bright red paint, transport them off the military installation . Relay materials required to complete other work of this contract shall be transported to the location of need. Reclaimer materials shall be classified and inventoried and stacked at the military installation storage site, all as indicated for salvage materials in paragraph Removal, Salvage, and Disposition of Materials.

f. Metal rail expansion shims shall be used when laying rail. Wood sticks or other material shall not be used as shims. The Contractor shall have a sufficient supply of each shim available to permit rail laying to progress without delay.

3.3.6.7 Out-of-Face Rail Relay

The Contractor shall replace existing rail with the designated new or used rail between designated limits in a continuous operation. It is expected that replacement of one rail of a given track will be completed prior to replacement of the opposite rail. Used rail shall be laid with previous gage side wear facing out, unless required to match existing wear patterns.

3.3.6.8 Spot Rail Replacement

Spot rail replacements shall be made where necessary to replace existing defective rails or to compensate for rail joint gap adjustments.

a. Replacement Rail: Replacement rail shall be of equal length or longer than the rail it replaces. The minimum length of rail used shall be 4 mm .

b. Spot Rail Replacement Resulting in Joint Staggers: Unless otherwise approved by the Contracting Officer on a case by case basis, spot rail replacement shall not result in joint staggers less than 1.33 m.

3.3.7 Joint Bars

Joint bars shall be clean, and the contact surfaces coated with petrolatum or petrolatum base compound with a corrosion inhibitor. Rail joints shall be installed so that bars are not cocked between the base and head of the rail. Bars shall be properly seated in the rail and the full number of correct-size bolts, nuts, and spring washers installed. Bolts shall be

placed with nuts alternately on inside and outside of rail. A corrosion resistant lubricant shall be applied to the bolt threads prior to application of nuts. Bolts shall be tightened to torque of approximately the value shown below for the applicable bolt size, beginning at the center of the joint and working both ways to the ends of the joint. After the track has been in service, but before acceptance of the work, all bolts shall be checked and retightened to a torque of approximately the value shown below for the applicable bolt size. Rail of different sections shall be connected by properly fitting compromise joint bars. The mismatch for compromise joints for either tread surface or on the gage side shall not exceed 3 mm . Defective joint bars discovered by the Contractor during track work operations, or as identified by the Contracting Officer shall be replaced with acceptable joint bars.

BOLT DIAMETER		TORQUE	
(mm)	(in.)	(N m)	(ft-lbs)
19	3/4	340	250
22	7/8	408	300
25	1	476	350
29	1-1/8	544	400

3.3.8 Spiking

3.3.8.1 Spiking Procedures

Rail shall be spiked promptly after being laid. Spikes shall be started and driven vertically and square with the rail. Spikes shall be driven to allow approximately 3 to 5 mm space between the underside of the spike and the top of the rail base. Spikes shall not be overdriven, or straightened while being driven. Spikes shall not be installed through the slots in skirted-type, slotted joint bars (angle bars). Spikes shall not be driven against the ends of joint bars.

3.3.8.2 Number of Spikes

Four rail-holding spikes shall be used on each tie on tangents and curves less than 4 degrees. Spikes on the gage side of the running rail shall be placed directly across from each other and the spikes on the field side of the running rail shall be placed directly across from each other. This pattern shall be held consistent. On curves 4 degrees or greater but not more than 8 degrees, six spikes shall be used on each tie with the spikes located as follows: High rail, one rail-holding spike and one plate holding spike on the field side and one on the gage side; Low rail, one rail-holding spike on the gage side, one rail-holding spike on the field side, and one plate-holding spike on the field side. Curves 8 degrees and greater shall be spiked with eight spikes per tie, located as follows: High rail, one rail-holding spike and one plate-holding spike on the field side and two rail-holding spikes on the gage side; Low rail, one rail-holding and one plate-holding spike on both the gage and field sides. Eight rail-holding spikes shall be used on each tie through road crossings.

3.3.9 Tie Plugs

If spikes are withdrawn, the holes shall be swabbed with creosote and plugged with creosoted tie plugs of proper size to fit the hole. If spikes are withdrawn and spikes are to be reinserted in existing spike holes, the holes shall be swabbed with creosote and plugged with creosoted tie plugs prior to redriving the spike. Tie plugs shall not be installed in prebored holes unless spikes have been driven and withdrawn.

3.3.10 Rail Anchor Placement

Rail anchors shall be located as indicated on the project plans. Where the use of rail anchors is indicated, apply the anchors per 11.9 m of rail in the number and pattern indicated on the project drawings. The rail anchors shall be spaced approximately uniformly along the rail length. Rail anchors shall be installed to the gage side of the rail against the same tie face on opposite rails. Rail anchors shall grip the base of the rail firmly and shall have full bearing against the face of the tie. Rail anchors shall not be moved by driving them along the rail. Rail shall be anchored immediately after spiking and before rail has experienced a large temperature change.

3.3.11 Not Used

3.3.12 Derails

Derails shall be properly installed where indicated. Derailed equipment shall not foul other tracks. Installation shall be in accordance with the manufacturer's instructions. Where no specific installation instructions are available for salvaged derails, reinstallation shall be in accordance with good track construction practice to ensure proper performance of their intended function.

3.3.13 Superelevation

Curves located on the Yard Lead Track (south of the main facility), the Wye Track, and the Biggs Spur realignment shall be superelevated unless otherwise directed by the Contracting Officer. Superelevation shall be obtained by raising the outside rail of the curve. The inside rail shall be maintained at grade. The maximum superelevation will be 15 mm . Full superelevation shall be carried throughout each curve. Superelevation runoff shall be at a uniform rate, and shall be applied on the tangents at the beginning and end of the curve. Where the required tangent length is not available due to the proximity of a turnout, the runoff can be extended into the curve. The rate of superelevation runoff shall be 13 mm in 9.4 m .

3.3.14 Preliminary Surfacing

The preliminary alignment and surfacing gangs shall follow the unloading of the ballast. Rail renewal, tie renewal, bolt tightening, and ballast placement shall be complete prior to commencement of surfacing and alignment work.

3.3.14.1 Lifts

a. The track, after being aligned, shall be brought to grade and surface in lifts not exceeding 100 mm each. After each lift, the ballast shall be tamped. When using jacks, they shall be placed close enough together to prevent undue bending of rail or stress of rail and joint. Both rails shall be raised at one time and as uniformly as possible, except where superelevation is required. The track shall be so lifted that after a period of not less that 5 train operations (70 metric ton ballast car) after the last lift, it will be necessary to give the track a final lift of between 25 and 50 mm to bring it to grade.

b. In areas where major track resurfacing is not required, the Contractor shall perform a "skim lift" tamping operation to ensure that the ties are adequately tamped, the ballast section is adequately compacted and dressed, and to correct minor deficiencies in surface and alignment. The rise in skim lift areas shall be 25 mm or less and usually will not require that additional ballast be placed.

c. A 50 mm rise shall provide an average 50 mm raise in the track being surfaced.

d. A 100 mm rise shall provide an average 100 mm raise in the track being surfaced, and shall be made in at least two lifts not to exceed 50 mm per lift.

e. A 150 mm raise shall provide an average 150 mm raise in the track being surfaced, and shall be made in at least 2 lifts. The initial lift shall not exceed 100 mm with the final lift not to exceed 70 mm.

3.3.14.2 Tamping

Raising and tamping of track shall be performed with an automatic, vibratory, squeeze type power tamper with 16 tamping heads, capable of raising both rails simultaneously and maintaining cross-level. The equipment to be used for surfacing operations is subject to approval by the Contracting Officer. Every tie in the track shall receive two or more full insertions of the tamping heads. Ballast shall be power-tamped under both sides of ties from each end to a point 380 mm inside each rail for 2.6 m ties,. The center shall be filled with ballast, but tamping will not be permitted in the center of the tie between the above stated limits. Both ends of the ties shall be tamped simultaneously and tamping inside and outside of the rail shall be done at the same time. Tamping tools shall be worked opposite each other on the same tie. Ballast under switch ties and road crossing ties shall be tamped the entire length of each tie. All ties shall be tamped to provide solid bearing against the base of the rail after the track or turnout is raised to grade at final surfacing. All down ties shall be brought up to the base of rail and shall be machine tamped. The resultant track surface and alignment shall be uniform and smooth. Tamping of track in snow or frozen ballast conditions will not be permitted.

3.3.14.3 Replacement of Ties

After tamping has been completed and the jacks removed, all ties pulled loose shall be replaced to their proper position, respiked and retamped to provide full bearing against the rail.

3.3.14.4 Not Used

3.3.14.5 Runoff of Track Raises

The runoff at the end of a rise shall not exceed 13 mm in 9.4 m of track unless otherwise approved by the Contracting Officer.

3.3.14.6 Horizontal Realignment

Horizontal realignment of curved track shall be established by the Contractor using manual or mechanical means as described in the AREMA Manual Chapter 5, Part 3 article titled, "String Lining of Curves by the Chord Method".

3.3.15 Final Surfacing

After preliminary surfacing has been completed, grade and line stakes shall be checked and the track brought to grade and alignment.

3.3.15.1 Final Tamping

Track shall be brought to grade and the ballast retamped in the manner described for preliminary surfacing, except that the tamping distance inside the rail shall be decreased from 380 to 330 mm for 2.6 ties.

3.3.15.2 Final Alignment

The track shall be given a final aligning conforming to the established track centers.

3.3.15.3 Final Dressing

After the final alignment the ballast shall be dressed to the section indicated. After final dressing ballast shall not cover the tops of the ties. The portion of the subgrade outside the ballast line shall be left with a full, even surface and the shoulder of the subgrade shall be properly dressed to the indicated section to provide proper drainage away from the track.

3.3.15.4 Surplus Ballast

Surplus ballast remaining after final surfacing and dressing of the ballast section shall be distributed or otherwise disposed of as directed by the Contracting Officer.

3.3.16 Cleanup

Upon completion of the work, the Contractor shall remove all rubbish,

waste, and discarded materials generated by the work from the project area . Areas where the Contractor has worked, including but not limited to, project areas, material storage sites, and borrow or disposal areas shall be left in a clean, well-graded, and well-drained condition.

3.3.16.1 Shoulder Removal and Reconstruction

Where track construction operations result in deposition of materials along the track shoulders that would impede the free drainage of the track structure, the Contractor shall remove the material. Where undercutting or ploughing operations leave fouled shoulder materials that impede free drainage of the the track structure, the shoulder material shall be removed, and the ballast shoulders shall be reconstructed using the materials and dimensions as indicated.

3.3.16.2 Spoil Materials

Spoil materials removed from the track shall be disposed of off site at the Contractor's expense. Spoil materials shall not be placed on the shoulders, in ditches, in drains, or in other areas where they would impede the flow of water away from the track.

3.3.17 Final Adjustments

Sixty calendar days after the track has been accepted and put into operation, the Contractor shall perform, at no cost to the Government, necessary resurfacing adjustments to leave the track in alignment and on grade.

3.3.18 Tolerances for Finished Track

Completed track shall meet the following tolerances. Track not meeting the tolerances specified below shall be repaired to meet these requirements, at no additional cost to the Government.

3.3.18.1 Gage

Track gage shall be within plus 6 mm or minus 3 mm of standard gage.

3.3.18.2 Alignment

Alignment shall be measured as the deviation of the mid-offset of a 18.9 m line, with the ends of the line at points on the gage side of the line rail, 16 mm below the top of the railhead. Either rail may be used as the line rail on tangent track; however, the same rail shall be used for the entire length of the tangent. The outside rail in a curve is always the line rail. Alignment on tangents shall not deviate from uniformity more than 13 mm Alignment on curves shall not deviate from uniformity more than 10 mm .

3.3.18.3 Track Surface

Track surface shall meet the following requirements:

a. The runoff at the end of a raise shall not exceed 13 mm in any 9.4 m of rail.

b. The deviation from design profile on either rail at the mid-ordinate of a 18.9 m chord shall not exceed 13 mm.

c. Deviation from zero cross level at any point on tangent or from designated superelevation on curves shall not exceed 13 mm .

d. The difference in cross level between any two points less than 18.9 m apart on tangents.

3.3.18.4 Guard Face Gage

Guard face gage is the distance between the guard lines measured across the track at right angles to the gage line, and is measured at the point of frog on both sides of the turnout. The design value for guard face gage is 1340 mm . Guard face gage shall be within plus or minus 3 mm of the design value.

3.3.18.5 Guard Check Gage

Guard check gage is the distance between the gage line of a frog and the guard line of its guard rail, or guarding face, measured across the track at right angles to the gage line. The design value for guard check gage is 1388 mm . Guard check gage shall be within plus or minus 3 mm of the design value.

3.4 TURNOUTS

Turnouts shall be located as indicated on the drawings. Switch, frog and guardrail assemblies shall be complete. Stock rails shall be accurately bent. Changes in rail weight or section will not be permitted within the limits of the switch ties. Headblocks shall be at right angles to the main track and shall be securely spiked in place. Except where directed otherwise, switch stands shall be installed so that when the switch is set for the normal position, the connecting rod keeps the points closed with a pulling force. Switches shall be properly adjusted. Switch components and slide plates shall be lubricated.

3.4.1 Not Used

3.4.1.1 [Enter Appropriate Subpart Title Here]
3.4.2 Not Used

3.4.2.1 [Enter Appropriate Subpart Title Here]
3.5 ROAD CROSSINGS

Road crossings within the project shall be constructed as indicated on the contract drawings.

3.5.1 Subgrade

Drainage areas shall be cleaned and sloped away from the crossing in both directions along the track and the roadway. Surface ditches and Subdrains shall be installed as indicated.

3.5.2 Geotextile Installation

Geotextile shall be placed between the subgrade and the ballast section in the crossing area and for 6 m beyond each end of the crossing.

3.5.2.1 Preparation

Surfaces on which geotextiles will be placed shall be prepared in accordance with the applicable portions of this specification and shall be free of irregularities such as sags, cavings, erosion, or vegetation. Any irregularities shall be corrected to ensure continuous, intimate contact of the geotextile with the whole surface. Any loose material or debris shall be removed prior to geotextile placement.

3.5.2.2 Placement

a. Not used.

b. Not used.

c. The geotextile shall be carefully placed on the prepared surface with the long dimension parallel to the prepared surface. The geotextile shall be placed free of wrinkles, folds, creases, and tension. The geotextile shall be held in place by pins, small aggregate piles or ballast bags, until it is completely covered. The geotextile shall be covered immediately after placement in track. The maximum exposure time for the geotextile, from removal of the protective shipping cover to placement of the ballast cover materials which prevent exposure to sunlight, shall be 2 consecutive days.

d. The minimum overlap of geotextile splicing seams shall be 900 mm. If several geotextile units are placed with the required overlap prior to the placement of the ballast, the overlap distance of each overlap shall be checked as placement of ballast approaches the overlap. The Contractor shall ensure that the required overlap exists when the geotextile is covered.

e. The geotextile shall remain free of any contamination such as mud, dust, sediment, debris, etc., that will impair its function. Contamination shall be removed without damage to the geotextile or to the prepared surface at the Contractor's expense. If the geotextile is damaged, its function impaired by the cleaning efforts, or if it cannot be properly cleaned, the Contractor shall repair the prepared surface, if necessary, and replace the damaged or impaired geotextile with geotextile meeting requirements of this specification. Equipment shall not operate in direct contact with the geotextile. Surface drainage, as much as possible, shall be directed away from the geotextile installation area to prevent accumulation of mud, debris, and sediment.

3.5.2.3 Placement of Cover Material

Placement of ballast cover material in contact with the geotextile shall be performed ensuring intimate contact of the geotextile with the prepared surface and with the cover material. The placement shall be performed without damage to the geotextile including tears, punctures, or abrasion.

3.5.2.4 Equipment Operations on the Cover Material

A minimum depth of 200 mm of cover material shall be placed over the geotextile before equipment is allowed to operate on the covered geotextile. Equipment operations on the covered geotextile shall be limited to those necessary for track construction and equipment turning will not be allowed on the covered geotextile.

3.5.2.5 Minimum Ballast Depth

The minimum depth of ballast between the bottom of the tie and the top of the geotextile shall be 406 mm.

3.5.2.6 Tamping Operations

Tamping of ballast materials shall be performed by setting the tamping force and insertion depth to the minimum necessary to adequately tamp the track. The tamper operator shall monitor the depth of tamping and limit the depth to prevent detrimental effects of the tamper feet on the geotextile.

3.5.2.7 Double Layers

Double layers of geotextile will not be allowed, except for splicing overlaps at seams.

3.5.3 Ballast Placement and Surfacing

Ballast shall be placed and tamped as specified in paragraph TRACK CONSTRUCTION AND OUT-OF-FACE RELAY except that in crossings, the ballast between the ties shall be thoroughly compacted with a vibratory compactor, or other approved means, after each raise. The ballast shall be tamped for the entire length of the crossties for road crossings. The track shall receive final alignment and surfacing prior to placement of the crossing surface. Final surfacing shall bring the track to the final grade and alignment as indicated on the contract drawings. The ballast in the cribs and on the shoulders shall be compacted using a vibratory plate compactor or other approved means.

3.5.4 Ties

Hardwood ties shall be used. Spacing shall be a minimum of 500 mm center to center. For premanufactured grade crossings, ties shall conform to the manufacturer's recommendations for the type of grade crossing surface materials being used.

3.5.5 Tie Plates, Spikes, and Anchors

All ties within the crossing and for 6 m beyond each end of the crossing shall be fully tie plated, and spiked with 4 rail-holding spikes per tie plate.

3.5.6 Rail

Rail within the crossing area and for 6 m beyond each end of the crossing shall be, at a minimum, 57 kg/m (115 RE). Rail shall not be protected from corrosion by application of an approved rust inhibitor. Bolted joints will not be permitted in any crossing or within 6 m of either edge of the crossing surface. Bolted joints will be eliminated by either field welding the joints to form continuous rail throughout this area or by using 24.4 m rail lengths.

3.5.7 Lining and Surfacing

Rail shall be spiked to line and the track mechanically tamped and surfaced to the grade and alignment of the existing track and roadway.

3.5.8 Crossing Surface

The surface of the roadway shall be in the same plane as the top of the rails for a distance of 600 mm outside of the rails for either single or multiple-track crossings. A smooth transition shall be made between the crossing surface and the adjoining pavement.

3.5.8.1 Not Used

3.5.8.2 Not Used

3.5.8.3 Not Used

3.5.8.4 Not Used

3.5.8.5 Not Used

3.5.8.6 Not Used

3.5.8.7 Type 4b Prefabricated Concrete Panel Crossings

Type 4A crossings and crossing materials shall be installed in accordance with the crossing manufacturer's instructions. Tie spacings and track materials used in the crossing shall be in accordance with the installation instructions and manufacturer's recommendations.

3.5.8.8 Not Used

3.5.9 Signs and Signals

The type and location of railroad-roadway crossing warning signs and signals shall conform to the requirements of FHWA SA-89-006, Part VIII.

3.5.9.1 Location and Positioning of Signs

Signs for both roadway and railroad track installation shall be located and erected as shown. Unless otherwise shown, signs shall be erected so that sign face is vertical and at a deflection angle of 87 degrees from the center of the roadway lane or track which the sign serves and facing the direction of travel. Where lanes or tracks are on curves, sign faces shall be on a deflection angle of 87 degrees to the tangent to the curve. Signs shall be erected so that specular reflection is minimized or eliminated. After installation is completed, the signs will be inspected during the day and at night by the Contracting Officer. If specular reflection is apparent on any sign, its positioning shall be adjusted to eliminate or minimize this condition. This adjustment and any subsequent adjustments shall be at no additional cost to the Government.

3.5.9.2 Traffic Control

During installation of roadway signs, the Contractor shall provide for the safe and expeditious movement of traffic through the work area. Schedule of lane closures, work zone safety and traffic control, and related items shall be provided.

3.5.10 Crossing Flangeways

Upon completion of the grade crossing installation, the flangeways through the crossing shall be a minimum of 50 mm deep and between 65 and 75 mm wide. The Contractor shall ensure that adequate flangeways are provided prior to installation of the final crossing surface.

3.5.10.1 Flangeway Filler

Except for Type I crossings all open crossing flangeways shall be filled with asphaltic concrete and compacted as indicated on the drawings.

3.5.10.2 Clean Grade Crossing Flangeways

Where grade crossing flangeways are obstructed (filled in), the Contractor shall remove foreign material to provide a minimum 50 mm depth and 65 mm width flangeways on the gage side of the rails.

3.6 BONDING AND GROUNDING TRACK

Track shall be bonded and grounded as indicated. Where track is designated for bonding and grounding, the rails shall be bonded electrically continuous and effectively grounded. Connections shall be made by exothermite welds in accordance with the manufacturer's instructions.

3.6.1 Rail Joint Bond

Rail joints on both rails of designated track shall be bonded using an exothermic type bond . The bond shall be applied to the field side of the rail web unless otherwise approved by the Contracting Officer. Track to be bonded and grounded shall be electrically insulated from the remaining track using one of the specified insulated joints.

3.6.2 Rail Cross-Bond and Ground

Rail cross-bond and ground shall be installed using an exothermic type bond. The cross-bond shall be applied to the rail web. One cross-bond and ground shall be installed at 30.5 m intervals along the designated tracks. Connections between grounding system or ground rods and rails shall be made with bare stranded copper cable, installed at least 300 mm below the bottom of the ties. Ground rods shall be driven vertically full-length. The top of the ground rod shall be located at the toe of the ballast slope and shall be a minimum of 300 mm below the top of the subgrade. Maximum resistance to ground from any grounded rail or structure shall not exceed 25 ohms. The Contractor shall make any corrections needed to reduce the resistance to below 25 ohms at no cost to the Government.

3.6.3 Inspection of Rail Bond and Ground

Loose, damaged, or missing rail bond wires, cross bond wires, ground connections, and ground rods shall be visually inspected. If there is a signal failure, bonding can be tested for current loss in the joints using a volt meter. Defective items shall be marked for repair.

3.6.4 Rail Bonds At Signalized Grade Crossings

Bolted rail joints within the approach circuits to signalized roadway grade crossings shall be double-bonded using both a rail head bond and a web bond.

3.6.5 Existing Bonds

The Contractor shall protect existing rail bonds, cross-bonds,, ground connections, and grounding rods from damage. Except for bonds attached to rails which are designated to be replaced in this contract, replacement of bonds damaged or destroyed by the Contractor's operation shall be replaced at no cost to the Government.

3.6.6 Removal of Defective Bonds

Bonds shall be removed by shear cutting old cables immediately adjacent to the weld. Flames or torches shall not be used to remove defective bonds.

3.7 INSTALLATION OF MISCELLANEOUS TRACK MATERIALS

3.7.1 Tie Plates

Tie plates shall be furnished to the work sites as required. Excess tie plates, remaining at the conclusion of the contract, shall be delivered to

the military installation storage site and stacked where directed by the Contracting Officer.

3.7.2 Insulated Joints

Insulated joints shall be installed where indicated and in accordance with the manufacturer's installation instructions.

3.7.3 Bumping Posts and Cushion Head

Bumping posts and cushion head shall be installed where indicated. Installation shall be in accordance with the manufacturer's instructions. Existing bumping posts and cushion heads on tracks to be removed shall become property of the Contractor.

3.7.4 Not Used

3.7.5 Gage Rods

3.7.5.1 Installation of Rods in The Crib and Closure Rail

One gage rod shall be installed in the crib immediately ahead of the switch point of all turnouts. Two gage rods shall be installed on the curved closure rail, one ahead of the joint, and one ahead of the toe of the frog in all turnouts.

3.7.5.2 Rods Per Rail Length

Three gage rods shall be installed per rail length on all curved track with a greater than 10 degrees curvature (0.174 radians, 174.86 m radius).

3.7.6 Installation of Joint Bars

Joint bars shall be installed with their full number of bolt assemblies unless otherwise noted. Bars shall be properly seated on the rail and the bolts tightened beginning at the center of the joint and working toward the ends of the bars, alternating between rails. Bolts used shall be of the proper diameter and length for the rail and joint bars at the joint. The use of extra washers to shim out track bolt nuts is prohibited. Bolts with nuts shall be placed alternately on inside and outside of rail.

3.8 Not Used

3.8.1 [Enter Appropriate Subpart Title Here]
3.9 ELECTRIC ARC WELDING

Welding shall be done in accordance with AREMA Manual, Chapter 5, Part 5, "Electric Arc Welding".

3.9.1 Welding Supervision

Electric arc welding shall be performed under the direct supervision of an experienced welding supervisor or foreman and by a certified welder.

3.9.2 Weather Conditions

Welding shall not be performed in rain, snow, or other inclement weather without adequate protection of the welding from the elements.

3.9.3 Not Used

3.9.3.1 [Enter Appropriate Subpart Title Here]
3.9.4 Not Used

3.9.5 Not Used

3.9.5.1 [Enter Appropriate Subpart Title Here]
3.9.6 Not Used

3.9.6.1 [Enter Appropriate Subpart Title Here]
3.9.7 Welding Rail Joints

Bolts in the joint bars shall be tightened and the joint pulled to a level surface. Joint bars shall be checked for wear and replaced if they are badly worn. Six hole bars shall be used if available. A straightedge shall be placed across the joint to determine the amount of batter. The straightedge shall be a minimum of 450 mm in length. A rail joint with less than 3 mm of batter shall not be welded. If batter is 3 mm or more, the rail joint shall be built up. If rail cracks or chipped out places are present in rail ends, they shall be melted out with acetylene torch, gouged out with arcair or ground out with grinder. If cracks or chips extend below ball, rail shall be replaced. If horizontal crack in ball of rail extends more than 200 mm rail shall be replaced. Rail ends shall be preheated to approximately 93 degrees C before welding. Starting 40 mm from the end, the rail shall be built back as follows: A strip shall be welded 25 mm into bead; the rail ends shall be ground to a level surface with surface grinder or cup wheel attachment; and rail joint shall be cross slotted with 5 mm grinding stone to keep rail ends from overlapping and chipping out.

3.10 THERMITE WELDING PROCEDURES

Thermite welding procedures shall be performed by a technician certified to meet ANSI/ASNT CP-189, level II or III qualifications and comply with the following paragraphs:

3.10.1 End Preparation

Rails to be welded shall meet the requirements of Paragraph 1, "Specifications for Fabrication of Continuous Welded Rail" given in Chapter 4, Part 2 of AREMA Manual. The rail ends shall be aligned in accordance with paragraph GAP AND ALIGNMENT. Rail ends shall show no steel defects, dents, or porosity before welding. Bolt holes shall not be made in, or permitted to remain in, the ends of the rail to be welded. One handling hole may be made in each end of welded string. Rail ends containing such holes shall be cut off during track construction. Rail which must be cut

for any reason shall be cut square and clean by means of approved rail saws or abrasive cutting wheels in accordance with Chapter 5 of AREMA Manual, article, "Recommended Practice For Use of Abrasive Wheels".

3.10.1.1 Cleaning

The rails to be welded shall be cleaned of grease, oil, dirt, loose scale, and moisture to a minimum of 150 mm back from the rail ends, including the railhead surface. Cleaning shall be accomplished by use of a wire brush, to completely remove dirt and loose oxide and by use of oxygen-acetylene torch to remove grease, oil and moisture. A power grinder with an abrasive wheel shall be used to remove scale rust, burrs, lipped metal and mill brands which would interfere with the fit of the mold, for 50 mm on each side of the ends.

3.10.1.2 Gap and Alignment

The minimum and maximum spacing between rail ends shall be as specified by the rail welding kit manufacturer and the approved welding procedures.

a. The ends of the rails to be welded shall be properly gapped and aligned to produce a weld which shall conform to the alignment tolerances below. Alignment of rail shall be done on the head of the rail. The rail gap and alignment shall be held without change during the complete welding cycle.

b. Vertical alignment shall provide for a flat running surface. Any difference of height of the rails shall be in the base.

c. Horizontal alignment shall be done so that any difference in the width of heads of rails shall occur on the field side. Horizontal offsets shall not exceed 1 mm in the head and/or 3 mm in the base.

3.10.2 Surface Misalignment Tolerance

Combined vertical offset and crown camber shall not exceed 3 mm per meter at 315 degrees C or less. Combined vertical offset and dip camber shall not exceed 1 mm/m at 315 degrees C or less.

3.10.3 Gage Misalignment Tolerance

Combined horizontal offset and horizontal kink camber shall not exceed 3 mm/m at 315 degrees C or less.

3.10.4 Thermite Welding

Welding shall be done in accordance with Chapter 4, Part 2 of AREMA Manual, articles "Thermite Welding - Rail Joints" and "Specifications for Fabrication of Continuous Welded Rail", except as modified by these specifications. All welds shall be visually inspected at the time of welding.

3.10.4.1 Thermite Weld Preheating

The rail ends shall be preheated prior to welding to a sufficient temperature and for sufficient time as indicated in the approved welding procedures to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld.

3.10.4.2 Thermite Weld Cooling

The molds shall be left in place after tapping for sufficient time to permit complete solidification of the molten metal and proper slow cooling to prevent cracking and provide a complete weld with proper hardness and ductility.

3.10.5 Weld Finishing and Tolerances

Welded joints in the finished track shall be brought to a true surface and alignment by means of a proper grinding or planing machine (shear). Finish grinding shall be performed with an approved grinder operated by a skilled workman grinding evenly and leaving the joints in a smooth and satisfactory condition. Finishing shall eliminate all cracks. The completed weld shall be finished by mechanically controlled grinding in conformance with the following requirements:

a. A finishing deviation of not more than plus or minus 1 mm of the parent section of the rail head surface will be allowed. The gage side of the rail head shall be finished to plus or minus 1 mm of the parent section.

b. Welds produced by welding kits which are specially designed to produce reinforced welds need not be ground in the finishing area except as necessary to remove fins, burrs, cracks, etc.

3.10.6 Weld Quality

Each completed weld shall have full penetration and complete fusion and be entirely free of cracks or fissures. Welds shall meet the acceptance criteria given in AWS D1.1.

3.10.7 Weld Numbering

The Contractor shall semi-permanently mark a sequential weld number on the rail immediately adjacent to the weld, using a quality lead paint marker at the time the weld is made. Welds shall be numbered sequentially in the order in which they are made. The Contracting Officer will provide the Contractor with the initial weld number. Defective welds which are replaced shall be assigned a new sequential number by adding a letter to the defective weld number (e.g., defective weld 347 would be replaced by 347A).

3.11 Not Used

3.11.1 [Enter Appropriate Subpart Title Here]
3.12 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory, or by the Contractor, subject to approval. If the Contractor elects to establish testing facilities, approval of such facilities shall be based on compliance with ASTM D 3740. Work requiring testing will not be permitted until the Contractor's facilities have been inspected and approved. The first inspection of the facilities will be at the expense of the Government and any subsequent inspections required because of failure of the first inspection shall be at the expense of the Contractor. Such costs will be deducted from the total amount due the Contractor.

3.12.1 Ballast Samples

Periodic sampling and testing of ballast material shall be performed to ensure continued compliance with this specification. During construction, one representative sample of the ballast material shall be taken from each 1818 metric tons of ballast delivered to determine the material gradation. For each 9090 metric tons or a fraction thereof of ballast delivered, an additional amount of material shall be obtained in order to perform the quality and soundness tests specified. Samples for material gradation, quality, and soundness tests shall be taken in conformance with ASTM D 75. Test samples shall be reduced from field samples in conformance with ASTM C 702. Sample sizes shall be sufficient to provide the minimum sample sizes required by the designated test procedures. If any individual sample fails to meet the gradation requirement, placement shall be halted and immediate corrective action shall be taken to restore the specified gradation. If any individual sample fails to meet the specified quality and soundness requirements, placement shall be halted and immediate corrective action shall be taken to restore the specified quality.

3.12.2 Ballast Tests

3.12.2.1 Sieve Analyses

Sieve analyses shall be made in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11.

3.12.2.2 Bulk Specific Gravity and Absorption

Bulk specific gravity and absorption tests shall be made in conformance with ASTM C 127.

3.12.2.3 Percentage of Clay Lumps and Friable Particles

The percentage of clay lumps and friable particles shall be determined in conformance with ASTM C 142.

3.12.2.4 Degradation Resistance

Resistance to degradation of materials shall be determined in conformance with ASTM C 131 and ASTM C 535. Materials with gradations having 100 percent passing the 25 mm sieve, shall be tested in conformance with ASTM C 131. Materials having gradations with particles larger than 25 mm shall be tested in conformance with ASTM C 535.

3.12.2.5 Soundness Test

Soundness tests shall be made in conformance with ASTM C 88.

3.12.2.6 Percentage of Flat or Elongated Particles

The percentage of flat or elongated particles shall be determined in conformance with CRD-C-119.

3.12.3 Tie Inspection

The Contractor shall be responsible for the quality of the treated ties. Each tie shall be permanently marked or branded by the producer in accordance with AWPA M6. Each treated wood tie shall be inspected, in accordance with AWPA M2, for conformance with the specified AWPA standards. The 100 percent inspection shall be performed by an independent inspection agency approved by the Contracting Officer. Inspection shall be made at the wood treatment site. The agency's report of inspection shall accompany delivery of the ties. The Contractor shall core and check preservative treatment once per 1000 ties delivered to the construction site.

3.12.4 Examination of Geotextile

The Contracting Officer may examine any geotextiles for defects, damage, or nonconformance prior to installation. Any geotextile not meeting the minimum property requirements of paragraph GEOTEXTILE, or geotextile that is determined to be damaged or defective shall be removed from the site and shall be replaced with additional geotextile meeting the requirements of this specification at no additional cost to the Government.

3.13 INSPECTION AND FIELD TESTING

Quality control inspection and field testing shall be performed by a technician certified to meet ANSI/ASNT CP-189 level II or III qualifications with a minimum of one year experience in testing rail for defects.

3.13.1 Track

Inspection shall be performed to ensure that all the requirements of these specifications are met. Bolted joints shall be inspected for loose bolts and for smooth transitions between rails of different sections. Rail, tie plates, and ties shall be checked to ensure that the rail is properly seated and has full bearing on the tie plate and tie. Upon completion of construction, measurements of track gage, cross level, and alignment shall be taken and recorded at least once every 60 m of track centerline length. A copy of these measurements shall be provided to the Contracting Officer.

3.13.2 Welded Joints - Visual Inspection

Each welded joint shall be inspected by the Contractor in the presence of the Contracting Officer after removal of the mold and grinding of excess metal. The Contractor shall pay particular attention to surface cracking,

slag inclusion, gas pockets, and lack of fusion. The Contractor shall correct or replace, at no extra cost to the Government, any weld found defective. The method of correction shall be as approved by the Contracting Officer.

3.13.3 Electric Arc Welding Inspection

Electric arc welds shall be inspected to determine that the item welded conforms to the desired contour and contains no visible cracks or voids.

3.13.4 Thermite Weld Joints Testing

Each thermite weld joint shall be ultrasonically tested following the visual inspection. The method of inspection and acceptance shall be in accordance with AWS D1.1. The Contractor shall correct or replace defective welds, at no additional cost to the Government. The method of correction shall be as approved by the Contracting Officer. Ultrasonic testing shall be performed by the Contractor after the rail has been installed in track. The testing will determine whether or not each weld meets the criteria of paragraphs Gap and Alignment, Weld Finishing and Tolerances, and Weld Quality. Welds made in the track which the Contracting Officer determines to be unacceptable shall be cut out of the rail and replaced by a section of new rail and two new welds. Saw cuts shall be made at least 150 mm from the centerline of the faulty weld. Replacement welds and replacement rails shall be at the sole expense of the Contractor. Replacement welds shall be renumbered as indicated. Replacement welds made in track shall be ultrasonically tested.

3.13.5 Electric Arc Weld Testing

The welds shall be visually inspected and the contours checked after completion and later tested by the ultrasonic method. The Contractor shall have the welds tested by the ultrasonic method. The testing will determine whether or not each weld meets the quality criteria. Defective welds will be removed and the item rewelded at the Contractors expense.

3.13.6 Not Used

3.13.7 Testing Relay Rail

3.13.7.1 Testing for Wear

Each relay rail shall be checked for wear by the Contractor's quality control representative in the presence of the Contracting Officer after the material is delivered to the construction site. The Contractor shall monitor the installation of track for defects in rail and joint bars being installed. Rail and joint bars that are found to be defective shall not be installed in track.

3.13.7.2 Testing for Defects

Upon completion of the track construction, the Contractor shall have the

rail tested by ultrasonic methods. Ultrasonic testing shall be done by a contractor normally engaged in this type of testing with a minimum of 5 years of experience. The Contractor shall schedule a rail testing machine and notify the Contracting Officer of the type of machine and schedule. Contractor furnished rails which are found to be defective at that time shall be removed and replaced by the Contractor at no additional cost to the Government. Contractor furnished joint bars and compromise joint bars that are found to be cracked or broken shall be removed and replaced at no additional cost to the Government.

RECORD OF FIELD WELD

INSTALLATION_____ WELD NUMBER _____

FINAL INSTALLED
LOCATION _____ TRACK _____
STATION _____ RAIL Left Right (Circle)

DATE _____ TIME _____ AM PM (Circle)

AIR TEMPERATURE _____ F*. WEATHER _____
RAIL TEMPERATURE _____ F*. _____

WELD KIT MANUFACTURER _____
RAIL GAP
NEAREST 1.6 MM _____
RAIL CUT REQUIRED? YES NO (Circle)
BACK RAIL
MANUFACTURER _____ USED RAIL? YES NO (Circle)
YEAR/MONTH ROLLED _____ HEAT NUMBER _____
_____

AHEAD RAIL
MANUFACTURER _____ USED RAIL? YES NO (Circle)
YEAR/MONTH ROLLED _____ HEAT NUMBER _____
_____

REMARKS_____
_____
_____

ULTRASONIC TEST DATE & RESULTS _____

KIT MFG. REPRESENTATIVE
PRESENT _____ WELDING FOREMAN _____
(Initial) (Signed)

CONTRACTING OFFICER'S
REPRESENTATIVE
PRESENT _____ RECORDER _____
(Initial) (Signed)

_____ RECORDER _____
(Initial) (Signed)

FOR GOVERNMENT USE ONLY

ULTRASONIC TEST DATE AND RESULTS _____

RECORD OF FIELD WELD

---

*NOTE: Determination will be made to the nearest 1/2 degree.

-- End of Section --

SECTION 09915

COLOR SCHEDULE
06/93
AMENDMENT 00001
AMENDMENT 00002

PART 1 GENERAL

1.1 GENERAL

This section covers only the color of the exterior and interior materials and products that are exposed to view in the finished construction. The word "color" as used herein includes surface color and pattern. Requirements for quality and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings. Items not designated for color in this section may be specified in other sections. When color is not designated for items, the Contractor shall propose a color for approval.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Samples

Color Schedule; G

AM 1 Three sets of color boards, 120 days after the Contractor is given Notice to proceed, complying with the following requirements:

a. Color boards shall reflect all actual finish textures, patterns, and colors required for this contract.

b. Materials shall be labeled with the finish type, manufacturer's name, pattern, and color reference.

c. Samples shall be on size A4 or 8-1/2 by 11 inch boards with a maximum spread of size A1 or 25-1/2 by 33 inches for foldouts.

d. Samples for this color board are required in addition to samples requested in other specification sections.

e. Color boards shall be submitted for approval to:

ARCHITECTUAL SECTION
DESIGN BRANCH
FORT WORTH DISTRICT

PART 2 PRODUCTS

2.1 REFERENCE TO MANUFACTURER'S COLOR

Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers.

2.2 COLOR SCHEDULE

The color schedule lists the colors, patterns and textures required for exterior and interior finishes, including both factory applied and field applied colors.

2.2.1 Exterior Walls

Exterior wall colors shall apply to exterior wall surfaces including recesses at entrances and projecting vestibules. Conduit shall be painted to closely match the adjacent surface color. Wall color shall be provided to match the colors listed below.

a. Brick: INTERSTATE:
BR-1; CANYON ROSE
BR-2; PLATINUM
BR-3; PARK ROSE

b. Mortar: GRAY

AM 1
c. Paint: **SHERWIN WILLIAMS, SUMMIT GRAY SW2127**.
AM 1
d. Splite-Face Concrete Masonry Units (Integrally Colored): **FEATHERLITE; SADDLETAN 707**
AM 1
e. Metal Wall Panels, Hardware, and Associated Trim: **TO MATCH GRAHAM ARCH. PRODUCTS, SAHARA SAND**.

2.2.2 Exterior Trim

Exterior trim shall be provided to match the colors listed below.

a. Doors and Door Frames: TO MATCH GRAHAM ARCHITECTURAL PRODUCTS; SAHARA SAND
Roll-up Doors: TO MATCH GRAHAM ARCHITECTURAL PRODUCTS: SAHARA SAND

b. Windows (mullion, muntin, sash, trim, and sill): **AM 2 - ANNODIZED DARK BRONZE**

d. Fascia: MBCI; COLONIAL RED

e. Downspouts, Gutter, Louvers, and Flashings: MBCI; COLONIAL RED

g. Soffits and Ceilings: TO MATCH STANDING SEAM METAL ROOF, MBCI, COLONIAL RED

j. Caulking and Sealants: COLOR TO BE SELECTED FROM MANUFACTUREER'S STANDARD COLORS TO MATCH ADJACENT WALL SURFACES.

2.2.3 Exterior Roof

Roof color shall apply to exterior roof surfaces including sheet metal flashings and copings, mechanical units, roof trim, pipes, conduits, electrical appurtenances, and similar items. Roof color shall be provided to match the colors listed below.

a. Metal: MBCI; COLONIAL RED

2.2.4 Interior Floor Finishes

Flooring materials shall be provided to match the colors listed below.

b. Carpet Tile:
CPT-1; INTERFACE, CIRCUIT BOARD, 3276 MONITOR WITH GLASBAC RECYLED TILE BACK

c. Vinyl Composition Tile:
VCT; TARKETT, EXPRESSIONS, #2037 BISQUE SHELL BROWN

h. Ceramic Tile:
CTF-1; DAL-TILE, KEYSTONES, SPICE 50X50mm

*NOTE; TO BE INSTALLED AT A 45 DEGREE ANGLE
AM 1 GROUT; MAPEI, GRAY 09 - GROUT TO BE SEALED

i. Porcelain Tile:
PTF-1; DAL-TILE, LANDSCAPE, TEBE LS04 TEXTURED, 300 X 300mm
PTF-2; DAL-TILE, LANDSCAPE, TEBE LS04 UNPOLISHED, 300 x 300mm

NOTE: TO BE INSTALLED AT A 45 DEGREE ANGLE

AM 1 GROUT RELEASE TO BE APPLIED PRIOR TO GROUTING

j. Grout: MAPEI, GRAY **AM 1 09**

NOTE: GROUT TO BE SEALED

2.2.5 Interior Base Finishes

Base materials shall be provided to match the colors listed below.

a. Resilient Base and Edge Strips:
RB-1; JOHNSONITE, TIGHTLOCK, TBC-65 CORONADO
RB-2; JOHNSONITE, 127 VANILLA

c. Ceramic Tile:
CTB-1; DAL-TILE, MB-5A, SPICE

d. Porcelain Tile:
PTB-1; DAL-TILE, LANDSCAPE, TEBE LS04, UNPOLISHED

AM 1 GROUT RELEASE TO BE APPLIED PRIOR TO GROUTING

e. Grout: MAPEI; GRAY 09

NOTE: GROUT TO BE SEALED

2.2.6 Interior Wall Finishes

Interior wall color shall apply to the entire wall surface, including reveals, vertical furred spaces, grilles, diffusers, electrical and access panels, and piping and conduit adjacent to wall surfaces unless otherwise specified. Items not specified in other paragraphs shall be painted to match adjacent wall surface. Wall materials shall be provided to match the colors listed below.

a. Paint:
P-1; SHERWIN WILLIAMS, ONLY NATURAL 1088

b. Vinyl Wall Covering:
WC-1; VICRTEX, MILANO, TORINO TAUPE ML21-36
WC-2; KENMARK; WALLTALKERS, ERASE-RITE, MATTE-WHITE,ML21-30

NOTE: WC-2, SEE ARCH DRWG. I1.01. CONTRACTOR TO FIELD MEASURE.

c. **AM 1 PTW-1**:
PTW-1; DAL-TILE, LANDSCAPE, TEBE LS04, UNPOLISHED, 300 X 300mm

NOTE: A GROUT RELEASE TO BE APPLIED PRIOR TO GROUTING.

GROUT; MAPEI, GRAY 09

d. Ceramic Tile:
CTW-1; DAL-TILE, KEYSTONES, SPICE
AM 1 CTW-2; DAL-TILE, PERMABRITES, GLOSS SABLE 6421, 50 X 50mm

e. Ceramic **AM 1 AND PORCELAIN** Tile Grout: MAPEI, **AM 109**
AM 1 GROUT TO BE SEALED
GROUT; MAPEI, GRAY 09

f. Acoustical Wall Covering:
AWC-1; PANEL SOLUTIONS, TRIMLINE
FABRIC; GUILFORD OF MAIN, 380 QUARTZ

NOTE: SEE ARCH DRWG. I1.01 FOR PLACEMENT

2.2.7 Interior Ceiling Finishes

Ceiling colors shall apply to ceiling surfaces including soffits, furred down areas, grilles, diffusers, registers, and access panels. Ceiling color shall also apply to joist, underside of roof deck, and conduit and piping where joists and deck are exposed and required to be painted. Ceiling materials shall be provided to match the colors listed below.

a. Acoustical Tile and Grid:
ATC; ARMSTRONG, ULTIMA, WHITE

b. Paint:
P-1; SHERWIN WILLIAMS, ONLY NATURAL 1088

2.2.8 Interior Trim

Interior trim shall be provided to match the colors listed below.

a. Doors: **AM 1**
P-1; SHERWIN WILLIAMS, ONLY NATURAL 1088
METAL; DARK BRONZE

b. Door Frames:
P-1; SHERWIN WILLIAMS, ONLY NATURAL 1088
METAL; DARK BRONZE

c. Windows (mullion, muntin, sash, trim, and stool): **AM 2 - ANNODIZED DARK BRONZE**

d. Window Sills:

P-1; SHERWIN WILLIAMS, ONLY NATURAL 1088

e. Fire Extinguisher Cabinets: STAINLESS STEEL

2.2.9 Interior Window Treatment

Window treatments shall be provided to match the colors listed below.

a. WINDOW SHADES: MECHO; EUROVEIL, 5304

2.2.10 Interior Miscellaneous

Miscellaneous items shall be provided to match the colors listed below.

a. Toilet Partitions and Urinal Screen: SANTANA, BLACK

b. Plastic Laminate:
RECEPTION COUNTER AND PASS THRU WINDOW
PL-1; WILSONART; BLACK 1595-60 **AM 1 FRONTS**
PL-2; WILSONART; BLACKSTAR GRANITE, 4551-60 **AM 1 COUNTERTOP**
NOTE; SEE ARCH DRWG. A1.02 & I1.02 FOR PLACEMENT

KITCHEN AREA
PL-3; WILSONART; **AM1 FIELDSTONE, 4792-60, COUNTERTOP**
PL-4; WILSONART; **AM 1 ALUMA STEEL 6277-419, CABINETS**
NOTE; SEE ARCH DRWG. I1.02 FOR PLACEMENT

SHELVING
PL-5; WILSONART; **AM 1** KHAKI BROWN D50-60

c. Signage Message Color (excluding handicapped signage): BASE STANDARD

d. Signage Background Color (excluding handicapped signage): BASE STANDARD

e. Lockers: BLACK

f. Operable Partitions: KWIK-WALL, STEEL PANEL 3000 SERIES
FABRIC; MAHARAM, TEK-WALL 1000, BISCUIT BEIGE 183

g. Corner Guards: CLEAR ARYCLIC

h. Wall Switch Handles and Standard Receptacle Bodies: IVORY

i. Electrical Device Cover Plates and Panels: IVORY

j. Casework:
RECEPTION COUNTER AND PASS THRU WINDOW

FRONT/SIDES; PL-1, WILSONART; BLACK 1595-60 **AM 1 FRONTS**
COUNTERTOP; PL-2, WILSONART; BLACKSTR GRANITE4551-60 **AM 1 COUNTERTOP**

KITCHEN AREA
COUNTER; PL-3, WILSONART, **AM 1 FIELDSTONE, 4192-60, COUNTERTOP**
FRONTS; PL-4, WILSONART, **AM 1 ALUMASTEEL 6277-419 CABINET**

NOTE: SEE ARCH DRWGS A1.02 AND/OR I1.02 FOR PLACMENT

SHELVING
PL-5; WILSONART, KHAKI BROWN D50-60

k. Shower Curtain: BEIGE

AM 1

l. THEATRE CHAIRS
SITMATIC; BLACK

2.2.11 ROOM COLOR AND FINISH SCHEDULE

ADMIN FACILITY

Area: Mechanical A101

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	Exposed P-1

Area: Communications A102

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	P-1

Area: Electrical A103

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	P-1

Area: Vending Area A104

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-1	WC-1	WC-1		WC-1	P-1

NOTE; FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Lobby 2 A105

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-1	-	P-1	P-1	WC-1	P-1

NOTE; FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Corridor A106A

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**	P-1	-	P-1	P-1	ATC

Area: Corridor A106B

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**	P-1	-	P-1	-	ATC

Area: Women's Latrine A107

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-2	PTW-1 CTW-2	PTW-1 CTW-2	PTW-1 CTW-2	PT2-1 CTW-2	P-1

NOTE: SEE ARCH. DRWGS. I1.02 FOR PATTERN
FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Men's Latrine A108

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-1	PTW-1 CTW-2	PTW-1 CTW-2	PTW-1 CTW-2	PT2-1 CTW-2	P-1

NOTE: SEE ARCH. DRWGS. I1.02 FOR PATTERN
FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Corridor A109

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**	P-1	P-1	-	P-1	P-1

Area: Janitor A110

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
NONE	CONC	P-1	P-1	P-1	P-1	P-1

Area: Mechancial A111

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	Exposed **AM 1 P-1**

Area: Break A112

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-1	WC-1	WC-1	WC-1	WC-1	ACT

NOTE; FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Corridor A113

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-1	WC-1	WC-1	-	WC-1	P-1

NOTE; FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Documents A114

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**	P-1	P-1	P-1	P-1	ATC

Area: Closet A115

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-2	**AM1 VCT-1**	P-1	P-1	P-1	P-1	P-1

NOTE: ALL SHELVING SURFACES W/ PLASTIC LAMINATE SHALL BE PL-5
ALL PAINTED SHELVING SHALL BE P-1

Area: Storage A116

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-2	**AM1 VCT-1**	P-1	P-1	P-1	P-1	P-1

OTE: ALL SHELVING SURFACES W/ PLASTIC LAMINATE SHALL BE PL-5
ALL PAINTED SHELVING SHALL BE P-1

Area: Corridor A117

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-1	WC-1	WC-1	WC-1	WC-1	ATC

NOTE; FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Reception A118

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-1	WC-1	WC-1	WC-1	WC-1	ATC

NOTE; FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: TCACCIS A119

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**	P-1	P-1	P-1	P-1	ATC

Area: Lobby 1 A120

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-1	**AM1 P-1**	**P-1**	**P-1**	**P-1**	P-1

NOTE; FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Office A121

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**	P-1	P-1	P-1	P-1	ATC

Area: Corridor A122A

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**	P-1	P-1	**WC-1**	P-1	P-1

AM 1 NOTE: WC-1 TO BE INSTALLED ON CURVED WALL ONLY

Area: Corridor A122B

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**		**WC-1**	P-1	P-1	P-1

AM 1 NOTE: WC-1 TO BE INSTALLED ON CURVED WALL ONLY

Area: Corridor A122C

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**		P-1	P-1	**WC-1**	P-1

AM 1 NOTE: WC-1 TO BE INSTALLED ON CURVED WALL ONLY

Area: Office A123

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**	P-1	P-1	P-1	P-1	ATC

Area: Classroom A124

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**	WC-2 AWC-1	PART.	P-1	WC-2 AWC-1	ATC

NOTE; SEE ARCH. DRWG I1.02 FOR WALLCOVERING PLACEMENT

Area: Classroom A125

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-1	**AM1 CPT-1**	WC-2 AWC-1	WC-2 AWC-1	P-1	PART.	ATC

NOTE; SEE ARCH. DRWG I1.02 FOR WALLCOVERING PLACEMENT

ENGINE SHOP

Area: Office E101

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
RB-2	**AM1 VCT-1**	P-1	P-1	P-1	P-1	ATC

NOTE; VCT TO BE INSTALLED AT A 45 DEGREEE ANGLE

Area: Repair Bay E102

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	Exposed

Area: Corridor E103

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1		P-1

Area: Men's E104

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
CTB-1	CTF-1	CTW-1 CTW-2	CTW-1 CTW-2	CTW-1 CTW-2	CT2-1 CT2-2	P-1

NOTE: SEE ARCH. DRWGS. A2.02 AND **AM 1** I2.0**1** FOR **CERAMIC WALL TILE** PATTERN
FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Women's E105

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
CTB-1	CTF-1	CTW-1 CTW-2	CTW-1 CTW-2	CTW-1 CTW-2	CT2-1 CTW-W	P-1

NOTE: SEE ARCH. DRWGS. A2.02 AND **AM1** I2.0**1** FOR **CERAMIC WALL TILE** PATTERN
FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

AM 1

Area: **JANITOR E106**

Base	**Floor**	**A Wall**	**B Wall**	**C Wall**	**D Wall**	**Ceiling**
None	**Conc**	**P-1**	**P-1**	**P-1**	**P-1**	**Exposed** **P-1**

Area: Mechanical E107

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	Exposed
						AM 1 P-1

Area: Comm Rm E108

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	P-1

Area: Electrical E109

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	Exposed
						AM 1 P-1

Area: Solvent Wash E110

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	Exposed
						AM 1 P-1

Area: Oil Storage E111

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	Exposed
						AM 1 P-1

Area: Pump Room E112

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	Exposed
						AM 1 P-1

LATERINES

Area: Vestibule L101

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-2	PTW-2	PTW-2	PTW-2	PTW-2	P-1
		CTW-2	CTW-2	CTW-2	CT2-2	

NOTE: SEE ARCH. DRWGS. I3.01 FOR **AM1 CERAMIC WALL TILE** PATTERN
FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Women's Latrine L102

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-2	PTW-2	PTW-2	PTW-2	PT2-2	P-1
		CTW-2	CTW-2	CTW-2	CTW-2	

NOTE: SEE ARCH. DRWGS. I3.01 FOR **AM 1 CERAMIC WALL TILE** PATTERN
FLOOR TILE TO BE INSTALLED AT A 45 DEGREE ANGLE

Area: Men's Latrine E103

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
PTB-1	PTF-2	PTW-2	PTW-2	PTW-2	PT2-2	P-2
		CTW-2	CT2-2	CTW-2	CTW-2	

NOTE: SEE ARCH. DRWGS. I3.01 FOR **AM 1 CERAMIC WALL TILE** PATTERN

FLOOR TILE TO BE INSTALLED A A 45 DEGREE ANGLE

Area: Maintenace E104

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
NONE	CONC	CTW-2	CTW-2	CTW-2	CTW-2	P-1

SCALE RACK

Area: Control Room S101

Base	Floor	A Wall	B Wall	C Wall	D Wall	Ceiling
None	Conc	P-1	P-1	P-1	P-1	P-1

Text

PART 3 EXECUTION (Not Applicable)

-- End of Section --