PROJECT TABLE OF CONTENTS

-- End of Project Table of Contents --

SECTION 01012

SITE WORK/CIVIL/UTILITIES

PART 1 GENERAL

1.1 REFERENCES

DEPARTMENT OF THE ARMY/Air Force

TM 5-803-5	(Mar 81) Installation Design [Ref: AFM 88-43]
TM 5-820-4	(Oct 83) Drainage Areas Other Than Airfields [Ref: AFM 88-5, Chap. 4]
TM 5-822-5	(June 92) Pavement Design for Roads, Streets Walks, and Open Storage Areas [Ref: AFM 88-7, Chap. 1]
TM 5-813-5	(3 Nov 86) Water Supply, Water Distribution [Ref: AFM 88-10, Vol 5]
TM 5-813-7	(2 Sep 86) Water Supply for Special Project [Ref: AFM 88-10, Vol 7}]
TM 5-814-1	(4 Mar 85) Sanitary and Industrial Wastewater Collection - Gravity Sewers and Appurtenances [Ref: AFM 88-11, Vol 1]
TM 5-814-2	(15 Mar 85) Sanitary and Industrial Wastewater Collection-- Pumping Stations and Force Mains [Ref: AFM 88-11, Vol 2]
	(15 Mar 85) Sanitary and Industrial Wastewater Collection-- Pumping Stations and Force Mains [Ref: AFM 88-11, Vol 2]

KANSAS DEPARTMENT OF TRANSPORTATION

KDOT	STANDARD SPECIFICATIONS FOR STATE ROAD AND BRIDGE CONSTRUCTION

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C651	(1992)Disinfecting Water Mains
AWWA M 17	(1989) Installation, Field Testing, and Maintenance of Fire Hydrants

FEDERAL STANDARDS (FED STD)

UFAS	(April 1988) Uniform Federal Accessibility Standards

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

NWS HYDRO-35	(June 1977) Five to 60-Minute Precipitation Frequency For The Eastern and Central United States
NOAA ATLAS 2	(1973) Precipitation-Frequency Atlas of the Western United States

HANDICAPPED STANDARDS (HS)

ADAAG	(January 1998) Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities; Play Areas

AMERICAN ASSOCIATION OF STATE HIGHWAY & TRANSPORTATION OFFICIALS (AASHTO)

AASHTO	A Policy on Geometric Design of Highways and Streets

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

D6.1-2000	Manual on Uniform Traffic Control Devices for Streets & Highways

MILITARY HANDBOOKS (MH)

MIL-HDBK-1008C	(10 Jun 1997) Fire Protection for Facilities Engineering, Design, and Construction

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances, 1995 Edition NFPA 24, Ch 8-1.1;

National Institute of Standards and Technology (NIST)

NIST 44	(Current Edition) Weights and Measures Handbook 44
UFC 4-010-01	DoD Minimum Antiterrorism Standards for Buildings

1.2 NOT USED

1.3 SURVEY

1.3.1 Field Survey.

The engineering survey to be used in the development of the design

submittal is available to the Contractor on CD-ROM furnished with this solicitation. The information is in a 3-d Bentley Microstation drawing file. The survey data information was gathered by a topographical survey performed in December 2002 to April 2003. Contours were gathered at 1 foot intervals. The survey drawings shall be used by the Contractor to prepare for development of design drawings. Any additional survey information required by the Contractor for preparation of his proposal or for development of design drawings shall be obtained by the Contractor at his own expense.

1.4 STAGING AND CONTRACTORS ACCESS

1.4.1 Staging Area

The location of the Contractor staging area shall be within the project limits as shown on the drawings. Contractor private vehicles shall not be allowed inside of the project limits but must park outside. Contractor vehicles shall be marked with the company name. Staging area shall be returned to its original condition or improved condition if indicated in the contract upon completion of construction.

1.4.2 Contractors Access Route

The Contractor's Access Route shall be through the west gate.

1.5 DEMOLITION

The buildings noted on the Demolition Plan and Bid Schedule to be demolished are included in the project. Floor plans and wall sections drawings have been provided if available. Soil removal/remediation is required as indicated on the plans. The Contractor shall remove all pavements, utilities and other appurtenances necessary to construct the new facility. Disposal shall be off base at contractor expense. The Contractor shall notify the Contracting Officer if any material to be disposed of is found to contain hazardous, toxic, biological or radiological substances. Rubbish and debris shall be removed from the site on a daily basis to avoid accumulation at the project site. Demolition shall conform to Unified Facilities Guide Specification (UFGS) Section 02220 DEMOLITION. Burining is not allowed. Foundations shall be removed to a depth of at least 42 inches. Fence posts and fence mow strips to be removed shall be removed entirely. ~~Refer to the plans for fences that may be reused.~~ The Air Force reserves salvage rights to all materials until building or structure is turned over to the contractor. Special scheduling is required as some facilities must be completed by the contractor before demolition may begin. The POL facility is an example. Demolition of an Oil Water Seperator is required. Refer to Specification 02000 OUTLINE SPECIFICATIONS for requirements. Note the requirements under fencing to salvage, protect, crate, and deliver for the Air Force gates, controls, and motors.

OIL Water Seperator requirement:

1.6 NEW CONSTRUCTION

The location and construction shall be as indicated on the attached drawings and in the specifications.

New utility service lines shall consist of sanitary sewers, waterlines, gas lines, electrical power and communications lines. All utility lines installed shall have a plastic marker tape minimum 6 inches(15 centimeters) wide by 0.4 inch (.01 centimeter) thick installed 8 to 10 inches below grade. The plastic marker tape shall include a metallic wire for detection purposes and shall bear a continuous printed inscription describing the type of utility line buried below. Metal pipes, (including ductile iron) and valves shall be cathodically protected and include test stations.
The exact limits are part of the design effort and depend on the existing pavments, design traffic and proposed construction.

1.6.1 Building

Location and construction of structures, roads, parking, utilities and landscaping shall be as indicated on the attached drawings and as specified herein. The new buildings shall be handicap accessible. Minor changes to the overall layout may be accepted by the Government if it is beneficial to the overall design of the project.

1.6.2 Walks

Exterior concrete walks 4 inches thick shall be placed to connect POV parking and buildings as needed. Walks shall have a medium broom finish. Adjustments to the walk layout may be made to facilitate the final Site Plan. Walks along the parking lots shall be a minimum of 10 foot wide. Walks leading to the main entrance shall be a minimum of eight feet wide and match the width of the front facade of the building. Walks leading to all other entrances shall be a minimum of 5 feet wide. Walks 10 foot wide shall have a five foot square joint pattern.

1.6.3 Parking Areas

As a minimum, curbs or wheel stops shall be used to maintain the AT/FP setback from vehicles to buildings. Parking areas are indicated on the Site Plan and shall be located a minimum of 25 meters (82 feet) from the building main entrance. Provide, as a minimum, the number of parking spaces as indicated on the Site Plan. Two Handicap van-accessible universal stalls in accordance with January 1998 Accessibility Guidelines for Buildings and Facilities, Appendix (with striping, signage, and ramps) shall be provided for the POL building . Adjustments to the parking lots as shown may be made but must be approved by the Government. The number of parking stalls shall be as shown on the drawings. Regular parking stalls shall be a minimum of 9.5 feet wide and 20 feet long. Driving lanes shall be a minimum of 2-12 feet wide. Parking stalls shall be delineated with 4 inch white stripes. Pavement design shall be the responsibility of the contractor according to the geotechnical report. Provide integral curb, double purpose walk, or concrete curb and gutter. Contractor shall use installation design standard designs, for example, use the 24 inch wide curb and gutter that is standard for MAFB.

See Section 01700: ELECTRICAL for exterior lighting requirements.

1.6.4 Screen Walls/Dumpster Enclosure

Construct screen walls to block the view of exterior mechanical equipment from vehicular and pedestrian traffic. Top of screen wall shall be no less than 12 inches higher than the top of any portion of the mechanical

equipment unless noted otherwise. Also, construct concrete dumpster pad(s) with a three-sided screen wall enclosure with wood gate. Screen walls shall be constructed in accordance with the installation standard design guide.. The dumpster enclosure shall be constructed in accordance with the installation standard design guide. Concrete walks to the dumpster pad and a concrete approach pad (if approach if not directly from a concrete pavement)a minimum of 15 feet wide (center of bollard to center of bollard) by 12 feet deep by 8 feet high. Approach slab shall be portland cement contrete not less than 15 feet by 15 feet unless otherwise noted. Comply with the AT/FP requirements for walls, enclosures and stand off distance.

1.6.5 Seeding

1.6.12.1 Soil Preparation

Prior to seeding, all surface soils shall be loosened to a minimum depth of four inches and broken up to a fine, workable texture suitable for seeding.

1.6.12.2 Seeding and/or Sodding

Turfed areas shall be seeded according to the installation guide. All newly turfed areas shall be fertilized with fertilizer at the rate and composition recommended by a soil test (submit FIO the test results to the COR. Seed shall be according to 01140 installation design guide at the rate and species indicated therein or 5 pounds per 1000 SF. (also called base standards).

Seeding shall be specified in accordance with Section 02000 of this RFP document and UFGS Section 02921A SEEDING.

Sodding shall be specified in accordance with UFGS Section 02922A SODDING.

1.6.6 Fence and Gates

a. Fences shall be 7 foot high fabric with top and bottom tension wire. Outriggers shall be constructed with barbed wire or ribbon wire atop the fence to match the adjacent fence. Post shape shall match the existing shape. Chain Link fencing shall be specified in UFGS Section 02821 FENCING. New fencing shall be constructed before removal of fencing to be demolished so the security of the base may be maintained.

b. ~~Double-swing~~Cantilever gates for vehicle access shall be a minimum width of back of curb to back of curb or edge of pavement to edge of pavement~~24 feet~~ wide unless otherwise noted on the drawings. Single swing personnel gates shall be a minimum of 4 feet wide. The height of the gates shall match the fence. Sliding, cantilever gates, motorized shall be required unless swing gates are indicated on the drawings. NEW gates and fences are required.~~G~~Existing gates~~ relocations (~~gates, motor and controls) (from this project shall be protected from damage and turned over and to the Base Civil Engineer. Controls, motors, drive assemblies shall be crated for turnover. Refer to the drawings. New cantilever, motorized gates shall have two conduits each from the controls to two pedistal mounted, waterproof switch boxes. Switch/control boxe face shall be located 12 inches behind the back of curb where curbs exist and 6 inches away from the road edge of pavement where there is no curb. ~~)rather than new gates are permitted~~. Gates shall be specified in UFGS Section 02821 FENCING.

c. All chain link fences constructed (permanent) shall have a concrete mow strip installed no more than one inch(25 mm below the bottom) tension wire. The mow strip shall be 6 inches deep by 12 inches wide with two No. 4 bars running parallel to the fence line. The top 6 inches of the fence post base shall be 12 inches by 12 inches square to accommodate the placement of 12.7 mm preformed expansion joints on each side of the fence post foundation.

d. Fence fabric for fences and gates shall have a PVC coating as specified in UFGS Section 02821, color shall be black .

1.6.7 CONSTRUCTION AREA FENCING

The Contractor shall maintain a 6' high chain link fence around the construction areas. Chain Link fencing shall be as specified in UFGS Section 02821 FENCING. Orange safety fence may be used around the parking lots and utility construction. Upon completion of construction, all fence materials shall be disposed of outside the limits of Government-controlled lands. ~~An orange snow fence shall delineate any area on the flightline side of the construction areas. This shall delineate a FREE ZONE for the contractors workers and seperate them from the high security area flight line side of the FREE ZONE FENCE.~~ A free zone fence shall be constructed to prevent construction worker from accidently walking outside the construction limit toward the flight line. This fence msy be an orange snow fence or the chain link, temporary construction fence. This fence shall be the first work in each area to preclude workers from wandering into and being challenged by Air Force security forces.

1.7 Exterior Gas Distribution

A new service line shall be provided and connected by tapping into the existing gas line. Service lines to buildings shall run parallel and/or perpendicular to the building lines, shall be buried at least 18 inches below the ground surface, shall not be laid in the same trench with other utilities, and shall be above other utilities whenever they cross. Gas lines shall not be laid under paved streets, parking lots, roads or in other locations subject to heavy traffic whenever practicably avoidable. Whenever it is necessary to locate gas lines in such locations, the lines shall be protected by suitable encasement or by burying to a depth to provide at least 4 feet of cover over the top of the pipe except that gas lines shall be provided with encasement (minumum 12 x 12 inches) when laid under new or existing paved streets, and parking lots. The tap into the existing line shall be a "hot tap" and the Installation's Fire Department shall be given 30 days advance notification of the date of the tap. The point of connection shall be provided with a shutoff plug valve, conveniently located outside of any traffic area and protected with a valve box. Service lines shall not be installed under or routed thru the facility. Except for piping located at the new gas meter/service regulator assemblies, no aboveground gas piping shall be exposed to view. The service line shall enter the building in an accessible location outside the mechanical room. The gas meter/service regulator assemblies shall be hidden from view to the greatest extent possible. Gas Distribution System shall include annodless risers at buildings and meters at each building. PE piping is required. Steel components shall be cathodically protected and include test stations.

1.8 Exterior Water Distribution

Water service line shall tap into the existing water lines. Minimum cover

for water mains and fire lines shall be according to the base standards. All valves shall be protected with bituminous coating. Mains and piping shall be disinfected in accordance with AWWA manual C-651. Fire hydrants shall be UL listed dry barrel type with break away flange and shall match in appearance and threading those presently in use on the installation. Hydrant laterals shall be 6-inch(152 mm) minimum size, and shall have an underground shutoff valve with an adjustable valve box in each lateral within 10 feet(3 meters) of the hydrant. Hydrants shall be set to provide 24 inches(610 mm) from finished ground to top nut of hydrant and 460 mm (18 inches) to center of pumper connection. Metal pipes, (including ductile iron) and valves shall be cathodically protected and include test stations. All plugs, caps, tees, bends, and hydrants on water mains and hydrant laterals shall be provided with reaction backing or movement prevented by attaching metal tie rods or clamps. Water line valves shall be provided for all water service lines. Valve boxes shall be provided for all valves and shall extend to finished grade. The facility shall be provided with an interior service main cutoff valve. Material shall be as required by the Base Standard. Seperate fire (with PIV) and domestic water lines shall be as required by the Base Standard.

1.9 Exterior Sanitary Sewer

Sanitary sewer connection shall be to the existing system. Manholes are required in changes in direction, slope and where required to keep the maximum length between manholes or building exit to 300 feet. An exterior cleanout or manhole is required for each building within 5 feet of the building exit. Cleanouts shall have a minimum colar of 18x18x6 inches. Plug shall be recessed type. Material shall be as required by the Base Standard..

1.10 Exterior Electric and Communications Distribution

Location of power and communications shall be as shown on the drawings. See SECTION 01017 ELECTRICAL REQUIREMENTS for additional information and requirements.

1.11 PAVEMENTS

1.11.1 Pavement Subgrade Preparation

Pavement subgrades shall be prepared, as a minimum, in accordance with the Corrosion Control Facility, Phase 1 Geotechnical Report recommendations.

1.11.2 Pavement Design

The Contractor shall use the pavement cross section in the Corrosion Control Facility Phase 1 Geotechnical Report as the minimum design pavement cross section.

1.11.3.1 Asphalt Concrete Pavement

The Contractor shall use the pavement cross section in the Corrosion Control Facility Phase 1 Geotechnical Report as the minimum design pavement cross section.

1.11.3.2 Portland cement concrete pavements: This project requires ~~limited surface~~ areas to be paved with Portland cement concrete, and construction of small concrete slabs on grade.

The Contractor shall use the pavement cross section in the Corrosion Control Facility Phase 1 Geotechnical Report as the minimum design pavement cross section. In addition the following requirements pertain:

The maximum water/cement (cementitious) ratio shall not exceed 0.42 by weight. Aggregate shall conform to ASTM C 33 Class 5S, except that the coarse aggregate shall not show more than 40 percent loss after 500 revolutions when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. The maximum allowable limit on Coal and Lignite shall be 0.25 percent. The aggregate shall meet or exceed the State Specifications requirement for Durability Class I. Portland cement concrete shall contain at least 564 pounds of Portland cement per cubic yard. Portland cement shall conform to ASTM C 150 Type I or II, and conform to the low alkali requirement. All Portland cement for use in the work shall be obtained from the same source. Class F Fly Ash may be used up to a maximum limit of 20 percent of the cementitious content. Fly Ash shall conform to ASTM C 618, meeting the optional physical and chemical requirements and the limit on available alkalies, Tables 1, 2,3, and 4. Slump shall be measured at the location of placement at the form. Concrete placed using pumping methods, slump shall be measured at the discharge end of the pump line at the location of placement.

1.11.3 [Enter Appropriate Subpart Title Here]1.11.4 Rigid Pavement Joint Layout

A typical joint layout for plain concrete road intersections is shown in Figure 13-1 of TM 5-822-5. A typical joint layout for plain concrete roads and parking areas is shown in Chapter 15 of TM 5-822-5. Odd-shaped slabs should be reinforced in two directions normal to each other using a minimum of 0.10 percent of steel in both directions. The entire area of the slab should be reinforced. An odd-shaped slab is considered to be one in which the longer dimension exceeds the shorter dimension by more than 25 percent or a slab which essentially is neither square nor rectangular. Odd-shaped slabs will generally be reinforced with steel welded wire fabric. Slabs in which a structure is placed shall also be reinforced with welded wire fabric. Each slab to be reinforced with welded wire fabric will be marked with an "R" on the joint layout plan. Details showing typical layout of joints at intersection as indicated in Figure 13-1 of TM 5-822-5 will be provided when applicable. All joints in concrete pavement shall be cleaned and sealed with a joint sealant. All concrete shall be proportioned using a maximum water/cement ratio of less than 0.42 by weight.

1.11.4 [Enter Appropriate Subpart Title Here] Sidewalks

~~P.C. concrete sidewalks shall be a minimum of 150 mm thick.~~c Transverse contraction joint spacing shall be as follows; 4 feet(1.2 m) for walks 4 and 8 feet(1.2 m and 2.4 m) wide, five feet(1.5 m) for walks five and 15 feet(1.5 m and 3.0 m) wide, six feet(1.8 m)for walks 6 and 12 feet (1.8 m and 3.6 m)wide. Longitudinal contraction joints shall be constructed in sidewalk widths 8 feet(2.4 m) and greater. Expansion joint spacing shall not exceed 40 feet(12.2 m). An expansion joint shall be provided at sidewalk intersections, between sidewalks and back of curbs, between sidewalks and vertical surfaces of structures, and between sidewalks and entrances to structures.

1.11.5 Bituminous Prime Coat

A bituminous prime coat shall be used at the option of the Contractor.

Bituminous prime coat will be used when it is anticipated that the constructed base course may be damaged by rain, wind, or traffic prior to placement of the bituminous concrete pavement.

1.11.6 Bituminous Tack Coat

Contact surfaces of previously constructed pavement, curbs, manholes, and other structures shall be sprayed with a thin coat of bituminous material. Tack Coat shall conform to KDOT specifications.

1.11.7 Joint Sealing

Joints in P.C. concrete pavements may be sealed with field molded sealants and specified in accordance with The Kansas Department of Transportation, "STANDARD SPECIFICATIONS FOR STATE ROAD AND BRIDGE CONSTRUCTION".

1.11.8 Concrete Sidewalks, and Curbs and Gutters

Concrete sidewalks and curbs and gutters shall be specified in accordance with The Kansas Department of Transportation, "STANDARD SPECIFICATIONS FOR STATE ROAD AND BRIDGE CONSTRUCTION".

1.12 GRADING

1.12.1 General

Positive drainage shall be provided for all areas and existing drainage ways shall be utilized to the extent possible. It is mandatory to direct drainage away from buildings to curb and gutter. Parking areas shall be graded such that storm water is directed off to the sides and not down the center of the parking area. Drainage along new entrance drives shall be controlled by the use of curb and gutter and drainage structures.

1.12.2 Borrow and Waste

Borrow material shall be obtained from locations off base. Excess waste material shall be disposed of by the Contractor off base.

1.12.3 Sidewalks

Concrete walks shall have a transverse grade of 2 percent. A desirable maximum longitudinal walk grade will be 4 percent with an abolute maximum of 8 percent. Handicapped accessible walks with a longitudinal slope greater than 5 percent shall be considered a ramp. See FED STD 795 Uniform Federal Accessibility Standards for ramp requirements. Special attention shall be given to sidewalks that are on the north (shaded) side of buildings. These walks should be designed to ensure a freeze/thaw cycle does not result in the formation of ice on the walk. Ice on walks should be a safety consideration for all areas. The use of steps in walks will be avoided whenever possible. The use of single riser steps is especially discouraged. When steps are unavoidable, they should have at least three risers and will be provided with handrails.

1.12.4 Transverse Parking Area Grades

a. Desirable minimum of 2 percent.

b. Absolute minimum of 1.5 percent for flexible pavement and 1 percent for rigid pavement.

1.12.5 Longitudinal Parking Area Grades

Maximum of 4 percent.

1.12.6 Ramp Grades

a. Desirable maximum of 6 percent.

b. Absolute maximum of 8 percent for short distances only.

1.12.7 Gutter Grades

a. Desirable minimum of 0.8 percent.

b. Absolute minimum of 0.5 percent.

1.12.8 Building Floor Elevation

Building finished floor elevation shall be set to 6 inches higher than the surrounding grade, except for entrance ramps. A 6 inch step up at doors is acceptable for NON-HANDICAPED entrances.

1.12.9 Grades Away From Building

a. Minimum of 5 percent for 10 feet. Grades between buildings can be less than the minimum due to the close proximity of the structures. Care shall be taken in the design to ensure that this area drains properly. Contractor consideration shall be given to the use of area inlets, trench drains, etc. to provide adequate drainage. Exception is for paved areas adjacent to buildings.

b. Maximum of 10 percent for 10 feet.

1.12.10 Overlot Grades

Provide positive drainage for all areas.

a. Minimum 1 percent for cohesionless sandy soils.

b. Minimum 2 percent for cohesive soils or turfed areas.

c. Sideslopes for ditches, roads, and other turfed areas shall be no steeper than 1V on 3H.

1.12.11 Adjustment of Existing Structures

All manholes, valve boxes, handholes or inlets of any nature within the project that do not conform to the new finish grade in either surfaced or unsurfaced areas shall be adjusted to the new finish grade. Where inlets, manholes, valve boxes, or handholes fall within a surfaced or unpaved roadway or parking, the existing frames and cover shall be removed and replaced with a heavy-duty frame and cover. The structure shall be adjusted as needed to fit the new conditions.

1.13 STORM DRAINAGE

1.13.1 Determination of Storm Runoff

The computation of runoff may be accomplished by the Rational Method. Sizing of storm drainage systems shall be based on rainfall of 10-year frequency.

1.13.1.1 Design Storm Return Period

Storm drains and culverts shall be sized for a design storm with a return period of 10 years. Provisions shall be made to protect all buildings and critical structures from a major storm with a return period of 100 years.

1.13.1.2 Rainfall Depth-Duration-Frequency Data

Rainfall data for states in the western United States shall be obtained from NOAA ATLAS 2. Rainfall intensity-duration data developed by cities or regions may be used if available.

1.13.2 Storm Drainage System Layout

The Contractor shall be responsible for the complete design of the storm drainage system. The new storm drainage system shall be coordinated with surrounding properties to ensure runoff does not cause damage to the other properties. Erosion control shall be provided for all storm drain structures. The Contractor shall provide details for all drainage structures. Under no circumstance shall storm drain lines be located beneath buildings.

1.13.2.1 Manholes

Diameter of manholes shall be large enough to accommodate pipes entering and exiting the manhole. No ladders or steps are to be provided.

1.13.2.2 Headwalls and Flared End Sections

Unless otherwise approved, headwalls or flared end sections shall be provided at the entrance and ends of culverts and at storm drain outfalls. Outlets and endwalls shall be protected from undermining, scour, lateral erosion.

1.13.2.3 Culverts

Culvert pipes shall have a minimum diameter of 18 inches wherever possible.

1.13.2.4 Roof Drain Outfall Lines

Downspouts and/or roof drains shall be connected to an underground roof drain system. Roof drain outfall lines beyond 5 feet from the building

shall be of the same materials as the exterior storm drainage system. Minimum diameters shall be 12 inchesfor lengths over 50 feet and 8 inches for lengths under 50 feet. In addition, the diameter shall be at least 2 inches larger than the diameter of the line as it leaves the building(downspout). Downspouts shall connect to a transition boot (cast iron, color to match). Boot shall have a brass cleanout plug. Boot shall extend a minimum 6 inches below graound level and a minimum 24 inches above graound level. All changes in direction of outfall lines shall occur at storm drain structures except that cleanouts may be used in lines smaller than 12 inches.

1.13.3 Storm Drain and Culvert Pipe

The Contractor shall select the appropriate storm drain and culvert pipe materials from the options specified in UFGS Section 02630 STORM DRAINAGE SYSTEM. RCP is preferred. Pipe, bedding, and backfill shall be of adequate strength (or stiffness) to support the earth, live, and construction loads imposed on the pipe. Only pipe materials which have a minimum design service life of 25 years shall be allowed for permanent installations. As a minimum, all pipe joints shall be soiltight. The Contractor shall specify watertight joints when the water table is at or above the pipeline.

1.13.3.1 Concrete Pipe

Reinforced concrete pipe shall be a minimum Class III. Type I cement may be used only when sulfates in the soil are 0.1 percent or less and dissolved sulfates in the effluent are 150 ppm or less. Type II cement may be used only when sulfates in the soil are 0.2 percent or less and dissolved sulfates in the effluent are 1,500 ppm or less. Only Type V cement may be used if sulfates in the soil exceed 0.2 percent or dissolved sulfates in the effluent exceed 1,500 ppm. Concrete culverts and storm drains shall be protected by a minimum of 1.0 m of cover during construction to prevent damage before permitting heavy construction equipment to pass over them during construction.

1.13.3.2 Corrugated Metal Pipe

The service life of corrugated metal pipe shall be the sum of the lives of the nonmetallic protective coating, the metallic protective coating, and the basic metal pipe. The life of the basic metal pipe and metallic protective coating shall be the time to first perforation. The time to first perforation for corrugated steel pipe shall be determined using the California Chart (California Division of Highways Test Method 643-B). Corrugated metal pipe shall not be allowed in areas where previous satisfactory service has not been achieved. Zinc-coated corrugated steel pipe shall not be allowed if the soil and water pH is less than 6 or greater than 8 or the minimum soil resistivity for the site is less than 2,500 ohm-cm. Aluminum-coated corrugated steel pipe shall not be allowed if the soil and water pH is less than 6 or greater than 9 or the minimum soil resistivity for the site is less than 1,500 ohm-cm. Stiffness of the corrugated metal pipe and soil envelope shall be such that the predicted long-term deflection shall not exceed 5.0 percent. Corrugated metal culverts and storm drains shall be protected by a minimum cover as recommended in Section 26 of AASHTO HB-16 during construction to prevent damage before permitting heavy construction equipment to pass over them during construction. In general, Coated 14 gage CMP is the minimum that will meet the duration requirements.***

1.13.3.3 Plastic Pipe

Stiffness of the plastic pipe and soil envelope shall be such that the predicted long-term deflection shall not exceed 7.5 percent. Plastic culverts and storm drains shall be protected by a minimum of 1.0 m of cover during construction to prevent damage before permitting heavy construction equipment to pass over them during construction. Split couplers shall not be allowed for corrugated high-density polyethylene pipe.

1.14 TRAFFIC SIGNAGE AND STRIPING

Traffic signage and striping shall be provided for all new roads and parking areas. Signage and striping shall be designed in accordance with the Manual on Uniform Traffic Control Devices for Streets and Highways.

1.15 EROSION AND SEDIMENT CONTROL

The Contractor shall be responsible for selecting and implementing Best Management Practices (BMPs) to minimize pollutants in storm water discharges associated with construction activity at the construction site. All erosion and sediment measures and other protective measures shall be maintained by the Contractor in effective operating condition. All temporary structural practices shall be removed once the corresponding disturbed drainage area has been permanently stabilized. N***PDES permit shall be required in accordance with the Kansas Department Of Health & Environment. Permit is required as area disturbed is over 1 acres. Permit can be obtained from industrial programs, stormwater program at (785) 296-5547. The internet website address is http://www.kdhe.state.ks.us/stormwater/index.html.***

1.15.1 Temporary Construction Entrance

Tracking of mud from the construction site onto adjacent roads and streets shall be kept to a minimum. A temporary stabilized stone pad shall be constructed at points where vehicular traffic will be leaving the construction site and moving directly onto a paved road or street. It shall extend the full width of the vehicular ingress and egress area and have a minimum length of 70 feet. The entrance shall be maintained in a condition which will prevent tracking or flow of mud onto adjacent roads or streets. If conditions on the site are such that the majority of the mud is not removed by the vehicles traveling over the stone, then the tires of the vehicles shall be washed before entering the road or street. Any mud which is tracked onto roads or streets shall be removed at least once daily.

1.16 COMPOSITE UTILITIES

The Contractor shall not run utilities underneath buildings. The Contractor shall avoid running utilities underneath streets and parking lots where practicable. In cases where it is necessary for the utilities to cross existing streets, the Contractor shall install the lines by trenchless excavation methods. No open trenching will be allowed through existing streets, unless written permission is obtained and approved by the installation.

1.16.1 Service Line Tracer Wire

For new underground non-ferrous service lines are installed, the service lines shall be identified by a tracer wire to permit locating with a metal detector. Tracer wires shall be 12 gauge AWWG copper wire. The tracer wire shall be installed 150 mm above the pipe.

1.16.2 Service Line Warning

New below grade lines shall be identified by placing a continuous plastic warning ribbon in the trench such that any excavation shall uncover the ribbon prior to reaching the line.

1.16.3 CATHODIC PROTECTION

Corrosion protection shall be provided for all buried gray or ductile-iron piping, fittings, valves, and other water line appurtenances, regardless of pipe material. Corrosion protection shall consist of an anode type cathodic protection system. See SECTION 01017 ELECTRICAL REQUIREMENTS.

1.16.4 WATERLINES

a. Waterlines shall be designed and constructed in accordance with the combination of the State of Kansas Department of Public Health and Environment's "*Design Criteria for Potable Water Systems (Revised March 31, 1997)*"and the Corps of Engineers Guide Specifications, Technical Manuals (TM), Engineering Manuals (EM), Military Handbooks (MH), and the industry standards listed herein. In the event of conflict, the Contractor shall follow the Local or State requirements/criteria (whichever are more stringent) which govern the waterlines. In addition to the State of Kansas criteria listed above, water distribution systems and service lines shall be designed and constructed in accordance with TM 5-813-5, TM 5-813-7, and UFGS Section 02510 WATER DISTRIBUTION SYSTEM. The Contractor shall be responsible for protection of existing waterlines. If any potable waterlines are damaged during construction, the Contractor must immediately notify the Contracting Officer. The Contractor shall disinfect all new water lines and any remaining lines which do not remain fully pressurized during construction or connection. The Contractor shall notify the Contracting Officer 7 days prior to disinfection of the water lines. The disinfection shall be in accordance with the American Water Works Association Standard AWWA C651, and shall not be considered complete until two consecutive days of bacteriological samples show no contamination. All bacteriological, lead and copper tests shall be performed by Environmental Protections Agency (EPA) certified laboratories. Copies of results of the analyses shall be forwarded to the Contracting Officer upon receipt.

b. The Contractor shall design and provide all facilities required to deliver water to the project. Service connections or extensions to the existing water distribution system shall be made without interruption to service. Sizing of the domestic water service lines for the new facility served shall be determined in accordance with the National Standard Plumbing Code Fixture Count Method. For design of the waterlines, use maximum Hazen-Williams "C" value of 130 for plastic pipe and 120 for other pipe materials.

1.16.4.1 Water Distribution and Service Lines

a. Flow Requirements

Water shall be supplied by service lines of appropriate capacity to provide

the flows determined to be necessary to meet all requirements of the new facility. The requirements for sizing the water lines include all domestic use, and interior and exterior fire protection water, as required.

b. Service Connections

A maximum velocity of 10 feet per second(3.048 meters per second) shall be used for metallic piping and five feet (1.5 meters(per second shall be used for nonmetallic piping. Service connections shall be made via corporation stops, appropriate gooseneck connections, or tapping sleeves and valves. The number and maximum size of corporations stops shall be as specified in the UFGS Section 02510 WATER DISTRIBUTION SYSTEM.

c. Dewatering, Hydrostatic Testing, and Flushing of Lines

The Contractor shall be responsible for implementing the terms and requirements of SECTION 01355 ENVIRONMENT PROTECTION for dewatering, hydrostatic testing, and flushing of lines after disinfection.

d. Domestic Service Stop Valve

Building shall be provided with separate service and stop valves in areas readily accessible to maintenance and emergency personnel.

1.16.4.2 Dedicated Fire Water Service Lines

a. Fire Flow Data

Hydrant flow data shall beconducted by the contractor. data to be recorded with the flow tests are static pressures, residual pressures, flowrates, pump status, date and time tests were conducted, and name of personnel conducting the fire hydrant flow tests. The static pressures, residual pressures, flowrates, test hydrant and flow hydrants shall be shown on the appropriate contract drawings. Fire hydrant flow tests required for fire protection design shall be made in accordance with the procedures specified in AWWA M17, (Installation, Field Testing, and Maintenance of Fire Hydrants). The Contractor shall coordinate with the McConnell Air Force Base Fire Department and BCE prior to conducting such tests. The Contractor shall submit verification of fire hydrant flow test data provided with the design calculations.

b. Fire Hydrants

The Contractor shall be required to install fire hydrants for the new facilities. One fire hydrant shall be located within a minimum of 150 feet(45 m) of the building fire department connection. All other hydrants shall be located in accordance with Military Handbook MH 1008C. Fire hydrant styles shall meet the installationrequirements.

c. Dedicated Fire Line

The Contractor shall be required to provide a separate fire water service line to the building for interior fire sprinkler protection in accordance with NFPA 24, and Military Handbook (MH)1008C. The fire water service line to the building shall be equipped with a Post Indicator Valve (PIV) that can be readily located by the fire department. The PIV shall not be placed closer than 40 feet(12 m) to the building it is serving and shall be provided with a tamper switch connected to the building fire control panel. The PIV shall be protected by base standard pipe bollards, filled with

concrete, painted and spaced in accordance with installation requirements.

1.16.5 WASTEWATER

Wastewater lines shall be designed and constructed in accordance with the combination of the State of Kansas, Dept. of Health and Environment," *Design Criteria Considered in Review of Wastewater Treatment Facilities, Policy 96-1*" and the Corps of Engineers Guide Specifications, Technical Manuals (TM), Engineering Manuals (EM), Military Handbooks (MH), and the industry standards listed herein. In the event of conflict, the Contractor shall follow the Local or State requirements/criteria (whichever are more stringent) which govern the wastewater lines.

1.16.5.1 Design Criteria

In addition to the State and Local criteria listed above, the sewage system shall be designed in accordance with TM 5-814-1, TM 5-814-2, and UFGS Guide Specification Section 02531 SANITARY SEWERS The Contractor shall field verify the location of the existing sanitary sewer system, the sanitary sewer system capacity and invert elevations to ensure that it is adequate for the flows generated by the new facilities. No interruption of service shall be allowed on the existing sanitary sewer line. The Contractor shall coordinate the sequencing of construction as it affects the existing sanitary sewer line with the Contracting Officer. Exterior building sanitary sewer service lines shall be 6 inch minimum diameter. All design slopes will be calculated using the Manning formula. The Contractor shall provide all calculations.

1.16.5.2 Manholes

Manholes are required at all changes of direction, slope, and size. Manholes shall be spaced not more than 300 feet apart. Avoid placing manholes where the tops will be submerged or subject to surface water inflow. Where the invert of the inlet pipe would be more than 18 inches above the manhole floor, a drop connection will be provided. The Contractor shall provide all calculations.

1.16.6 Sewer Mains

The peak diurnal and extreme peak flowrates shall be calculated according to TM 5-814-1. Curved sewers are prohibited. Pipes shall be designed to provide a minimum velocity of two feet per second at the average hourly flowrate, and a minimum velocity of 2.5 to 3.3 feet per second at the peak diurnal flowrate. Maximum velocity shall be 10 feet per second.

1.16.7 Exterior Gas Distribution

This Section contains instructions and engineering requirements relating to the design of the new exterior natural gas distribution system where required, including the building gas service lines and gas service regulator and meter assemblies. The line to the building shall be sized by the Contractor (see minimum service line sizing paragraph Service Line Sizing). The gas distribution systems shall be designed in accordance with NFPA-54, and shall meet the requirements of UFGS Section 02556A GAS DISTRIBUTION. See SECTION 01016, MECHANICAL REQUIREMENTS for additional information and requirements.

1.16.7.1 Service Line Pressure

Natural gas shall be distributed to the building at about 0.4 psi. The designer shall verify the actual gas pressure in the existing gas main.

1.16.7.2 Manholes or Valve Boxes

All manholes, or valve boxes of any nature within the project that do not conform to the new finish grade in either surfaced or unsurfaced areas shall be adjusted to the new finish grade. Where manholes, or valve boxes fall within a surfaced or unpaved roadway or parking, the existing frames and cover shall be removed and replaced with a heavy-duty frame and cover. The structure shall be adjusted as needed to fit the new conditions. All structures shall be of a type suitable for the intended use and shall conform to the requirements of the applicable section of these specifications.

1.16.7.3 Service Line Sizing

The size of the service lines shall be sufficient to supply the demand without excessive pressure drop and shall not be less than one inch in size.

1.16.7.4 Service Line Materials

All new service lines shall be underground and shall be polyethylene. All aboveground lines at the meter set assembly shall be steel as specified in UFGS Section 15190A, GAS PIPING SYSTEMS and Section 01016, MECHANICAL REQUIREMENTS.

1.16.7.5 Cathodic Protection

Cathodic protection shall be provided for all underground metallic piping and fittings except cast iron. Design of cathodic protection system shall in accordance with Section 01017 ELECTRICAL REQUIREMENTS, paragraph entitled "Cathodic Protection".

1.16.7.6 Gas Meters

A new gas meter shall be provided as part of the new service regulator assemblies. Meters shall be provided with a direct non-resettable, digital readout. Meters shall have a pulse switch initiator capable pulse output of operating up to speeds of 500 pulses per minute with no false pulses and shall require no field adjustments or 4-20 mA output. Initiators shall provide the maximum number of pulses up to 500 per minute that is obtainable from the manufacturer. It shall provide not less than one pulse per 100 cubic feet(2.8 cubic meter) of gas. Meters shall be connected to the EMCS.

1.17 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

1.17.1 Trenches

A trenchless excavation method shall be required when an underground utility line crosses any roadway. Sewer and water lines, mains or laterals, shall be placed in separate trenches. The separate trenches shall maintain a minimum horizontal separation of 10 feet and the bottom of the water line shall be at least 18 inches above the top of the sewer. Sewers crossing above potable water lines shall maintain a vertical separation of 18 inches and must be constructed of suitable pressure pipe or fully encased in concrete for a distance of 3 m on each side of the crossing.

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Bedding and initial backfill material shall be in accordance with the manufacturers recommendations. Where no manufacturer's installation manual is available, trench walls shall be excavated to a stable angle of repose as required to properly complete the work. Trench excavations shall adhere to requirements prescribed in EM 385-1-1, September 1996, Safety and Health Requirements Manual. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. Excavation, trenching, and backfilling shall be performed in accordance with the UFGS Section 02316A EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES SYSTEMS.

1.18 Oil Water Separators

Existing Oil Water Separators (OWS) are at capacity. New OWS must be provided by the contractor for work covered in this contract. OWS are required for the military fuel station and for the Refueler Maintenance Facility. Effluent quality shall meet the KDHE standard. Design, size, location are contractor responsibilities. OWS shall have an alarm sounding when the oil volume reaches the alarm quantity. Trench drains connected to OWS and thence to Sanitary Sewers are required at the Refueler Maintenance Facility and Military Fuel Station. Size, configuration, maintenance methods are the responsibility of the contractor. Ventilation of gasoline fumes and ease of cleaning are required features.

1.19 Termite Treatment

Termite Treatment shall be required for all buildings without chloropyrifos as an active ingredient (shall be equal to Demon TC).

PART 2 NOT USED

PART 3 NOT USED

-- End of Section --

SECTION 01016

MECHANICAL REQUIREMENTS
02/02

PART 1 TECHNICAL REQUIREMENTS

This Section contains instructions and engineering requirements relating to the design of the new mechanical systems for the Refueler Maintenance Facility (RMF), POL Operations Center (POLOPS), and Military Fuel Pumps. The design of all systems shall comply with the standards listed below in the Reference section. Delineation of the mechanical work between the building and the site utilities construction shall generally, with the exception of the natural gas system, be a point 5 feet outside of the building. The design and installation of all mechanical systems, including manufacturer's products, shall meet the instructions and requirements contained herein and the requirements of the provided technical guide specifications. Where conflicts between these instructions and the guide specifications or criteria exist, these instructions shall take precedence. Any installation requirements within these instructions, but not contained in the specifications, shall be added to the specifications or shown on the drawings. The HVAC system type for the Refueler Maintenance Facility (RMF)and POL Operations Center (POLOPS) has been selected by the government on the basis of lowest Life Cycle Cost as required by Federal Law 10CFR436 to approach the Energy Use Budget (EUB) as required by Federal Law 10CFR435. Individual mechanical equipment selection by the designer shall also consider life cycle operability based on 25 years, maintenance and repair of the facility and real property installed equipment components and systems. The mechanical systems of the Refueler Maintenance Facility (RMF) shall consist of gas distribution, plumbing, all water hydronic heating with overhead unit heaters for the maintenance bays, gas fired unitary heating and split system DX cooling equipment for non-work bay areas including administration, air supply, distribution, ventilation, exhaust systems, and direct digital control systems with the following components as specificed herein. The mechanical systems of the POL Operations Center (POLOPS) shall consist of gas distribution, plumbing, all hydronic hot water heating, split system direct expansion cooling, two-deck multizone air handler for administration, air supply, distribution, ventilation, exhaust systems, and direct digital control systems with the following components as specificed below. The mechanical systems of the Military Fuel Pumps shall consist of new tank truck bulk off-loading, tank truck bulk loading, and ground vehicle dispensing pumps and dispenser for the two existing above ground tanks 3 and 4, and ground vehicle dispensing pumps and dispenser for the two existing underground tanks 7 and 8 as specificed below.

a. Interior Gas Piping Systems.
b. Thermal Insulation of Mechanical Systems.
c. Plumbing Systems.
e. Hydronic Heating Systems.
f. Pulse boilers.
g. Refrigeration/Chilled Water Systems.
j. Hot and chilled water pumps.
k. Horizontal, ceiling hung, DX-type computer room or fan coil unit one per communication room.
l. multi-zone air handler.
o. Exhaust fans

p. Propeller Unit Heaters (Located in the mechanical rooms.
q. Appropriate DDC controls for all systems.

All equipment installed shall be capable of maintaining the design conditions for all spaces throughout the life of the facility. Ease of access to components and systems in accordance with industry standards and safe working practices is a design requirement. Maintenance clearances shall be as minimum as recommended by the equipment manufacturer. All like equipment and accessories shall be from a single manufacturer.

1.1 REFERENCES

The design shall comply with good engineering practice. Mechanical systems shall be designed to comply with the documents listed below, whether or not referenced otherwise in this specification. The publications are referred to in the text by basic designation only. The latest edition of the following standards and codes in effect and amended as of date of supplier's proposal, and any subsections thereof as applicable, shall govern design and selection of equipment and material supplied:

Air Conditioning and Refrigeration Institute (ARI) Standard

American Conference of Governmental Industrial Hygienists (ACGIH) - Industrial Ventilation, A Manual of Recommended Practice, 24th Edition.

American Society for Testing and Materials (ASTM) publications - A53, D1248, F876, F877.

American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):

Guides; Terminology of HVAC&R, 2nd Edition etc.
Guideline 1, The HVAC Commissioning Process.

Handbooks; 1999 HVAC Applications, 2002 Refrigeration, 2001 Fundamentals, 2000 HVAC Systems & Equipment, etc. SI editions

Standards; 15-1994, 54-1992, 62-1999, 90.1-1989 & Addendum 90.1-1989, 52.1-1992, 111-88 etc..

American National Standards Institute (ANSI) publications - Z83.6.

American Society of Mechanical Engineers (ASME), 22 Law Drive, P.O. box 2900, Fairfield, N.J. 07007-2900.

Army Technical Instructions, TI 800-01, Design Criteria, dated Jul 1998.

Army Technical Instructions, TI 809-04, Seismic Design for Buildings, dated Dec 1998.

Army Technical Instructions, TI 810-10, Mechanical Design, Heating Ventilating and Air Conditioning, dated Feb 1999.

Army Technical Instructions, TI 810-11, Heating, Ventilating and Air Conditioning Control Systems, dated Nov 1998.

Army Technical Instructions, TI 810-32, Heating and Cooling Distribution Systems, dated Jan 2002.

Army Technical Manual, TM 5-805-4, Noise Control for Mechanical Equipment, dated May 1995.

Army Technical Manual, TM 5-810-5, Plumbing, dated Aug 1993.

Instrument Society of America Standard (ISA S75.01), Current edition.

Manufacturers Standardization Society of the Valve and Fitting Industry, Inc. (MSS) Standards

UFC 3-600-01, Fire Protection for Facilities

MIL-HDBK-1022A, Petroleum Fuel Facilities

National Fire Codes (NFPA), with most current updates, including NFPA 70 National Electrical Code (NEC).

International Plumbing Code (IPC).

Sheet Metal and air-conditioning Contractors National Association (SMACNA) Standards

Underwriters Laboratories (UL 142),(UL 441) Current edition.

International Building Code, latest edition

Military Criteria is available on the internet at www.usace.army.mil/inet/usace-docs/ and/or www.hnd.usace.army.mil/techinfo/instruct.htm.

Engineering Weather Data, TM 5-785, dated Jul 1978.

1.2 General Mechanical Requirements

As applicable, the following shall be provided for all new mechanical systems:

1.2.1 Design Submittals

Drawings, specifications, design analysis and calculations shall be provided in accordance with SECTION 01019 - DESIGN AFTER AWARD-35 PERCENT, SECTION 01020 - DESIGN AFTER AWARD-60 PERCENT and SECTION 01021 - DESIGN AFTER AWARD-100 PERCENT.

1.2.2 National Electrical Code NFPA 70 (NEC), Class 1 Requirements.

The NEC requirements apply to all facilities, and shall be exceeded as follows; All equipement installed above the floor, including near the roof, in the Work Bays and Inspection Bay of the Refueler Maintenance Facility (RMF) shall meet Class 1 Division 1 requirements. Other requirements, including Class 1 Division 1 area, per NEC shall apply.

1.2.3 Technical Specifications

For minimum technical specification requirements see SECTION 15000 - MECHANICAL SYSTEMS - OUTLINE SPECIFICATIONS.

1.2.4 Equipment Efficiency

Mechanical equipment shall be energy efficient per Executive Order 12902, 13123 and ASHRAE/90.1. Where products are not yet rated as energy efficient products by ENERGY STAR (Registered Trademark) the Contractor should strive to provide products that meet the above criteria and be in the upper 25 percent of energy efficiency as designated by FEMP.

1.2.5 Mechanical/Electrical Equipment Coordination

Arrangement of all mechanical equipment and piping shall be coordinated with electrical work to prevent interference with electrical componets. Special care shall be taken with conduits and other componets that may run through the mechanical room and to insure adequate space in shared chases. Mechanical equipment (pipes, ducts, etc. unless items solely serve the area) shall not be installed OVER OR WITHIN SPACE which is dedicated to transformers, panelboards, or other electrical equipment unless items solely serve the area. When electrical equipment is located in a mechanical equipment room, the dedicated electrical space shall be indicated by a dashed line and noted "Electrical Equipment Space".

1.2.6 Finished Spaces.

All piping and equipment located in finished areas of the building shall be concealed or furred-in; exposed piping and equipment is only allowed in utility, equipment, storage and other rooms of this nature.

1.2.7 Mechanical Spaces.

There is some flexibility in the size of some of the mechanical spaces. All mechanical rooms and yards shall have sufficient size as required to house all mechanical equipment and provide adequate clearance as specified below. All clearances required by the equipment manufacture for operation, routine maintenance, and replacement of minor and major components shall be provided for all mechanical equipment. Piping and supports shall not interfere with equipment maintenance access or pull space. In addition a minimum of 2 feet clear shall be provided around all mechanical equipment. Ample space shall be provided around equipment to allow unobstructed access for entry, servicing, and routine maintenance to include pull space for service and/or replacement of filters, coils, motors, boilers and other equipment items. Pull space provided in rooms for service and/or replacement of mechanical equipment items shall be indicated with broken (dashed) lines on the drawings. Provisions for installation, removal, and future replacement of equipment shall be coordinated with the architectural design. The arrangement, selection, and sizing of all mechanical equipment shall be such that it can be broken down and removed from the building without dismantling any adjacent systems or structures. All required clearances shall be provided for government acceptance to verify mechanical space layout. Servicing and maintenance areas interior and exterior to building shall be sized according to manufacturer's recommendations for equipment. All pipe insulation shall be jacketed within 6 feet above the finished floor.

1.2.7.1 Mechanical Room.

The mechanical room shall house the boilers, air handling units, domestic hot water heating system, all pumps, and miscellaneous equipment. The gas service, domestic service and fire service enterances shall also be located in the mechanical room. The mechanical equipment room layouts shall be

provided with ample floor space to accommodate routine maintenance of equipment and have head-room to accommodate required equipment as specified above.

1.2.7.2 Mechanical Equipment Yard.

The mechanical equipment yard shall house the air cooled condensing unit(s). The equipment yard shall be as specified in Section 01012, SITE WORK/CIVIL/UTILITIES. In addition, ample space shall be provided around all cooling equipment to allow adequate air flow for heat rejection with consideration to the type of screening provided. At a minimum, all clearances shall be per the manufacture's recomendations.

1.2.8 Roof Mounted Equipment

Except for plumbing vents and boiler vents, no other mechanical equipment shall be located on the roof of the facility.

1.2.9 Safety, Noise and Security.

Equipment shall be selected to meet the following safety, noise, and security criteria:

1.2.9.1 Rotating Guards.

All mechanical equipment selected shall have proper guards for rotating parts.

1.2.9.2 Noise.

All equipment selected shall not produce objectionable noise or vibration in occupied areas. All air supply devices shall be selected to have a noise criteria rating of NC30 or less.

1.2.9.3 Vibration Isolation/Equipment Pads

Provide vibration isolation devices on all new floor mounted or suspended mechanical equipment. All new floor mounted mechanical equipment shall be provided with housekeeping pads. Housekeeping pads shall be as specified in Section 01015, Structural Requirements.

1.2.9.4 Mechanical Rooms.

All mechanical rooms shall be secured and shall have access by only authorized personnel.

1.2.9.5 Fire Rated Walls

Fire-rated of walls shall be as required in Section 01013 ARCHITECTURAL BUILDING REQUIREMENTS.

1.3 General Facility Descriptions and Requirements

1.3.1 Refueler Maintenance Facility (RMF)

The purpose of the facility is for repair of refueler vehicles, which are are completely full in most cases, and can weigh 68,000 lbs, with the fuel weight at 40,000 lbs. Thus an empty truck weighs 28,000 lbs. The R-11 refueler truck is 22 ½ feet long and the R-12 refueler truck is 14 feet

long. All work shall conform to MIL-HDBK-1022A, Petroleum Fuel Facilities, UFC 3-600-01, Fire Protection Engineering for Facilites, Industrial Ventilation by ACGIH, and other references listed in this section.

1.3.2 POL Operations Center (POLOPS)

The purpose of the facility is to control fuel dispensing at the installation. All work shall conform to MIL-HDBK-1022A, Petroleum Fuel Facilities, UFC 3-600-01, Fire Protection Engineering for Facilites, Industrial Ventilation by ACGIH, and other references listed in this section.

1.4 HVAC Load Calculations.

This Section contains instructions and engineering requirements relating to the design of the new HVAC supply and distribution systems. The design of all systems shall comply with the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbooks, Terminology of HVAC&R guide and to the requirements of NFPA Standards Nos. 90A. Load calculation procedures shall be based on ASHRAE. Calculations shall be provided for all mechanical equipment such as boilers, heating & cooling coils, condensing units, unit heaters, piping, pumps, expansion tanks, fans, ducts, louvers, gas services and piping, plumbing, water heaters, and etc.

1.4.1 Safty Factors

A 20% safety factor shall be applied to the total room-heating load. A 10% safety factor shall be applied to the total room-cooling load.

1.4.2 Infiltration Rates.

All outdoor air shall be introduced into the occupied portions of the buildings through the air handling unit or the blower coil unit. Therefore, all occupied spaces shall be positively pressurized. However, for the purposes of sizing equipment, an infiltration rate of 0.5 air changes per hour (ACH) shall be included for all rooms with an exterior exposure. A rate of 4 ACH shall be allowed for the vestibules.

1.4.3 Building Thermal Properties.

Building thermal properties shall be as follows;

Coefficient of Heat Transmission ("U" Value)	
Roofs	0.030 Btu/square ft - degree F
Walls	0.058 Btu/square ft - degree F
Windows	0.31/0.32 Btu/square ft - degree F (winter / summer)

Exterior doors shall be hollow metal with rigid insulation cores.

These values represent the minimum acceptable level of building insulation. The mechanical designer shall verify the actual building materials meet or exceed these values. If the building envelop fails to meet these levels, the mechanical designer shall inform the Contractor, the Architectural designer and the Contracting Officer's representative of the condition and recommended corrective action. A copy of all calculations shall be included in the design submittal.

1.4.4 Computer Programs.

Capacity of heating and cooling systems shall be based on load calculations for individual spaces as well as block loads. Heat loss and heat gain calculation shall use actual design U-values. All calculations shall be based on ASHRAE methods as computed by a commercially recognized computer HVAC loads program i.e., Elite Software Inc., Trane Trace Load 700, Carrier E20-II Hourly Analysis Program (HAP) version 3.04 . A copy of all load calculations, both input and output, shall be included in the design submittal.

1.4.4.1 Delete Paragraph

1.4.4.2 Delete Paragraph

1.4.5 Internal Heat Gains for Cooling Calculations

All installed electrical equipment shall be assumed to impose 100% resistive heating load on the space except as indicated below for return air plenums.

1.4.5.1 Lighting Loads

The heat gain from space lighting loads shall be coordinated with Electrical Design Engineer (see Section 01017 ELECTRICAL REQUIREMENTS). Where the space above the ceiling is a return air plenum, than a minimum of 70% of the heat gain from the lights shall be assumed to place a direct load on the space. A maximum of 30% of the heat gain from the lights shall be assumed to place a direct load on the return air plenum.

1.4.5.2 Communication Equipment Loads

The heat gain from the communication equipment installed in the communication equipment rooms shall be coordinated with Electrical Design Engineer (see Section 01017 ELECTRICAL REQUIREMENTS).

1.4.5.3 PC/monitor/printer Loads

The heat gain from each PC/monitor/printer combination shall be 240 watts total per station.

1.4.5.4 People Loads

The heat gain from people shall be 75 Watts/person sensible and 70 Watts/person latent for walking and standing per ASHRAE Handbook of Fundamentals.

1.4.5.5 Solar, Transmission, conduction, slab loads etc Loads

The heat gain from solar sources shall be as shown in ASHRAE Handbook of Fundamentals.

1.4.6 Deleted Paragraph

1.4.7 Deleted Paragraph

1.5 HVAC Load Calculations.

1.5.1 Heating & Cooling Equipment.

1.5.1.1 Outdoor Design Temperatures.

Outdoor design conditions shall be in accordance with TM 5-785 Engineering Weather Data.

1.5.1.2 Indoor Design Temperatures.

Mechanical designs shall give maximum consideration to the comfort of the occupants. The HVAC systems shall, at all times, maintain all occupied spaces, except for the restrooms, laundry and utilty spaces, within the ASHRAE comfort zone as defined in Standard 55-1992, Thermal Environmental Conditions for Human Occupancy. The restrooms and laundry shall be maintained with in this same comfort zone when exterior temperatures and humidities are below the comfort zone. Actual indoor design conditions and setpoints, in degrees F, shall be as follows:

Occupied Areas	Heat/Cool	68/78, 50%RH
Storage/Rest rooms	Heat/(Vent)	68/84
Mechanical/utility	Heat/(Vent)	55/84
unoccupied/Setback	Heat only	55

1.5.1.3 Heating

All areas of the buildings shall be heated. Vestibules, etc, shall be heated for freeze protection of sprinklers only (or Mechanical design shall be coordinated with the Fire Sprinkler Installation for freeze protection).

1.5.1.4 Cooling

All areas of the buildings shall be provided with mechanical cooling (via refrigeration) except for the RMF work bays, restrooms, vestibules, storage areas, mechanical rooms, and electrical rooms. The storage areas, mechanical rooms, and electrical rooms shall receive additional ventilation as specified below for summer cooling. Note, all communication room shall be provided with mechanical cooling and positively pressurized.

1.5.1.5 Humidity

Humidity shall not be directly controlled in any space during the cooling season. Humidity control shall be limited to 50% relative humidity through good selection of the cooling coil. Deleted Sentence.

1.6 Ventilation.

1.5.2 Mechanical Ventilation.

The design shall insure that indoor air quality shall be maintained for all occupants during the occupied periods. Mechanical ventilation shall be provided to the buildings in strict accordance with ASHRAE Ventilation Standard 62. The maximum ventilation rate per system shall be calculated using the Ventilation Rate Procedure. The outside air rates for each system shall be corrected for multiple spaces as required by ASHRAE Ventilation Standard 62. A complete room by room ventilation analysis for each AHU shall be included in the design submittal.

1.5.3 Combustion Air

The mechanical equipment rooms containing gas burning equipment that is not directly vented to the outdoors for both combustion air and combustion by-productst shall be provided with combustion air louver sized and located in accordance with NFPA 54. Care shall be taken in design in order to minimize the potential for piping freeze-up in the mechanical room due to combustion air intake.

1.5.4 Building Exhaust.

A undercut door and/or transfer duct shall be required to allow for replacement air when required make-up air is specified to be transfered from adjoining spaces.

1.5.4.1 Toilet Exhaust.

The toilets shall be supplied with 50 cfm of exhaust per water closet or urinal as required by ASHRAE Ventilation Standard 62 or a minimum of 10 air changes per hour, which ever is greater. The required make-up air for the exhaust system shall be transfered from adjoining spaces. Finned tube radiators, cabinet unit heaters, etc. can be used to supply heat.

1.5.4.2 Janitors Closets

Janitors closets shall be exhausted at the rate of 50 cfm. The required make-up air for the exhaust system shall be transfered from adjoining spaces.

1.5.4.3 Refueler Maintenance Facility Work Bay, Inspection Bay Emergency Exhaust

An emergency exhaust system shall be installed in the Work Bay and Inspection Bay of the Refueler Maintenance Facility providing 10 air changes per hour and activated by a push button located in the bay. For the Work Bay this is about 10,400 cfm. Spark proof exhaust fan()s per AMCA, with aluminum wheels and housing, and explosion proof electric or air driven motors shall be provided. Louvers shown on Architectural Elevation Sheets above Work Bay and Inspection Bay garage doors shall be used, with intake on one side and exhaust on the other side of building. All equipment located in the Work Bay and Inspection Bay, including controls, shall meet requirements for NEC class 1 division 1 construction.

1.5.4.4 Refueler Maintenance Facility Exhaust in Areas Adjacent to Work Bay, Inspection Bay

Install exhaust in areas adjacent to, and communicating with, the Work Bay or Inspection Bay in accordance with the National Electrical Code to prevent these areas from requiring hazardous construction.

1.5.4.5 Summer Ventilation.

Ventilation shall be supplied in all parts of the building that do not receive summer cooling via mechanical cooling (i.e. the mechanical, electrical, and storage rooms). The space shall be ventilated and cooled with outside air by thermostatically controlled fans. The fans shal be set

to operate when the respective space temperature exceeds 86 degrees F. The volume of air supplied shall be calculated using an assumed delta temperature of 10 degrees F or a minimum of 10 air changes per hour. A copy of all calculations shall be included in the design submittal.

1.5.5 Building Pressurization

Entire building shall be pressurized to reduce infiltration. A building air balance calculation shall be included with the complete room by room ventilation analysis for each AHU specified above. A relative positive or negative pressurization shall be as specified below:

1.5.5.1 Restrooms and Janitor's Closet

The restrooms and janitor's closet shall be maintained at a negitive pressure relative to the rest of the facility. Supply air to these rooms shall be limited to the smaller volume of volume required to meet the heating load or 90 percent of the exhaust air volume. Remaining exhuast air shall be transfered from adjacent spaces.

1.5.5.2 Control Rooms for POL Operations Center.

The Control Rooms shall recieve filtered conditioned relief air transfered from the main ceiling plenum into the communication rooms to maintain the space under positive pressure.

1.5.6 Building Envelop Penetrations.

All building envelop penetrations for ventilation, supply, exhaust and relief, shall be provided with low leak motorized control dampers to maintain a tight building envelop anytime the ventilation is not required.

1.5.6.1 Building Outside Air Intakes.

Air intakes to heating, ventilation, and air conditioning (HVAC) systems shall be located at least 10 feet above the ground. Building envelop penetrations for outside air intake shall be located in the roof and/or clear story walls. A minimum of 40 feet shall be maintained between outside air intakes and any boiler exhaust vents, plumbing vents, the exhaust air or relief air penetrations. If feasible, locate intakes and exhausts on different building faces.

1.5.6.2 Building Relief Air.

All building relief air shall not be returned to the air handling units prior to being relieved or exhausted from the building. Building relief penetrations shall include a gravity backdraft damper in series with the motorized control damper required above.

1.6 Force Protection

In addition to the requirements listed below, the mechanical design shall include the following measures for force protection:

1.6.1 Emergency Shutoff or Kill Switch

Provide an emergency shutoff switch in the HVAC control system that can immediately shut down air distribution throughout the building. The switch (or switches) must be located to be easily accessible by building

occupants. The actual location shall be determined during design. If the occupant so directs, than the switch shall be located the greatest distance possible from the equipment location.

1.6.2 Utility Service Entrance

For all new inhabited buildings, route critical or fragile utilities so that they are not on exterior walls. Secure exterior access to gas mains, and water supplies with manual shut-off valves.

1.6.3 Building Outside Air Intakes.

Air intakes to heating, ventilation, and air conditioning (HVAC) systems shall be located at least 10 feet above the ground.

1.6.4 Equipment Bracing

Mount all overhead utilities and other fixtures to minimize the likelihood that they will fall and injure building occupants. Design all equipment mountings to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction. This standard does not preclude the need to design equipment mountings for forces required by other criteria such as seismic standards.

1.7 Seismic Protection

The facility is to be considered seismic use Group I, and site classifications indicated in Section 01015 STRUCTURAL REQUIRMENTS.

1.7.1 Fire Protection Systems

Seismic protection for sprinkler systems for fire protection systems shall be as required by the current issue of the National Fire Protection Association NFPA 13.

1.7.2 All Other Mechanical Systems and Equipment

All other mechanical equipment, piping and ductwork shall be provided with seismic protection as required by TI 809-04, Seismic Design for Buildings and FEMA 302.

1.7.3 Materials and Installation

When seismic protection is required, the seismic restraints shall be designed in accordance with UFGS Section 13080A, SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and shall meet the requirements of Section 15070A, SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.

1.8 Mechanical Insulation Systems

Insulation requirements of new mechanical systems, including insulation of plumbing systems and equipment, hot water piping systems, chilled water piping systems and equipment, and the insulation of the duct systems shall meet the requirements of Section 15080ATHERMAL INSULATION FOR MECHANICAL SYSTEMS. All hot and chilled water piping shall be insulated. Hot water piping shall be required to follow tabulated thicknesses. Domestic hot and cold water piping shall be insulated. All ducts shall be insulated in the mechanical rooms. All supply and outside air ducts shall be insulated regardless of location. Cold piping and ductwork shall have a vapor

barrier. High abuse areas shall have aluminum jackets such as janitor closets and mechanical rooms, within 6 feet above the finished floor.

1.9 Natural Gas Piping System.

The facility shall be provided with natural gas. This Section contains instructions and engineering requirements relating to the design of new interior natural gas piping systems. Interior gas piping systems shall extend from the outlet of the gas service regulator/meter assembly to the point of connection of each gas utilization device. Natural gas shall be provide to the boilers and domestic hot water heater. The aboveground gas piping system shall be designed, sized and installed in accordance with NFPA 54.

1.9.1 Gas Service Entrance

The gas service shall not be located on the front elevation of any building. The gas service shall be located as far from the front elevation of any building as practical, and the vent for the gas meter and gas regulators shall be at least 30 feet from outside air intake louvers. An anodeless riser shall be provided where PVC is connected to a metal riser prior to entering the building. An emergency gas connection shall be provided, with a sign stating "EMERGENCY GAS CONNECTION" located on the adjacent wall.

1.9.2 Gas Piping

Piping shall be sized in accordance with NFPA 54 to supply the demand without excessive pressure drop between the point of delivery and the gas utilization equipment. The pressure at the outlet of the meter set at the building's service entrance to the inlet of the individual appliance pressure regulators shall be 2 psig. Deleted sentence. Design for all piping for all systems, valves, regulators, etc. shall be per applicable industry criteria and standards and as referenced in above. All materials used for piping, valves and miscellaneous equipment shall meet or exceed the calculated design pressures, loads and stresses for each system. During design of the piping systems, consideration shall be given to future operations and maintenance activities. All systems shall be capable of being maintained with a minimal amount of disassembly of all assemblies and sub-assemblies. Interior piping shall be black steel as specified in Section 15190A, GAS PIPING SYSTEMS. Minimum interior gas pipe size shall be 3/4 inch. Gas piping shall be shown on the mechanical HVAC Drawings. The following items shall be provided as part of the building's natural gas system in the order listed below;

1.9.3 Automatic Shut-off Natural Gas Safety Device

A separate automatic shut off device shall be located up stream of regulators at the service entrance to the building. The safety device shall be a mechanical, pilot operated device which does not require electrical power to operate. The pressure sensing element of the pilot operated device shall be located down stream of first requlators to cut off gas flow if the supply pressure to the building exceeds the safe inlet pressure to all down stream requlators.

1.9.4 Building Requlator

Coordinate with base on natural gas distribution pressure prior to design. The designer shall verify the actual gas pressure in the existing gas main.

Natural gas shall be distributed within the building at about 2 psig with an inline regulator near appliance reducing pressure as required. The building regulator shall have a maximum turn down ratio of 20 to 1. This may result in two building natural gas regulators in series if supply pressure is greater than 40 psig. The contractor shall submit shop drawing showing natural gas regulator(s) inlet and outlet pressure recommended orifice diameter, and orifice diameter installed, to insure its within the manufacturer's recommendation for the gas system pressure design. Install a pressure relief valve immediately downstream of the building service pressure regulator (prior to the meter), even if the regulator is equipped with an integral pressure relief valve.

1.9.5 Gas Meter

A gas meter shall be provided for each building (POL and Refueler Maintenace facilities). The gas meter shall contain visual readout and pulse initiator connected to the base wide EMCS system. Readout shall index in cubic feet.

1.9.6 Appliance Regulator

Each piece, except as noted below, of equipment which is fired by natural gas shall be provided with a separate gas pressure appliance regulator to reduce the gas pressure to the value as recommended by the manufacture of the gas burning appliance. When multiple pieces of the identical gas burning equipment, such as boilers, are to be installed in the same room a single appliance regulator shall be provided for the group of identical equipment. Other equipment with in the same room maybe combined onto a common appliance regulator if all equipment served by the common appliance regulator require the same inlet gas pressure.

1.9.7 Equipment Connections

The final connection to gas equipment shall be made with rigid metallic pipe and fittings. Accessible gas shutoff valve and coupling are required for each piece of gas equipment.

1.10 Plumbing System.

This Section contains instructions and engineering requirements relating to the design of the new plumbing systems as required. A plumbing system consists of the Drain Waste and Vent system (DWV) system; the domestic hot and cold water supply distribution system to the various plumbing fixtures; and the Domestic Hot Water Heating System; make-up water piping to the various hydronic type environmental control systems; and shall extend from connections within the structure to a point 5 feet outside the structure. The design of all plumbing systems shall, unless otherwise stated herein, comply with the most current TM 5-810-5 and International Plumbing Code (IPC) and shall meet the requirements of Section 15400A PLUMBING, GENERAL PURPOSE. The quantity of plumbing fixtures shall be as shown on the contract Architectural drawings. The designer shall submit for review all plumbing calculations demonstrating his pipe sizing methods and assumptions.

1.10.1 Piping Runs

Piping runs in buildings shall be arranged to not interfere with movement of personnel and equipment. Neither water nor drainage piping shall be located over electrical equipment or panels. Domestic water piping located

outside of mechanical equipment areas shall be routed in the ceiling space above the corridors. Water and waste piping shall not be located in exterior walls or other spaces where there is possibility of freezing. Where piping is to be concealed in wall spaces or pipe chases, such spaces shall be checked to insure that clearances are adequate to properly accommodate the piping.

1.10.2 Soil, Waste and Vent Piping System.

Horizontal soil and waste piping shall be installed at a uniform pitch in accordance with the International Plumbing Code (IPC) in the buildings. Soil, waste and vent stacks shall be located to serve each fixture or group of fixtures depending on fixture proximity to stack. Material type shall be as specified in Section 15400A, Plumbing, General Purpose.

1.10.2.1 Piping Invert Elevations

All building underslab piping elevations should be shown on the drawings. Verify that the pipe elevations do not conflict with building structural footings and foundations walls.

1.10.2.2 Floor Drains

Floor drains shall be provided as shown in section 01018, Space Data Sheets. The mechanical equipment rooms shall be provided with sufficient floor drains to accommodate routine maintenance and drain down of equipment and piping within the room without running drain pipes over the floor. In addition, a floor drain shall be provided in the mechanical room and janitors closet. To prevent traps from drying out, deep seal traps shall be provided on all floor drains.

1.10.2.3 Cleanouts

On straight runs of pipe, cleanouts shall be provided at not more than 50 feet apart. Cleanouts shall be provided at each change of direction of pipe and shall be provided at the base of all storm, soil, waste, and vent stacks.

1.10.2.4 Oil Water Seperator for Refueler Maintenance Facility

An oil water separater shall be provided for the Refueler Maintenance Facility to serve trench drains in the Work Bays and Inspection Bay.

1.10.2.5 Plumbing Vents

Where feasible, combine circuit vents in a concealed space to a main vent through the roof in lieu of an excessive number of individual vents through the roof. All vent lines through roof shall be 4 inches and terminate with a minimum of 6 inches above finished roof. Where vents connect to horizontal soil or waste lines, the vent shall be taken off so that the invert of the vent pipe is at or above the centerline of the horizontal soil or waste pipe.

1.10.3 Domestic Potable Water System.

Domestic potable water pipe sizing criteria shall be based on a system supply pressure, residual pressure, and flow rate to provide a minimum of 25 psig at the most hydraulically remote fixture. The system supply pressure, residual pressure, and flow rate as specified in Section 01018,

FIRE PROTECTION REQUIREMENTS. Water service entrance shall be sized for the maximum probable demand. Water piping shall be designed not to exceed a velocity of 8 feet per second at full flow. All domestic potable water piping shall be nonferrous as specified in Section 15400A, Plumbing, General Purpose. All materials used for piping, valves and miscellaneous equipment shall meet or exceed the calculated design pressures, loads and stresses for each system. During design of the piping systems, consideration shall be given to future operations and maintenance activities. All systems shall be capable of being maintained with a minimal amount of disassembly of all assemblies and sub-assemblies.

1.10.3.1 Water Service Entrances

New water service entrances shall be provided with a water meter and isolation valves located inside the building. Meters shall be provided with a direct non-resettable, digital readout. Meters shall have a pulse switch initiator capable pulse output of operating up to speeds of 500 pulses per minute with no false pulses and shall require no field adjustments or 4-20 mA output. Initiators shall provide the maximum number of pulses up to 500 per minute that is obtainable from the manufacturer. Meters shall be connected to the EMCS system.

1.10.3.2 Protection of Water Supplies

Cross connections between water supply piping and waste, drain, vent, or sewer piping are prohibited. Exterior water fountains shall be connected to the domestic water to the building and be provided with a reduced pressure principle type backflow preventor. Reduced pressure type backflow preventers shall be provided on all make-up water systems. All backflow preventers shall be installed for accessibility per International Plumbing Code (IPC) and shall comply with the requirements of the State of Kansas regulations. State licensed plumbers shall install and/or test backflow preventors and cross connections devices. For Fire Protection backflow preventor requirements see Section 01018FIRE PROTECTION REQUIREMENTS.

1.10.3.3 Water Hammer Arresters

Commercially available water hammer arresters shall be provided at all new quick closing valves such as flush valves and solenoid valves and shall be installed according to manufacturers recommendations. Vertical capped pipe columns in lieu of water hammer arresters are not permitted.

1.10.3.4 Deleted Paragraph

1.10.3.5 Freeze-Proof Wall Hydrants and Hose Bibbs.

Exterior freeze-proof wall hydrants with vacuum-breaker-backflow-preventer shall be provided on the exterior of the buildings to accommodate a maximum hose length of 100 feet. Wall hydrant drops shall be installed within interior partitions to eliminate freeze potential. A wall hydrant shall be provided near all Mechanical Room's exterior doors. Exterior wall hydrants shall be mounted 2 feet above finished grade.

The Refueler Maintenance Facility (RMF) shall contain interior hose bibbs, one at each end of the Work Bay, and one in Wash Bay. An interior hose bibb shall be provided in all mechanical rooms. All hose bibbs shall be mounted 3 feet above the finished floor.

1.10.3.6 Deleted Paragraph

1.10.3.7 Service Stop Isolation Valves

For normal maintenance or replacement, servicing stop isolation valves shall be installed in water connections to all installed new equipment and new fixtures. In addition, stop valves shall be provided to isolate portions of systems so as to not require shutdown of entire systems. Stop isolation valves for piping and equipment shall be shown on the drawings. Service stop isolation valves to faucets shall meet ANSI/NSF 61, section 9 lead leaching requirements.

1.10.4 Domestic Hot Water Heating System.

Domestic water heating system shall be located in the mechanical equipment rooms. Heater(s) shall be natural gas fired with a combined or separate water storage tank(s). The capacity of the water heater(s) shall be adequate to meet the peak hot water requirements of the facility and shall be designed in accordance with Chapter 48, Service Water Heating, of the 1999 ASHRAE HVAC Applications Manual. The domestic hot water heater(s) and/or storage tank(s) shall be selected to provide the combination of recovery capacity and usable storage capacity to the building as required by ASHRAE. Only 75 percent of the installed storage capacity shall be considered usable in calculating the required recovery rate.

1.10.4.1 Equipment Size Limitations.

Size limit of individual storage tanks or domestic hot water heaters shall be limited to a size that can be removed and replaced through the mechanical room door on a dolly without dismantling the building, the door, the domestic hot water heater, the storage tank or any other installed mechanical equipment, piping or ductwork.

1.10.4.2 Domestic Cold Water Inlet Temperatures.

An inlet water temperature of 50 degrees F. shall be used for sizing the water heaters.

1.10.4.3 Domestic Hot Water Supply Temperatures.

Domestic hot water shall be supplied to the building for general use at a temperature of 140 degrees F.

1.10.4.4 Domestic Hot Water Storage Temperatures.

Water storage temperature shall be 140 degrees F. as a minimum to prevent bacterial growth within the tank.

1.10.4.5 Deleted paragraph

1.10.5 Domestic Water Pumps.

Domestic hot water pumps shall be all bronze centrifugal pumps. Pumps and motors shall be properly sized for the application required. Pump capacity, efficiency, motor size, speed and impeller types shall be

optimized for the application. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pumps and motors shall operate at 1800 RPM (maximum).

1.10.5.1 Domestic Water Circulation Pumps.

When seperate heater and storage tanks are provided, one or more individual domestic hot water pumps shall be provided to circulate hot water between the hot water storage tanks and the heater seperate from the domestic hot water recirculation pump.

1.10.5.2 Domestic Water Recirculation Pumps.

Each domestic hot water system shall have a domestic hot water recirculation pump to recirculate 5 gpm of domestic hot water from within a minimum of 50 feet of every plumbing fixture that utilizes hot water within the building and back to the heating system. The system shall continually circulate domestic hot water in order to insure that domestic hot water is available at each fixture without delay. In buildings operated on a nominal 40-hour week or on a nominal two-shift basis (either a 5-or a 7-day week) a clock or other automatic control shall be installed on domestic hot water circulation pumps to permit operation only during periods of occupancy plus 30 minutes prior.

1.10.5.3 (Re)Circulation Pipe Sizing Criteria.

The piping systems shall be sized to limit pressure loss and noise. Pipes 2 1/2 inch and larger shall be sized for a maximum pressure loss of 4 feet per 100 feet. Pipes 2 inches and smaller shall be sized for a maximum velocity of 4 feeet per second.

1.10.5.4 Computer Program or Spreadsheet.

The pressure loss, velocity and volume of each piping segment shall be calculated by a computer program/spreadsheet, based on the actual pipe material installed for each piping segment. The computer program/spreadsheet shall calculate the pressure loss through each and every individual flow path of each system to determine the maximum pressure lost of the system. The computer program/spreadsheet shall also calculate the total system volume. A copy of all calculations, both input and output, shall be included in the design submittal.

1.10.6 Plumbing Fixtures.

Plumbing fixtures shall conform to ASME standards and Executive Order 12902 with lead-free faucets. End-point devices shall meet lead leaching requirements of ANSI/NSF 61, section 9, lavatory faucets, kitchen and bar faucets, supply stops and endpoint control valves. All plumbing fixtures shall be the water conservation types as specified in Section 15400A, Plumbing, General Purpose.

1.10.6.1 Handicapped Water Cooler Drinking Fountains

Handicapped water cooler drinking fountains shall be Elkay model EBFSA8 or equal. Front and side push bars, stainless steel finish,ADA compliant, no lead design. For non-handicapped water cooler drinking fountains, use Elkay model LWAE8 or LWCE8, or equal. Drinking fountains shall meet the requirements of NSF 61, Section 9. Water cooler drinking fountains shall: be self contained, conform to ARI 1010, use one of the fluorocarbon gases

conforming to ARI 700 and ASHRAE 34 which has an Ozone Depletion Potential of less than or equal to 0.05.

1.10.6.2 Shower Receptors

Shower Receptors; Florestone Terrazzo Shower Receptor model 200 or equal, tan color, marble chips cast in white Portland cement to produce a compressive strength of over 3000psi and reinforced with 16 gauge galvanized wire. Removeable type strainers are supplied. 1 1/4 inch tiling flange on 3 sides. Center drain.

1.10.6.3 Laboratory Sink for POL Operations Center

Stainless steel, single bowl, self rim with holes for faucet and spout, single compartment 28 x 18 x 10 inches deep, seamless 20 guage 302 stainless steel with full undercoat.

Faucet, Handles, and Spout - Single lever control with gooseneck faucet. Faucets shall meet the requirements of NSF 61, Section 9. Spout body, base, dome, and handles are chrome-plated brass. Faucet is protected from back siphonage by combination of two check valves and a vacuum breaker. Flow shall be limited to 0.16 liters per second (2.5gpm) at a flowing water pressure of 549kPa (80psig).

1.10.6.4 Break Room Sink and Refrigerator Ice Maker for POL Operations Center

Self rim with holes for faucet and spout, double bowl, left compartment 14 x 15 3/4 x 10 inches deep, right compartment 14 x 15 3/4 x 7 inches deep with waste disposer drain opening, seamless 20 guage 302 stainless steel with full undercoat, right compartment equipped with food waste disposer. The food waste disposer shall contain a 3/4 horsepower motor with 2700rpm grinding action and delux sound insulation.

Faucet, Handles, and Spout - Single lever control with pullout retractable spray, Elkay model LK4330FCR or equal. Faucets shall meet the requirements of NSF 61, Section 9. Spout body, base, dome, and handles are chrome-plated brass. Faucet is protected from back siphonage by combination of two check valves and a vacuum breaker. Flow shall be limited to 0.16 liters per second (2.5gpm) at a flowing water pressure of 549kPa (80psig). Valves shall be thermostatic mixing type with pressure compensation.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel.

The refrigerator shall contain an icemaker domestic water hook-up

1.10.6.5 Lavatory Sinks

Handles - Two lever type handles required, one for hot, and one for cold.

1.10.6.6 Janitor Closet Sinks

A enameled cast iron floor mounted type service sink shall be provided in all janitor closets. Overall sink dimensions shall be approximately 28 inches x 28 inches. The depth of the floor sink bowl shall be approximately 10 inches.

1.10.7 Storm Drainage

Where required storm drainage system shall include roof drains, overflow drains, leaders, and conductors within the building to a point 1.5 m outside the building. Where required by the architectural drawings, roof drains, with auxiliary overflow drains, shall be provided at the low points of the roof. Storm water shall be routed through interior downspouts and piped directly to the facility storm drainage system. Roof drains shall be designed for a maximum rainfall rate of 111 mm per hour and shall be sized in accordance with the International Plumbing Code (IPC). All elbows for the storm drainage and overflow drainage piping 10 inches and smaller shall be 90 degree short sweep elbows.

1.10.8 Cathodic Protection

Cathodic protection shall be provided for any new underground ferrous piping, fittings, and valves except cast iron. Design of cathodic protection system shall in accordance with Section 01017 ELECTRICAL REQUIREMENTS, paragraph entitled "Cathodic Protection".

1.11 General Hydronic Systems.

System, equipment and calculation requirements listed below shall be required for the heating hydronic systems. The building distribution piping shall be direct return with automatic flow control valves. The material and installation requirements for items common to both systems shall be as specified in UFGS Section 15569A WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH.

1.11.1 Flow Medium.

The hot water system designs shall include safeguards to protect against freezing damage. The flow medium for the hot water systems shall be a mixture 40% propylene-glycol.

1.11.2 Computer Program or Spreadsheet.

The pressure loss, velocity and volume of each piping segment shall be calculated by a computer program/spreadsheet, based on the actual pipe, fitting, and valve material installed for each piping segment. The pressure loss calculations shall include the actual pressure loss through each valve such as control valves, triple duty valves, shut off valves, etc, based on the valve Cv. The designer shall show the valve Cv used in the hydronic calculations on the construction drawings. The computer program/spreadsheet shall calculate the pressure loss through each and every individual flow path of each system to determine the maximum pressure lost of the system. The computer program/spreadsheet shall also calculate the total system volume. A copy of all hydronic calculations, both input and output, shall be included in the design submittal.

1.11.3 Piping

The hot and chilled water piping shall be as specified in UFGS Section

15569A WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH.

1.11.3.1 Pipe Sizing Criteria.

The hydronic piping systems shall be sized to limit pressure loss and noise. Pipes 2 1/2 inches and larger shall be sized for a maximum pressure loss of 4 feet per 100 feet. Pipes 2 inches and smaller shall be sized for a maximum velocity of 4 feet per second.

1.11.3.2 Piping Material.

All materials used for piping, valves and miscellaneous equipment shall meet or exceed the calculated design pressures, loads and stresses for each system. During design of the piping systems, consideration shall be given to future operations and maintenance activities. All systems shall be capable of being maintained with a minimal amount of disassembly of all assemblies and sub-assemblies. The technical specifications contain more than one possible material type. If the material type or valve Cv for any one piping segment is changed after the hydronic calculations for a given system have been calculated. The entire system shall be recalculated, as specified above, based on the actual materials installed and the pump shall be reselected.

1.11.3.3 Piping Slope

All piping shall be pitched up in the direction of flow, shall be designed without pockets which would permit accumulation of air, and shall be provided with vents at high points and drains at low points. Piping located outside of mechanical equipment areas shall be routed in the attic or in the pipe chases. Slope of piping shall be as indicated in technical specifications.

1.11.3.4 Pipe Expansion

In runs of pipe 50 feet and longer, or in shorter runs where designer deems it is required, indicate size on project drawings the location of all anchors, bends, loops, and pipe guides to adequately limit and provide for pipe expansion. Do not use expansion joints in piping unless absolutely necessary and justified. Anchors and guides shall be indicated on the project drawings and detailed for installation in the building structure provided. STRUCTURAL DESIGN ENGINEER shall be thoroughly informed of all forces generated.

1.11.4 Coils and Terminal Equipment

Provide isolation valves, balancing valve, flow measuring device, and pressure/temperature test taps at all heating and/or cooling units, pumps, and hot water unit heaters. Pipe taps, suitable for use with temperature or pressure probe, shall be located at each pressure gauge. All coils shall be provided with valved drain and air vent connections. A thermometer shall be installed on the supply and return piping to/from each coil. All thermometers shall be legible to service mechanics standing at ground level. Temperature/pressure taps shall be provided on the supply and return piping of each coil. All three-way type control valves shall be provide with a balancing globe valve or cock in the bypass piping.

1.11.5 Pumps.

Pumps and motors for hot water systems shall be properly sized for the

application required. Pump capacity, efficiency, motor size, speed and impeller types shall be optimized for the application. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pumps and motors shall operate at 1800 RPM (maximum).

1.11.6 Expansion Tanks

A daiphram type expansion tank shall be provided in the hot water piping systems. The expansion tank's precharge pressure and acceptance volume shall be selected based on the design of the piping systems. The STRUCURAL DESIGN ENGINEER shall be thoroughly consulted before hanging any thing from the building structure.

1.11.7 Air Separation Tanks

The hot and chilled water piping systems shall be provided with an air separation tank. The air separators shall include an automatic air vent and make-up water system, consisting of a pressure reducing valve, strainer, reduced pressure type backflow preventer and isolation valves.

1.11.8 Water Treatment Systems

Provide a mixture of 40% propylene glycol and 60% water into the hot water piping systems. Provide a shot feeder (chemical feeder) at the hot water circulating pumps to allow introduction of chemicals into the system. Provide the chemical treatment necessary to protect the system equipment from damage due to corrosion.

1.11.8.1 Chemical Treatment

The water shall be treated to maintain the conditions recommended by the boiler manufacturer. Chemicals shall meet required federal, state, and local environmental regulations for the treatment of boilers and discharge to the sanitary sewer. The services of a company regularly engaged in the treatment of boilers shall be used to determine the correct chemicals and concentrations required for water treatment. The company shall maintain the chemical treatment and provide all chemicals required for a period of 1 year from the date of occupancy. Filming amines and proprietary chemicals shall not be used. The water treatment chemicals shall remain stable throughout the operating temperature range of the system and shall be compatible with pump seals and other elements of the system.

1.11.8.2 Make Up Water

The makeup water conditions reported per ASTM D 596 shall be as specified in Section 15569A WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH. Water softener and water analysis shall be as specified herein for makeup water. A water treatment plan shall also be provided as specified in accordance with Section 15569A WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH

1.12 Hydronic Heating System for POL Operations Center and Refueler Maintenance Facility.

Gas fired radiant heat shall not be used in the Work Bays or Inpsection Bay of the Refueler Maintenance Facility. Heating system for the Refueler Maintenance Facility (RMF) shall be hot water system with unit heaters in Work Bays and Inspection Bay, fan-coil units in heated only center areas.

Heating system for the POL Operations Center shall be a forced-air/hot water system consisting of a natural gas fired boilers, water distribution system, circulating pumps, and associated space heating equipment. The hydronic heating system shall provide 100% of the buildings heating requirements for both space and ventilation loads. The use of electric resistance heating is not permitted. The heating system designs shall meet the requirements of UFGS Section 15569 WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH and, unless otherwise stated, shall comply with the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbooks and Terminology of HVAC&R guide. The hydronic heating system shall be heated by gas fired modular pulse condensing hot water boilers. The boilers shall be located in the mechanical room. The hot water heating system shall be circulated in a primary/secondary arrangement.

1.12.1 Gas Fired Modular Pulse Condensing Hot Water Boilers.

Gas Fired Modular Pulse Condensing Hot Water Boilers shall be provided for the POL Operations Center and the Refuler Maintenance Facilicty as specified in Section 15569A, WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH. All boiler modules which serve the same building shall be of the same size. The boilers shall have a minimum rated efficiency of 90 percent with a return water temperature of 120 degrees F.

1.12.2 Pulse Boilers Venting.

The boilers shall have a flue gas temperature low enough to permit side wall venting. Boiler vents shall be located through the side wall at approximately 28 inches above the finished grade. Maximum separation, as recommended by the boiler manufacture, shall be provided. The boilers shall be individually vented, both intake and exhaust, directly to the outside. Boiler vent exhaust fans shall not be provided. Boiler vents shall not be located on the front elevation of any building. Boiler vents shall be located as far from the front elevation of any building as practical.

1.12.3 Hot Water Supply Temperature.

The system shall be controlled to reset the supply water temperature based on outside air temperature without the use of three-way valves at the boilers. The hot water system shall be designed for a maximum supply temperature of 150 degrees F, a maximum return temperature of 120 degrees F and a minimum return temperature of 80 degrees F. Since the boiler efficiency is an inverse function of the return water temperature, the hot water return temperature of 120 degrees F was selected by the Government to allow for maximum system efficiency. Deleted sentence. Sufficient coil capacity shall be provided.

1.12.4 Hot Water Pumps.

Hot water centrifugal pump shall be as specified in Section 15569A, WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH. In addition to the boiler pumps required above, the building shall be provided with a hot water based-mounted centrifugal pump and standby pump for the hot water heating system. The pumps shall distribute hot water through the building distribution piping to the coils located in air handling units, blower coil units and unit heaters.

1.12.5 Propeller Unit Heaters.

The mechanical and electrical equipment rooms shall be provided with a thermostatically controlled, hot-water, horizontal throw unit heaters to maintain a space temperature of 45 degrees F. minimum. Unit heaters shall be cycled from a space thermostat to maintain the space setpoint. Propeller unit heaters, as specified in Section 15569A, WATER AND STEAM HEATING; OIL, GAS OR BOTH; UP TO 20 MBTUH, shall be provide to heat the mechanical rooms.

1.13 POL Operations Center Control Room.

Communication rooms shall be provided with individual horizontal, ceiling hung, direct expasion type computer room or fan coil units for filtration, mechanical cooling, heating and pressurization. The unit shall transfer filtered relief air from the main ceiling plenum into the communication room to maintain the space under positive pressure. The unit shall be as specified in Section 15700A, UNITARY HEATING AND COOLING EQUIPMENT.

1.14 Air Supply and Distribution Equipment.

This Section contains instructions and engineering requirements relating to the design of the new HVAC supply and distribution systems. The air supply and distribution system shall inculde all air handling equipment, fans, ductwork, hoods, etc. The design of all systems shall comply with the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbooks, Terminology of HVAC&R guide and to the requirements of NFPA Standards Nos. 90A. All HVAC systems shall be designed in accordance with NFPA for fire dampers, smoke dampers and fan shutdown. The designer shall show on the construction drawings all fire or smoke dampers required by NFPA. The materials and installation of the air supply and distribution system shall be as specified in Section 15895A, AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

1.14.1 Two-deck Multizone Air Handling Unit for POL Operations Center (POLOPS).

A portion of the POL Operations Center shall be heated & cooled by a two-deck (cold and hot) multizone air handling unit. All air handling unit components shall be located within the air handling unit. Coils shall be selected with no more than 500 feet per minute coil face velocity. To maintain outside air percentage less than 25% of the multi-zone supply, only a portion of the ventilation air required by ASHRAE standard 62 shall be supplied by the multizone AHU, with balance supplied by a blower coil.

1.14.1.1 Two Deck Multizone Module for POL.

Part or all of the AHU shall be manufacture's standard modular design or a custom design as required to provide a cold deck with cooling coil, and a hot deck with heating coil.

1.14.1.2 Two Deck Multizone Zone Control Dampers for POL.

There shall be one damper actuator per zone. Control dampers shall be as specified in Section 15951, DIRECT DIGITAL HVAC CONTROL SYSTEMS.

1.14.1.3 Filter Mixing Box.

A filter mixing box with 2 inch pleated filter shall be provided.

1.14.1.4 Return Air Plenum

A return air plenum shall be provided for the POL Operations Center with no air being returned from the Laboratory, Laboratory Office, or Toilet Rooms.

1.14.1.5 Access Sections.

The designer shall show access sections in the AHU where required to provide access for inspection, maintenance and/or control sensor installation.

1.14.1.6 Mandatory Space Zoning Requirements for POL

At least six multi-zone air handling unit zones shall be provided for the POL, and these are Office 116 (corner office), Office 115 plus Office 114, Classroom, Laboratory plus Lab Office, Break Room, and Ready Room plus Vestibule.

1.14.2 Exhaust Systems.

Except for wall mounted propeller units, all fans shall be centrifugal type and connected directly to weather-proof louvers using ductwork. Low leakage motorized dampers shall be provided. In-line fans located outside the main mechanical and electrical areas shall be the provided with a manufacturers standard acoustical enclosure to inhibit noise transmission to the adjoining occupied spaces. Sone value of fans measured 5 feet from fan inlet shall be less than 30 sones outside the mechanical equipment room. Sound transmission data shall be submitted for approval by the designer and acceptance at the governments option and design shall indicate noise criteria on schedules.

1.14.2.1 Mechanical Electrical Rooms.

Exhaust or intake fan(s) shall be provided in the mechanical and electrical rooms for summer ventilation as specified above. Intake fans shall be provided when the mechanical room contains gas burning equipment that is not directly vented to the outdoors for both combustion air and combustion by-products. Sidewall mounted fans with exterior louvers shall be provided. The fans shall be controlled by a space mounted thermostat to cycle the fans on when the space temperature rises above 85 degrees F.

1.14.2.2 Toilets.

The restroom exhaust shall be provided through inline exhaust fans, duct systems, and louvers directly to the exterior. Each set (male and female) of restrooms shall be provided with an individual inline centrifugal fan. Exhaust fans shall be provided with a single speed motor.

1.14.3 Duct Systems Calculations.

The velocity and total pressure loss, both velocity and static, of each duct segment shall be calculated by a computer program/spreadsheet, based on the equal friction method or by T-method Optimization as described by ASHRAE. The computer program/spreadsheet shall calculate the pressure loss through each duct segment for each and every individual flow path and determine the maximum pressure loss of the system. The computer program/spreadsheet shall perform calculations based on the actual material installed. A copy of all duct calculations, both input and output, shall be included in the design submittal.

1.14.3.1 Duct Pressure Classification

The designer shall indicate the duct pressure classification for each duct segment on the construction drawings. All ductwork shall be sealed to seal class A.

1.14.3.2 Diffusers, Registers and Grilles.

Supply diffusers and registers shall be sized for a maximum total pressure (velocity and static) loss of 0.15 inches w.g. and a maximum noise criteria (NC) of 30. Return, exhaust and relief registers and grilles shall be sized for a maximum total pressure (velocity and static) loss of 0.1 inches w.g. and a maximum noise criteria (NC) of 20. Diffusers, registers, and grilles in humid areas shall be aluminum or stainless steel for corrosion resistance.

1.14.3.3 Supply Duct Systems Maximum Friction Rate.

Supply duct friction rate for the equal friction method shall not exceed 0.08 inches w.g. per 100 feet.

1.14.3.4 Return and Exhaust Duct Systems Maximum Friction Rate.

Exhaust duct friction rate for the equal friction method shall not exceed 0.08 inches w.g. per 100 feet.

1.14.3.5 Positive Pressure Duct Velocity.

Except for relief duct and openings, the maximum velocity for ductwork under positive pressure shall be limited as specified below. Building relief duct and openings shall be sized for a maximum velocity of 300 feet per minute.

a. Areas with Exposed Ductwork. For areas with exposed ductwork or dustwork above an open grid type ceiling, the maximum main air duct velocity shall be 1200 feet per minute for rectangular duct and 2200 feet per minute for round duct. Branch air ducts maximum velocity shall be 80 percent of the velocity values specified above for main air ducts. The maximum velocity for runouts to outlets shall be 50 percent of the velocity values specified above for main air ducts.

b. Areas with Gypsum Ceilings. For ductwork located within the ceiling space above a gypsum ceilings, the maximum main air duct velocity shall be 2000 feet per second for rectangular duct and 2500 feet per second for round duct. Branch air ducts maximum velocity shall be 80 percent of the velocity values specified above for main air ducts. The maximum velocity for runouts to outlets shall be 50 percent of the velocity values specified above for main air ducts.

c. Areas with Acoustical Ceilings. For ductwork located within the ceiling space above a acoustical ceilings, the maximum main air duct velocity shall be 1500 feet per minute for rectangular duct and 2500 feet per minute for round duct. Branch air ducts maximum velocity shall be 80 percent of the velocity values specified above for main air ducts. The maximum velocity for runouts to outlets shall be 50 percent of the velocity values

specified above for main air ducts.

1.14.3.6 Negative Pressure Duct Velocity.

For ductwork under negative pressure the maximum velocity shall be limited to 80 percent of the value specified above for positive pressure ductwork except that transfer air openings and return air openings from return air plenums shall be sized for a maximum velocity of 300 feet per minute. Return air openings from return air plenums shall be with bell-mouth type entrances into the return duct system.

1.14.3.7 Duct Fitting Pressure Loss Coefficients.

Pressure loss through ductwork fittings shall be determined utilizing both methods and coefficients as presented in the ASHRAE Duct Fitting Database. Fitting types that are not part of the ASHRAE Duct Fitting Database shall not be designed provided or installed. The designer shall show, on the drawings, the fitting type used in the system calculations.

1.14.4 Ductwork Componets.

1.14.4.1 Acoustical Duct Liner.

Acoustical Duct Liner shall not be provided. To the maximum extent possible, objectionable sound shall be attenuated through the design and layout of the duct system. If required to control objectionable noise, sound attenuators shall be provided as specified in Section 15895A, AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

1.14.4.2 Moist Exhaust Ducts.

Exhaust ductwork serving high moisture areas, such as shower areas, shall not be routed through unconditioned spaces and shall be sealed water tight and constructed of stainless steel or welded aluminum.

1.14.4.3 Duct Drainage

Outside air intake louvers, louvered penthouses and moist exhaust ducts specified above shall be ducted and shall have provisions to dispose of melted snow, wind-blown rain and condensate which enters through the louvers or condenses in the duct. The duct seams shall be sealed watertight by soldering, brazing or welding and a drain provided at the duct low point. The drain shall be routed to a floor drain in a non-finished area such as the mechanical room. Duct access doors shall be provided near the louvers and drains.

1.14.4.4 Fire Dampers.

Fire dampers shall be provided as required by NFPA 90A and 90B. The designer shall show, on the construction drawings, all fire dampers as required by NFPA 90A and 90B. The pressure loss resulting from a full open fire damper shall be included in the system calculations specified above.

1.14.4.5 Manual Balancing Dampers.

Manual balancing dampers shall be provided at all branch take-offs in duct systems to permit adequate opportunity for balancing the system. Balancing dampers shall be located within 12 inches of the main duct. Splitter type dampers or air deflectors which project out of the branch and into the main

duct shall not be provided. The designer shall show, on the construction drawings, all balancing dampers. The pressure loss resulting from a full open balancing damper shall be included in the system calculations specified above.

1.14.4.6 Manual Zone Balancing Dampers.

Manual zone balancing dampers shall be provided on each zone's main duct at the multizone AHU. These dampers shall be located within the mechanical room and within 3 feet vertically from the discharge of the AHU. The designer shall show, on the construction drawings, all balancing dampers. The pressure loss resulting from a full open balancing damper shall be included in the system calculations specified above.

1.14.4.7 Louvers.

Fixed blade louvers shall be located where exhaust fans and relief dampers discharge from the building and where outside air is brought into the building. Motorized dampers shall be provided at all duct penetrations of the building envelope to prevent loss of energy. Relief louvers and dampers (both a motorized and a backdraft per louver) shall be provided as specified above.

1.14.4.8 Cold Air Diffusers.

When the leaving air temperature for the cooling coil is below the dew point temperature of the space, diffusers designed for diffusion of cold air below 50 degrees F shall be provided. The designer shall clearly indicate on the construction drawings which diffusers are required to be cold air diffusers.

1.15 HVAC Controls.

Design of the Direct Digital Controls (DDC) for the various HVAC systems shall be included as part of the system design. Direct Digital Controls shall be as specified in Section 15951, DIRECT DIGITAL HVAC CONTROL SYSTEMS. The designer shall use the same basic format (symbols, nomenclature and identifiers) as shown in TI 810-11 for Single Loop Digital Controls.

1.15.1 Permanent Maintenance Instrumentation

Provide sufficient instrumentation to aid maintenance personnel in balancing and/or troubleshooting mechanical systems. Instrumentation shall be provided in the media at each change in temperature and at all mixing points in air handling systems, at all discharges of air handlers, and at all return mains. Pressure gauges, thermometers, flow indicators, sight glasses, etc., shall be installed to be easily read from the adjacent floor. Separate pressure gauges shall be installed on both the suction end and discharge end of pumps. Provide an isolation valve on all pressure gauges. Thermometers shall have separable socket thermo-wells. Allow for the removal, repair, or cleaning of flow measuring devices without having to shut down the system. Provide a portable meter, with appropriate range, for each type of flow measuring device installed.

1.15.2 EMCS Connection .

The contractor shall povide programming to construct new graphical interfaces at central operators console located in the building specified

by the Contracting Officer's Representative. The contract shall provide software all hardware as required to connect the facility to the existing McConnell AFB Barber Coleman basewide centralized Energy Monitoring and Control System (EMCS).

1.15.2.1 Power Outage Start-Up

Upon an electrical power outage, all air handling units, pumps, and other major mechanical equipment shall shut down and shall be restarted in a logical and efficient manner. Timing between starts and sequence of equipment starting upon restoration of electrical power shall be provided and programmed into the HVAC temperature control system, with programming capable of being changed by the operating personnel.

1.15.2.2 Local Space Temperature Control

Control of local space temperature setpoints shall be under control of the EMCS.

1.15.2.3 Freeze Protection

Standard type freeze stats shall not be provided. The equipment is protected from freezing by the glycol mixture of the heating and cooling fluids. The control systems shall send an alarm through the EMCS and shut down the equipment when an averaging type sensor reports the delivery of air at a freezing temperature from any system within the facility. The equipment shall be restartable at both the local control panel and by the EMCS. Low temperature averaging safety sensors shall be as specified for other averaging type sensors in the air stream and may or may not be required to preform another control function.

1.15.3 Construction Control Drawings.

As a minimum, the designer's construction control drawings shall include a system schematic (following the format and symbology contained in TI 810-11), the sequence of operation, a table of all digital and analog inputs and outputs (points), all control valve Cv's, and wiring diagrams for all motor starters. The above information shall be provided for each and every distinct mechanical system.

1.15.3.1 System Schematic.

The system schematic shall identify all system sensors, indicators, actuators, pressure switches, gages, etc, and all major mechanical components such as fans, filter banks, dampers, coils, and control valves. An indicator shall be shown and installed everywhere a sensor is shown and installed for troubleshooting purposes. Separate stem type thermometers shall be required at the inlet and outlet of all hot water coils, all chilled water coils, and all dry cooler coils.

1.15.3.2 Sequence of Operations.

The sequence of operation shall be completed by the designer and shall be as specified in Section 15951, DIRECT DIGITAL HVAC CONTROL SYSTEMS. The designer shall modify all setpoints in the sequence of operation as required to match the final design of the system.

1.15.3.3 Input and Output Table.

The table of all digital and analog inputs and outputs shall, at a minimum, include function, setpoint and any appropriate remarks.

1.15.3.4 Control Valve Cv Table.

The table of all control valve Cv's shall, at a minimum, include each control valve's unique identifier, function, type, range and minimum required Cv. The control valve Cv shown here shall be the Cv used in the hydronic pressure loss calculations specified above.

1.15.3.5 Wiring Diagrams.

The wiring diagrams shall, at a minimum, show the source of power; control transformers (as necessary) including primary and secondary voltages; grounding; overcurrent protection; overload protection; safety devices; and all control contacts and switches. The diagrams shall be coordinated with the requirements of Section 16415A, Electrical Work Interior. All control voltages shall not be more than 120 volts to ground. All three-phase motors over 1 horsepower shall be wired with phase failure relay in the motor starter.

1.15.4 Control Panels.

The DDC HVAC panel shall be located in the mechanical room.

1.15.5 Package Equipment.

Package equipment, such as boilers and chillers, shall be provided with standard manufacture's DDC controls for each individual piece of equipment.

1.15.5.1 Boilers.

Each boiler shall accept a start/stop signal from the HVAC control system and shall provide a unit failure signal to the HVAC control system.

1.16 MILITARY FUEL PUMPS GENERAL INFORMATION

All work shall conform to MIL-HDBK-1022A, Petroleum Fuel Facilities, UFC 3-600-01, Fire Protection Engineering for Facilites, Industrial Ventilation by ACGIH, and other references listed in this section. Four fuels will be dispensed which are ethanol, bio grade diesel fuel B-20, normal diesel fuel, and MOGAS (unleaded regular gasoline). Existing above ground storage tanks will contain the two diesel fuels, and the existing underground tanks will contain the ethanol and MOGAS. Installation must comply with federal, state, and local government regulations that are in effect at a particular facility. This contract may be more stringent than the previously mentioned standards because all pipe must be double wall type with leak detection devices monitored at the POL Operations facility constructed under this contract. However, where this contract is less stringent than MIL-HDBK-1022A, UFC 3-600-01, ACGIH, or federal, state, and local government regulations, these standards and regulations shall take precedence over this contract. See civil sheet CG2.6 and mechanical demolitions sheets contain photographs of existing facilities.

This contract includes installation of two ground vehicle fuel dispensing units located as shown on the architectural plans, each dispensing unit containing two nozzles (four total nozzles), with fuel pumps located remotely at the existing storage tanks. Each of the four fuels being dispensed (ethanol, MOGAS, and two grades of diesel), from four existing

remote fuel storage tanks, will be dedicated to one nozzle. These remote tanks, which are shown on the civil drawings, are two aboveground Tanks 3 and 4, and two underground tanks 7 and 8.

Also, four 25gpm pumps, each dedicated to one of the four fuels, will be required near the aboveground tank, or submerged in the underground tank, and serving the remote ground vehicle fuel dispensing units. Two of these pumps will be submersible installed in the existing underground tanks, one in underground tank number 7, and one in underground tank number 8, located approximately as shown on the civil and mechanical sheets. Assume that no provisions have been made in these existing underground tanks for insertion of these two submersible pumps. The remaining two pumps will be mounted outside on the ground near the above ground tanks, one serving tank 3, and the other tank 4.

In addition, one 300 gpm bulk loading, and one 300gpm bulk unloading, aboveground pumps shall be added at the tank farm. At the tank farm (location of subject tanks 3, 4, 7, and 8), are bulk loading and unloading equipment for tank trucks. For the aboveground tanks 3 and 4, there are two existing pumps, one for loading, and the other for unloading tank trucks, with existing pipe and valves controlling connections to either tank 3 or tank 4. Two additional 300gpm pumps must be installed, one for loading, and one for unloading, tank trucks. Each tank will be re-piped with a dedicated loading and unloading pumps, and independent piping, for each of tank 3 and tank 4.

All piping serving the ground vehicle dispensing units from the four existing storage tanks, and the bulk loading and unloading header stations serving the four existing storage tanks, shall be new with leak detection monitoring, with existing underground pipe abandoned or removed, and existing aboveground pipe removed, as required by applicable codes or regulations. For bulk loading, unloading , and ground vehicle dispensing units, the piping system shall be changed so that each of the four fuels have independent dedicated piping without possibility of contamination of one fuel by the other. Thus four separate pipes are required, routed mostly underground, double wall monitored from the tanks to the new ground vehicle dispensing units, one dedicated fuel pipe run per nozzle. New aboveground pipe is required carrying fuel over the dikes serving aboveground tanks from bulk tank truck unloading station, through pump, and to tank 3. Re-use existing pump, related components, and unloading station. Also, for tank 4 new aboveground pipe is required similar to tank 3, but new pump, unloading station, and all related components area required, similar to existing. New tank truck loading pipes are required, double walled monitor type for underground pipes, and aboveground pipe shall be over existing dikes and monitored, is required from tanks 3 and tank 4, through pumps, to truck loading stations. For tank 3, existing pump and truck loading header station can be re-used, but will be dedicated to tank 3. For tank 4, a new pump with related components as stated, and the existing second truck loading header station can be used but must be re-pipe so that it is dedicated to tank 4 without contamination from tank 3 fuel. The existing submersible bulk truck load pumps for each of tanks 7 and 8 will not be part of this contract.

All four fuel storage tanks shall be cleaned after installation is complete. Modify these aboveground and underground tanks to meet standards listed in this specification section.

1.17 MILITARY FUEL PUMPS

1.17.1 PUMPS FOR EXISTING ABOVEGROUND TANKS 3 AND 4

Provide one 300 gpm centrifugal bulk tank truck unloading pump and related equipment configured for automatic air elimination to serve aboveground Tank 4, and exsting pump will serve only Tank 3. Locate pump in underground covered vault with proper depth to meet net positive suction head requirements. Install fuel system pump components required by MIL-HDBK-1022A, including that specified in paragraph 3.3.2.3, and shown on Facility Plate No. 003, including flexible pipe joints at pump connections, isolation valves, strainer, flow switch, gauge, and surge check valve, and similar to existing installation to serve tank 3. The new pump shall be equal to the existing pump which is Gorman Pump, Mansfield OH, RD3A31-BAR, 7 5/8 inch impeller, 1154579N, US Electric Motor 40 HP, 3ph, 60hz, except it must conform to MIL-HDBK-1022A and provide 300gpm.

Provide one 300gpm truck loading pump to serve aboveground Tank 4, and exsting pump to serve only Tank 3. Install fuel system pump components required by MIL-HDBK-1022A, including flexible joints, isolation valves, fuel meter, and surge check valve. The new pump shall be equal to the existing pump which is Byron Jackson Pumps, BW/IP Internation Inc., serial number 97ER1740, model TP-4, 300gpm, 112feet head, 3600rpm, 1000psi test pressure, 667mwp, 15hp, 460volts ac, except it must conform to MIL-HDBK-1022A.

Provide two 25 gpm pumps serving remote ground vehicle dispensing units, one dedicated to tank3, and the other dedicated to tank 4, each to be activated by dispenser nozzle removal, each with fuel system pump components required by MIL-HDBK-1022A, including flexible joints, isolation valves, fuel meter, and surge check valve. Pumps shall conform to API Std 610, Appendix A, except as modified herein. Mechanical seals within the pump shall be Buna-N or Viton. Pump casing, bearing housing, and impellor shall be stainless steel ASTM A 743/A 743M GR CF8M or GR CA6NM or aluminum ASTM A 356/A 356M GR T6. Pump shaft shall be stainless steel ASTM A 276 Type 410 or 416. Pump baseplate shall be of cast iron construction. Internal pump components in direct contact with the fuel to be handled shall be of compatible construction. Pump assembly shall be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow. Pump bearings shall be selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Pump shall be driven by an explosion-proof motor for Class I, Division l, Group D hazardous locations as defined in NFPA 70. Pump shall be accessible for servicing without disturbing connecting piping. Pump control panel shall include on and off indication lights for each pump. The panel shall contain an adjustable control logic for pump operation in accordance with the indicated operation. The panel shall also have a manual override switch for each pump to allow for the activation or deactivation of each pump. Panel, except as modified herein, shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR.Pump shall be the in-line, split-case, double suction, single stage, self-priming, centrifugal type. Pump motor shall be mounted horizontal to the pump housing and be provided with flanged end connections.

1.17.2 SUBMERSIBLE PUMPS FOR EXISTING UNDERGROUND TANKS 7 AND 8

Provide two submersible dispensing pump, one for each underground tank to serve the new ground vehicle dispensing units, to be activated by dipenser nozzle removal. The submersible pumps to be located in the existing product storage tanks. Pump and motor combination shall operate efficiently totally submerged in product of storage tank. When pump only is submerged, pump shall be driven by explosion-proof motor for Class I, Division l, Group D hazardous locations as defined in NFPA 70. Each pump shall have delivery capacity of 25 liter per second at a total discharge head to be determined by the designer. Install on discharge side of each pump, an approved leak detection device which will provide indication when piping between tank-mounted pump and dispensers are not liquid-tight. Pump inlet shall be horizontal. Provide clearance of not less than 127 mm nor more than 178 mm between bottom of tank and end of pump. Pump shall be a single- stage vertical pump and extend inside the tank to within 150 mm of the striker/impact plate. Pump and motor combination shall operate totally submerged in the product of the storage tank. Pump fuel inlets shall be horizontal. Pump, motor, and column pipe assemble shall mount through a NPT pipe penetration in a tank's manway cover. Pump mounting shall completely support both the weight and vibration of the pump. The unit shall be provided with a steel lifting lug capable of supporting the weight of the entire pump and motor assembly. Pump shall include a vertical solid shaft motor, base mounting flange, horizontal pump discharge, low net positive suction head (NPSH) first stage impellers, dynamic and thrust balancing of impellers, and a stainless steel one piece pump shaft. Pump shall be provided with flanged end piping connections.

1.18 CLEANING OF EXISTING FUEL STORAGE TANKS

The two existing above ground tanks number 3 and 4, 70,000 gallons each, and the two underground tanks, 10,000gallons each, shall be cleaned after all work is complete in accordance with MIL-STD-1022A and American Petroleum Institute API 2015. Existing Tank 7 contains de-icing solution.

1.19 MILITARY FUEL PUMPS PIPING

1.19.1 Piping General

Route four underground pipes from each pump serving the four fuel storage tanks to the new ground vehicle dispensing unit. Use double wall fiberglass re-inforced pipe with leak detection system monitored by the POL Operations Center. Piping routinely carrying fuel shall be fiberglass reinforced plastic (FRP) or stainless steel as defined herein.

1.19.2 Secondary Containment Piping

All piping installed shall be secondarily contained, unless otherwise indicated. Piping system shall be of double-wall construction with the internal pipe being the product pipe and the exterior pipe being an fiberglass reinforced plastic containment pipe as defined herein. Piping system shall be a factory manufactured piping system designed in accordance with ASME B31.3 and NFPA 30. The containment piping shall allow for complete inspection of the product piping before the containment piping is sealed. Containment piping shall be chemically compatible with the type of fuel to be handled. Containment piping shall be non-corrosive, dielectric, non-biodegradable, and resistant to attack from microbial growth. Containment piping shall be capable of withstanding a minimum 35 kPa air pressure. Containment piping shall be evenly separated from the primary pipe using pipe supports which are designed based on pipe size, pipe and fuel weight, and operating conditions. The supports shall be constructed

of the same material as the primary pipe and shall be designed so that no point loading occurs on the primary or exterior pipe. Supports shall be permanently attached to the product pipe either by tack welding or by an adhesive. The exterior piping and supports shall allow for normal draining as well as the installation of any necessary leak detection equipment or cables. Supports shall be designed and installed to allow for pipe movement of both the product piping and the exterior piping without causing damage to either. Containment piping shall be capable of withstanding H-20 highway loading as defined by AASHTO HB-16.

1.19.3 Fiberglass Reinforced Plastic (FRP) Pipe

1.19.3.1 Pipe

Pipe shall be compatible with the fuel to be handled and be in accordance with ASTM D 5677. Pipe shall be compatible with the fluid being transported. Use of FPR piping is limited to buried service only and at pressures not exceeding that marked on the pipe.

1.19.3.2 Fittings

Fittings and joining materials shall be in accordance with ASTM D 5677. Threaded fittings shall not be used for product piping in inaccessible locations. Fittings for secondary exterior pipe of double-wall piping system shall accommodate the primary inner pipe and any additional equipment required, such as leak detection cables. Fittings and joining materials shall be compatible with the fuel to be handled.

1.19.4 Stainless Steel Pipe

Stainless steel pipe 150 mm or smaller shall be in accordance with ASTM A 312/A 312M Schedule 40, Type TP304L, seamless only. Longitudinally welded 150 mm pipe also can be provided if made in accordance with the procedures in ASTM A 358/A 358M with wall thickness of 6.4 mm . Stainless steel pipe larger than 150 mm shall be in accordance with ASTM A 312/A 312M Schedule 10S, Grade 304L, seamless only or ASTM A 358/A 358M Grade 304L, Class 1 or 3, welded with wall thickness no less than 6 mm for pipe 300 mm and smaller, and 8 mm for pipe larger than 300 mm.

1.19.4.1 Connections

Connections for pipe smaller than 65 mm shall be forged, socket weld type, Type 304 or 304L, 2000 W.O.G. conforming to ASTM A 182/A 182M and ASME B16.11. Connections for pipe 65 mm and larger shall be butt weld type conforming to ASTM A 403/A 403M, Class WP, Type 304L, seamless or welded, and ASME B16.9 of the same wall thickness as the adjoining pipe. Piping in inaccessible locations, such as product piping inside of containment piping, shall be welded.

1.19.4.2 Welding Process and Electrodes

The welding process for stainless steel piping shall be a gas tungsten arc or gas metal arc process in accordance with ASME B31.3. Welding electrodes shall be E308L conforming to AWS A5.4.

1.19.5 Valves

Portions of a valve coming in contact with fuel shall be compatible with the fuel to be handled. Valves shall have bodies, bonnets, and covers

constructed of stainless steel conforming to ASTM A 743/A 743M, Type 304 or 316; or aluminum alloy conforming to ASTM B 26/B 26M, Type 3003, 6061-T6, or 356-T6. Each valve shall have stainless steel stem and trim. Valves shall be suitable for a working pressure of 1900 kPa (275 psig) at 38 degrees C with a weatherproof housing and be provided with flanged end connections unless indicated otherwise. Seats, body seals, and stem seals shall be Viton or Buna-N.

1.19.6 Piping

Piping shall be inspected, tested, and approved before burying, covering, or concealing. Piping shall be installed straight and true to bear evenly on supports. Piping shall be free of traps, shall not be embedded in concrete pavement, and shall drain toward the corresponding storage tank. Any pipe, fittings, or appurtenances found defective after installation shall be replaced. Piping connections to equipment shall be as indicated or as required by the equipment manufacturer. Pipe and accessories shall be handled carefully to assure a sound, undamaged condition. The interior of the pipe shall be thoroughly cleaned of foreign matter and shall be kept clean during installation. The pipe shall not be laid in water or stored outside unprotected when weather conditions are unsuitable. When work is not in progress, open ends of pipe and fittings shall be securely closed so that water, earth, or other substances cannot enter the pipe or fittings. Cutting pipe, when necessary, shall be done without damage to the pipe. Pipe shall be reamed to true internal diameter after cutting to remove burrs. Changes in pipe sizes shall be made through tapered reducing pipe fittings. Stainless steel pipe shall in no case be welded directly to carbon steel pipe. Cutting of FRP pipe shall be performed with a hacksaw or circular saw. Fuel supply piping from a storage tank shall extend to within 150 mm of the tank's bottom.

1.19.6.1 Aboveground Piping

Pipe sections shall be installed as indicated and be complete prior to performing any piping tests. FRP shall not be used aboveground.

1.19.6.2 Belowground Piping

Nonmetallic pipe shall be installed in accordance with pipe manufacturer's instructions. Belowground piping shall be laid with a minimum pitch of 25 mm per 6 m. Horizontal sections of pipe shall be installed with a minimum of 450 mm of backfill between the top of the pipe and the ground surface. The full length of each section of belowground pipe shall rest solidly on the pipe bed. Joints in secondary piping shall not be made until inner pipe is successfully pressure tested.

1.19.6.3 Pipe Hangers and Supports

Seismic requirements shall be in accordance with Sections 13080, SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT. Additional hangers and supports shall be installed for concentrated loads in piping between hangers and supports, such as for valves. Miscellaneous steel shapes as required shall be installed in accordance with ASTM A 36/A 36M. Pipe supports shall be installed in accordance with MSS SP-58and MSS SP-69. Pipe spacing shall be as follows:

Nominal Pipe Size (mm)	25 and Under	40	50	80	100	150	200	250	300
Maximum Hanger Spacing (m)	2.1	2.7	3	3.7	4.3	5.2	5.8	6.7	7.0

1.19.6.4 Pipe Sleeve

Piping passing through concrete or masonry construction shall be fitted with sleeves. Sleeve shall be of sufficient length to pass through the entire thickness of the associated structural member and be large enough to provide a minimum clear distance of 13 mm between the pipe and sleeve. Sleeves through concrete shall be 0.91 mm steel, fiberglass, or other material as approved by the Contracting Officer. Sleeves shall be accurately located on center with the piping and securely fastened in place. The space between a sleeve and a pipe shall be caulked and sealed as specified in Section 07900A JOINT SEALING. In fire walls and fire floors, both ends of a pipe sleeve shall be caulked with UL listed fill, void, or cavity material.

1.19.6.5 Pipe Anchor

Where steel piping is to be anchored, the pipe shall be welded to the structural steel member of the anchor and the abraded area shall be patched with protective coating or covering as specified.

1.20 MILITARY FUEL PUMPS PIPING LEAK DETECTION MONITORING SYSTEM

Where conflicts exist between this section and the electrical section, the electrical section shall govern. Provide continuous surveillance leak detection system suitable for operation in an NFPA 70, Class l, Division l, Group D environment and located in the leak containment space between interior and exterior walls of double-wall piping. System shall detect leakage into containment space by monitoring interstitial pressure, vacuum variations, or sense hydrocarbon vapors electronically. Sensor output and transmission shall be electronic. Sensors shall be compatible with and detect leakage of materials stored in pipe at a rate of 0.105 milliliter per second with 95 percent probability of detecting this size leak and five percent probability of declaring pipe leaking at this rate when, in fact, it may be leaking less as well as ground water which may leak through secondary containment. Panel shall be in a NEMA enclosure suitable for the environment and have an audible and visual alarm for each zone and include acknowledgement switch and rechargeable battery backup capable of operating the system continuously for a minimum of 48 hours. Panel shall incorporate self-test system which permits operator verification of proper operation of leak detection equipment. Mount panel in POL facility as indicated. Enclose underground cable in PVC coated conduit. Provide instructions and equipment required for calibration of leak detection system and manufacturer's recommend calibration maintenance schedule.

1.21 FUEL DISPENSING UNITS FOR GROUND VEHICLES

For ground vehicles, two dispensing units are required each with two hose

outlets, and shall be located on island shown on civil and architectural drawings. When fuel pump nozzle removed, card key entered at pedestal, and subsequent approval is obtained, then respective remote tank fuel pump will start. Each nozzle will be dispense only one type of fuel and will be piped separately from the remote fuel storage tank and pump. These four nozzles will be located on two dispensing unit enclosures on an island as shown, allowing four vehicles to fuel simultanously.

Each dispensing unit shall be computer controlled, lighted, double sided, remote type, with two hose outlets each suitable for single product delivery flow rate of 0.76 liter per second from each nozzle. Steel frame shall be capable of resisting normal vertical and lateral loads and secured to dispensing island with at least two 15 mm anchor bolts. Exterior panels shall be either stainless steel or steel with baked enamel finish, or combination of the two. Provide manufacturer's standard microprocessor which has the following functions:

a. Totalizer: Eight-digit (999,999.99) electronic totalization with identification for each product volume in liters.

b. Filters: Replaceable filter element on each product line with a nominal filtration efficiency of 0.025 mm with a flow rating equal to the rate of the dispensing unit.

c. Backup: Battery backup with automatic charging circuits to hold data for a minimum of three months without recharging.

d. Accessories: Equip each assembly with accessories such as built-in air eliminators, line check valves, and emergency shut-off valve. Install centering ring or stabilizer bar to ensure proper shearing action for emergency shut-off valve if the dispensing unit is knocked from it's supports.

e. Interlocks: Units shall include nozzle supports interlocked to pump motor control switch to start and stop the pump by nozzle removal and replacement. Provide each unit with interlock switch and valve arrangement that prevents flow of product until meter is reset after dispensing nozzle is returned to holder.

f. Hose: Provide dispensing hose conforming to UL 330, gasoline and oil resistant, statically grounded, flexible in sub-zero temperatures. Provide a minimum of 3.70 meters of hose for each product line on the dispenser. Provide each hose with spring loaded cable to return device attached near mid-length of hose.

g. Nozzles: Dispensing nozzles shall be automatic shutoff type, without latch-open device, aluminum body, and full hand insulator to prevent splash-back.

h. Breakaway device: Provide each product hose with UL listed emergency breakaway device designed to retain liquid on both sides of breakaway point. Breakaway device shall have pressure balancing chamber to override line pressure to prevent nuisance breaks caused by a restriction in delivery hose diameter.

1.22 MILITARY FUEL PUMPS BULK FUELING LOADING AND UNLOADING HEADER STATIONS

1.22.1 Loading and Unloading Header Stations, General

To serve aboveground existing tank 4, install new tank truck bulk loading and unloading (off loading) equipment in accordance with MIL-STD-1022A, including requirements in paragraphs 3.4.2 and 3.3.2.3 and Facility Plate 003, and similar to existing loading and unloading stations shown on the drawings. Re-pipe and dedicate existing tank truck loading and off-loading stations to tank 3. There will be a total of two each off loading fueling hoses for each aboveground tank (four total hoses). The new station shall contain a check valve and strainer for each hose. Replace deicing truck loading header station by providing new hose for existing underground tank 7 and associated piping for arrangement similar to tank 8, and in accordance with MIL-HDBK-1022A.

1.22.2 Fueling Hose

Hose shall be in accordance with API Std 1529, Grade 3, Type A or C, semi-hardwall. Hose shall be compatible with the specified fuel and withstand a working pressure of 2070 kPa (300 psig) . Hose shall be constructed of braided synthetic cord surrounded by an interior rubber tube and an exterior rubber cover. Each fueling hose shall be provided with a stainless steel hose tray. The hose tray shall provide support for the entire length of the fueling hose, allow for draining of rainwater, support the fueling hose at the height indicated, protect the hose from the sun's ultraviolet rays, and allow for easy insertion and removal of the fueling hose.

1.23 Miscellaneous Requirements.

1.23.1 Hydraulic Lift for Refueler Maintenance Facility (RMF)

A 75,000 lbs hydraulic lift is required in one Work Bay of the Refuler Maintenance Facility with hydraulic pump and reservoir located outside. See architectural floor plan for details.

1.23.2 Wash Bay Equipment for Inspection Bay of Refueler Maintenance Facility (RMF)

Provide wash bay equipment as required. See architectural plan for location.

1.23.3 Air Compressor and drops for Refuler Maintenance Facility (RMF)

Provide are compressor designed for outside installation, 125psig with 80 gallon receiver, and compressor capacity equivalent to Ingersoll Rand model 2545 located in the existing facility. See architectural plan for location. Provide compressed air drops in Tool Room, Inspection bay, and two per stall in Work Bay (between each door).

1.23.4 Vacuum Pump and Hood for POL Operations Center Laboratory

Provide hood equivalent to Iroquois Hoods except meeting 29 CFR 1910.1450

and MIL-HDB-1022A, 2100 Burton Street, 40inches x 32inches high x26inches deep, 816-726-5971. Provide vacuum pump capable of 25inches of mercury in the laboratory for the POL facility hood, ¼ hp motor, equivalent to Vacuum System Inc. model IPC-2, serial number 5112.

1.23.5 Ventilation of the POL Operations Center Laboratory and Lab Office

The Laboratory, and Lab Office, shall exhausted to maintain a negative room pressure between each of these rooms and adjacent areas (Laboratory and Lab Office may be neutral to each other). Room air from the Laboratory and Lab Office shall not be re-circulated to other building areas. Ventilation shall conform to the ACGIH manual, MIL-HDBK-1022A, and other relevant standards.

PART 2 NOT USED.

PART 3 NOT USED

-- End of Section --

SECTION 01017

ELECTRICAL REQUIREMENTS
[03/01]

PART 1 GENERAL Electrical requirements described in this section are for Refueler maintance, service station, and POL buildings. Attachment sketch #1 to this section describes Service station electrical requirements.

1.1 REFERENCES

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEES C2 (1997) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code (NEC)

NFPA 72 National Fire Alarm Code

NFPA 75 (1999) Standard for the Protection of Electronic Computer/Data Processing Equipment

NFPA 101 (2000) Safety to Life from Fire in Buildings and Structures

NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

NACE RP0169 (1992) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

ILLUMINATING ENGINEERING SOCIETY (IES)

(2000) Illuminating Engineering Society Handbook

DEPARTMENT OF DEFENSE (DOD)

MIL HDBK 1008C (1997) Fire Protection for Design and Construction

INSTALLATION INFORMATION INFRASTRUCTURE ARCHITECTURE (I3A)

I3A Installation Information Infrastructure Implementation Guide, Ver. 2

AMERICANS WITH DISABILITIES ACT (ADA)

ADA Americans with Disabilities Act--Accessibility Guidelines

UNITED STATES ARMY CORPS OF ENGINEERS (USACE)

Lighting Standards

(1997) Corps of Engineers Standard Lighting Fixture Details Drawing Series No. 40-06-04, http://cadlib.wes.army.mil, CADD Details Library, Electrical Details, USACE Standard Details 40-06-04

Electrical Distribution Standards

Corps of Engineers Standard Electrical Distribution Details. http://cadlib.wes.army.mil, CADD Details Library, Electrical Details, Electrical Service and Distribution

UNITED STATES ARMY TECHNICAL MANUAL (TM)

TM 5-811-1 Electrical Power Supply and Distribution

TM 5-683 Facilities Engineering Electrical Interior Facilities

UFC-3-520-01 Electrical Design, Interior Electrical System
TI-800-01 Technical Instructions- Design Criteria

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARDS

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA),

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) CODES

UNDERWRITERS LABORATORIES SPECIFICATIONS

1.1 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted.

1.2 Seismic Protection

Seismic Protection for electrical equipment shall be designed and installed in accordance with the requirements of Seismic Protection for Electrical Equipment Specification SECTION 16070.

1.3 COORDINATION OF ELECTRICAL CRITERIA

All electrical criteria provided in this section shall be coordinated with the architectural section, mechanical section, fire protection section, structural section, interior design section, civil and site section, and

other sections as required. The number and location of all electrical equipment indicated in the electrical requirements & space data sheets are approximate. Contractors design shall meet the intent of the electrical requirements provided in this section. Contractor shall coordinate the final locations of all electrical equipment with the user.

1.4 EXTERIOR PRIMARY ELECTRICAL DISTRIBUTION SYSTEM

General: It shall be the Contractor's responsibility to protect all existing utility lines from damage during excavation. Any damage resulting to existing utility lines and systems shall be repaired by the Contractor, to the satisfaction of the Contracting Officer, at no additional cost to the Government,except as noted below. The Contractor shall be required to locate and mark underground utilities for McConnel AFB owned gas, water, sanitary sewer, storm sewer, and electrical, but excluding fiber/telephone and communications. The Contractor will have use of McConnel AFB utility drawings to aid in their location. The Contractor shall be responsible for the location of the electric lines and all other utilities listed above that are of metal or have tracer wires available for locating. The utilities that are of nonconductive construction such as plastic or Transite and have no tracer wire or other means of applying a signal are to be located from the utility maps to the best of the Contractor's ability. The utilities that are located from maps that appear to be in the vicinity of the excavation are to be hand-dug for location purposes. If a line is damaged that is within 10 feet of that shown on the utility maps, the Contractor will be held responsible for its repair.

1.4.1 Refueler Maintenance.

Run medium voltage (MV) underground conductors from existing pedestal through the manhole (MH) (on which the pedestal sits) to refueler Maintenance pad mounted transformer (existing pedestal is located east of the Topeka, Independence Roads intersection).

1.4.2 Service station.

Run MV underground conductors from refueler Maintenance pad mounted transformer (loop feed) to service station pad mounted transformer routing through the pedestal MH (same pedestal that is located east of Topeka, Independence Roads intersection).

1.4.3 POL

Run MV underground conductors from existing pedestal to the new pad mounted transformer feeding POL (existing pedestal is located east of the Atchison, Independence Roads intersection).

1.4.4 System design.

The distribution level voltage is 12.47 kV. Pedsestal switch shall be manufactured by: Durham Co. Labannon, Missouri or approved equal. Coordinate utility interruptions in advance with Contracting Officer. System shall be a radial/loop- MV (primary) system as described above. Primary feeder cables shall be copper and encased in 75 mm of concrete. MV conductors shall have protective shielding. Cable shall be buried below frost line but a minimum of 3 ft below the finished grade to the top of the concrete encasement with continuous cable marker tape and tracer wire 6 inches below grade. Cable markers shall be installed along the length of direct burial cable runs to identify their routes from the surface. Markers will be provided at changes of direction and at intervals not to exceed 500 ft. Electrical on-site distribution system shall be designed in compliance with the rules and recommendations of ANSI C2, National Electrical Safety Code, TM 5-811-1 Electrical Power Supply & Distribution and NFPA 70,

National Electrical Code and UFCGS section 17375 Electrical Distribution system Underground whichever is more stringent. The distribution system and transformers shall be located in near vicinity of the building served. Provide tracer wire and warning tape over all electrical underground utilities. One spare conduit shall be included in the primary ductbank identical in size to the other conduits. Provide pull string in empty conduits. Underground street crossing shall be bored.

1.4.5 Conductors. Provide three 15-kV primary conductors and one 600V insulated neutral. All primary conductor insulation shall be 133 percent and cross-linked polyethylene (NEMA WC7) or ethylene propylene rubber (NEMA WC8). Loading at connections shall be balanced between all three phases. Distribution of primary feeders shall be radial fed as described above. Distribution system includes duct banks, conductors, pad-mounted switches (pedestals) transformers and pads. Coordinate the installation of the electrical system with the telephone and cable TV system companies.

1.4.6 Underground splices. Underground connection or splices are prohibited, except in manholes (MH). Splices shall be in a self-draining, rodent resistant box with a cover.

1.4.7 Transformers. Transformers shall be Contractor furnished and installed. Transformers shall be pad-mounted and have two non-fused switches for the loop connection. The high voltage compartment of the transformer shall include a load break switch with fused circuit for the transformer. The primary voltage shall be 12.47KV, three-phase. The transformed secondary voltages shall be 120/208V, three-phase, four-wire. In selecting a transformer, the name plate rating shall not be less than 90 percent of the kilovolt/amperes (kVA) demand load calculated for the transformer. The demand load shall be calculated per NFPA 70, National Electrical Code. Transformers shall be low profile, pad mounted type, mineral oil insulated, with tamperproof enclosure. Transformers shall be certified non-PCB and shall contain less than 50 parts per million PCB. Transformer shall meet the requirements of this section and specification section 16375

1.5 EXTERIOR UNDERGROUND SECONDARY ELECTRICAL DISTRIBUTION REQUIREMENTS

Service laterals shall be underground. The length of secondary distribution service laterals from the transformer secondary to the building service entrances shall be minimized. Secondary service laterals shall be copper conductors in ducts direct-buried. Exterior secondary electrical distribution system to the Refueler Maintenance, Service station & POL shall be 120/208 volt, 3-phase, 4-wire feeder to a Main Distribution Panel (MDP) located in the electrical room. Each facility shall have a MDP. Service entrance equipment (MDP) shall be UL labeled for the application and sized for the available fault current. Main facility feeder and main distribution panel shall be sized to have a minimum of 25% spare capacity above the estimated maximum demand for the building. Design of the exterior secondary electrical system shall be in accordance with Electrical Distribution System, Underground - SECTION 16375 and the requirements of this section. The transformer shall be located a min. of 10 meters from the building served. Sizing of secondary feeders and conduit from the transformer to the facility main distribution panel will be the Contractors responsibility. Service entrance conductors, branch and feeder circuits shall be single conductor Type USE in accordance with NFPA 70. All conductors shall be copper with insulated grounding conductor in conduit. Aluminum conductors and direct buried cables shall NOT be used. One spare conduit shall be included in the secondary ductbank identical in size to

the other conduits.1.5.1 Electrical Outlets for Truck Heaterss

Provide 10 outlets in weather proof housing pedestal mounted with adequate protection from being knocked by a truck in the Refueler Maintenance parking stalls. Each outlet shall consist of two simplex twist lock receptacle (120V, 20A, 2P, 3W). Each simplex receptacle shall be home run dedicated circuit to the refueler maintenance panelboard in underground conduit. Each pedestal to be located such to serve two stalls.

1.5.2 Entry Gate Power Requirement

Provide 120V, 20A ckt (2- #10, 1-#12 GND in 3/4" C.) from POL panelboard out to the location of entry gate. Provide a NEMA 3R junction box mounted on a pedestal in the vicinity of the gate and provide 18" of pigtail

1.5.3 Conduits

Conduits shall be single, round-bore type, with wall thickness and fittings suitable for the application.

1.6 EXTERIOR LIGHTING SYSTEM

Area lighting shall be provided for all parking lots, walkways, above all exit doors, and area signage. Lighting fixtures shall utilize high pressure sodium lamps. Pole/fixture heights shall be no greater than 9.15 meters above finished grade. Fixture/pole finish shall be round tapered brushed aluminum. The light poles should be designed to allow for 160 kilometers per hour wind speed. Design shall be in accordance with IES Handbook,Corps of Engineers Lighting Std. Det. Dwg. No. 40-06-04, Exterior Lighting Specification SECTION 16528, Electrical Distribution System, Underground Specification SECTION 16375 and the requirements in this section.

1.6.1 Area Lighting

Area lighting shall be provided for all areas noted above. Lux levels for the parking lot of Refueler Maintenance & POL lighting shall be 6 lux minimum as measured on the pavement.

1.6.1.1 Walkway Lighting

Walkway lighting fixtures shall be bollards in front of the buildings. Walkway lighting bollards shall be placed along main walkway in front of the facilities and sidewalks leading from each parking lot to the building. Illumination level for new bollards shall be 6 lux along sidewalk. Walkway lighting shall be controlled as described below in lighting control.

1.6.1.2 Parking Lot Lighting

Parking lot lighting fixtures shall be cobra head type fixtures (Corp of Engineers Fixture Type EH2) with single arm or double arms as required mounted on a 9.15 meter tapered brushed aluminum pole. Lamps shall be high pressure sodium and sized to meet lighting criteria (Corp of Engineers Fixture Type EH2). Poles shall not be located within the parking lot areas. All lighting will be from the perimeter of the parking lot. Control for the parking lot lights will be as described below in lighting control.

1.6.1.3 Exterior Building Lighting

Exterior building lighting fixtures shall be Corps of Engineers Fixture Type EH5. Lamps shall be high pressure sodium and sized to provide 10 lux 3 meters from the building. Fixture(s) shall be mounted at each entrance to the building. Exterior building lighting fixtures shall be controlled as described below in lighting control.

1.6.1.4 Service Station Lightingg

Provide two light fixture (100w MH each) pole mounted (20'AL round tappered) located in the dipensing fuel island. Locate light switch by the service entrance equipment.

1.6.1.4.# Service Station Canopy Lighting (Option)

Provide 4- light fixtures, Corps of Engineers Std Drwg 40-06-04 type PH7. Secure fixtures to structure equally spaced w/ swivel mounts @16' AFF to the bottom of fixture. Run underground branch circuit 20A, 277V from the panelboard (located in the MCC). Locate on/off switch 42" AFF on one of the coloumn.

1.6.2 Lighting Control

Provide disconnect switch with HAND-OFF-AUTOMATIC switch and lighting contactors for exterior lighting controls. Install lighting controls in the electrical room of each building. Lighting shall be controlled by a combination of a photocell and astronomical timer when switched to the auto mode. Install lighting controls per requirements of this section. Exact location of all lighting controls shall be verified with the USER during design of the project for each building.

1.6.3 Underground Lighting Circuits

Provide underground branch circuits for all exterior lighting circuits. Branch circuits shall be insulated copper conductors with insulated grounding conductor in conduit. Aluminum conductors are NOT acceptable. Direct buried conductors are NOT acceptable. All underground lighting conductors shall be in minimum 27mm Schedule 40 PVC conduit. Top of conduit shall be 900mm below finished grade.

1.6.3.1 Lighting Pole Grounding

All exterior lighting poles or bollards shall be grounded at the base of the pole. Provide a 19 mm by 3050.0 mm copper clad grounding rod at each pole.

1.6.3.2 Conductors

Cables shall be type USE conforming to UL 854, with copper conductors and type RHW or XHHW insulation conforming to UL 44, and shall include green ground conductor. Cable shall be provided with insulation of a thickness not less than that given in TABLE 15.1 of UL 854. Cable shall be rated for 600 volts. Parts of the cable system such as splices and terminations shall be rated not less than 600 volts. Conductors larger than No. 8 AWG shall be stranded.

1.6.3.3 Conduits

Conduits shall be single, round-bore type, with wall thickness and fittings suitable for the application. Conduits shall be direct-burial,schedule 40 for lighting circuits.

1.6.4 Building Lighting Circuits

All exterior fixtures mounted on the surface of the building shall be wired from within the building and shall conform to the Interior Wiring Methods paragraph of this section. No building lighting circuits shall be surface mounted.

1.6.5 Hazaradous locations

Areas that are classified hazaradous are indicated. Electrical wiring and devices, fixtures installed in such locations shall as a minimum meet the NFPA requirements.

1.7 EXTERIOR COMMUNICATION DISTRIBUTION SYSTEM

1.7.1 Communications Overview

This design shall be in accordance with the Telephone System, Outside Plant Specification SECTION 16711,Fiber Optic Outside Plant Specification SECTION 16713 and the requirements of this section. McConnel AFB personnel will locate underground Post telephone and communications lines. The contractor shall deliver a diagram showing the approximate area that the posts telephone and communication lines need to be located. The Contractor shall mark the proposed route or limits of the excavation in white prior to the request where to mark for utilities. The Contractor should allow a minimum of ten (10) working days for the utility locates to be conducted. If the Contractor damages any marked lines during excavation, the Contractor shall contact the Government QA Representative immediately to determine whether the Contractor will perform repairs or reimburse the Government for repairs. Both telephone and single mode fiber optic cable will be required for the Refueler, service station & POL facilities.

1.7.2 Refueler Maintenance

Install 2-4" underground duct bank direct buried from MH 19 to the facility comm. Room and stub adjacent to the telephone terminal board (TTB). Install 4 -1" inner ducts in 1- 4" duct. Run 1 - 12 strand Single mode (SM) fiber optic cable (FOC) in 1- 1" inner duct from MH 19 to comm. Room. Terminate FOC on patch panel provided in the comm. Room. Provide 50 ft of FOC in MH 19 for base comm. Personnel to splice the FOC. Run 1- 25 pair 24 AWG copper cable in 1-1" inner duct from MH 19 to comm. Room. Terminate on 110 block provided on TTB. Provide 15 ft of copper cable in MH 20 for base comm. personnel to splice.

1.7.3 Service station

Service station comm requirements shall be extended from POL. Sketch #1 attached to this section identifies two empty 1 1/2" conduits from the service station island to the control room of POL. Cabling to service station through these empty conduits shall be by others.

1.7.4 POLL

Install 2-4" underground duct bank direct buried from MH 19 to the facility comm. Room and stub adjacent to the telephone terminal board (TTB). Install 4 -1" inner ducts in 1- 4" duct. Run 1 - 12 strand Single mode (SM) fiber optic cable (FOC) in 1- 1" inner duct from MH 19 to comm. Room. Terminate FOC on patch panel provided in the comm. Room. Provide 50 ft of FOC in MH 19 for base comm. Personnel to splice the FOC. Run 1- 75 pair 24 AWG copper cable in 1-4" duct from MH 19 to comm. Room. Terminate on 110 blocks provided on TTB. Provide 15 ft of copper cable in MH 19 for base comm. personnel to splice.

1.8 CATHODIC PROTECTION SYSTEM

A sacrificial anode cathodic protection system shall be provided for all underground metallic lines, fittings, valves and fire hydrants. In addition to the anodes, all metallic pipes must be provided with a coating system. The systems shall be designed and installed in accordance with NACE RP 169 Standards. Criteria for determining the adequacy of protection shall be in accordance with NACE RP-01-69 and shall be selected by the corrosion engineer as applicable. Design shall be in accordance with Cathodic Protection System, (Sacrificial Anode) - Specification SECTION 13110 and the requirements of this section. Each anode shall be connected to the structure through a flush-to-grade test station with a concrete maintenance collar. At least one test station shall be provided on each valve, fire hydrant and metallic pipe.

1.9 UNDERGROUND CABLE MARKINGS

All underground cables and ductbank should be marked with utility marking tape with appropriate utililty type label name.

1.10 INTERIOR ELECTRICAL DISTRIBUTION SYSTEM

The interior secondary distribution voltage within the building shall be 208/120 volt, 3-phase, 4-wire. Conductors shall be copper. Aluminum conductors shall not be used. The voltage (208 volts 3 phase) shall be used for larger motor loads, equipment loads and all other required loads. The lower voltage (120 volts 1 phase) shall be used for all lighting loads, receptacle, small motors, computer, and all other loads as required. Design shall be in accordance with Electrical Work, Interior - Specification SECTION 16415 and the requirements of this section.

1.10.1 Service Equipment Main Distribution Panel (MDP)

Service equipment/disconnecting means shall be provided in the Main Distribution Panel (MDP) located in the electrical room of each building except sevice station service equipment shall be located exterior adjecent to the pad mounted transformer. The MDP shall be a free standing switchboard if service is determined to be 800 amps or greater or a wall mounted panelboard if less than 800 amps. Service disconnect means shall be of the bolt-on circuit breaker type. MDP shall include transient voltage surge protection incorporated into the panel. Metering shall include kwh meter, voltage meter, current meter, and shall be equipped with pulse initiatiors for connection to the base EMCS. The main breaker shall be solid state and the branch breakers shall be molded case. All breakers 225 amps and larger shall be adjustable trip.

1.10.2 Protective Coordination Study

A protective coordination study to include overcurrent and short circuit analysis shall be done on the electrical distribution system for the building if the building service transformer is 750 kva or larger. The study shall include the interior electrical distribution system back to the secondary side of the pad mounted transformer.

1.10.3 Panelboards

Lighting and appliance branch-circuit panelboards shall be of the bolt-on molded case circuit breaker type conforming to NEMA AB-1 and UL 489 and shall be located in the electrical room. Enclosures shall be general purpose wall mounted type. Busses for all panelboards shall be copper. Aluminium shall not be used. The maximum number of poles in an individual panelboard shall be 42 poles.

a. All panelboards shall have after construction, a minimum of 25 percent spare capacity for all loads. Panelboards shall have a minimum of 25 percent spare circuit breakers. Spare circuit breakers shall be redundant of the type of circuit breaker being provided in the panelboard.

1.10.4 Emergency Power requirements.

POL.
Provide an emergency diesel generator sized for the entire building load with auto transfer switch (ATS). Locate generator in mechanical yard. Above ground fuel tank to hold a min of 400 gallons shall be located in close proximity to the generator. ATS shall be housed in the electrical closet.

Service station.
Provide a weather proof emergency receptacle with a manual transfer switch for mobile generator hook up. Install receptacle & transfer on a free standing structure in close proximity of the serving MCC.

1.10.5 Motors

Motors shall be of sufficient size for the duty to be performed and shall not exceed the full-loading rating when the driven equipment is operating at specified capacity under the most severe conditions encountered.

a. All motors shall have open frames and continuous-duty classification and be based on a 40-degree C ambient temperature reference.

b. All permanently wired polyphase motors of 747 watts or more shall meet the minimum full-load efficiencies as indicated in Section 16415: ELECTRICAL WORK, INTERIOR.

c. Motors with power supplied from a variable frequency drive shall be a definite purpose inverter fed mothor in accordance with Part 31 NEMA MG-1.

1.10.6 General Purpose Receptacles

Duplex receptacles for general purpose applications shall be NEMA 5-20R, 20 amp, 125 volt, 2-pole, 3-wire grounding type. A maximum of five duplex

receptacles may be connected to a receptacle circuit. Receptacle circuits shall not supply lighting loads and shall have dedicated neutrals. All receptacle circuits shall be 20 amps. General purpose duplex receptacles shall be located in the facility per the space data sheets and limited as described below:

a. Provide general duplex receptacles every 3.5 meters along the walls in all areas of the building. For small rooms that do not have 3.5 meter walls, a minimum of one (1) outlet shall be installed on each wall. All office receptacle circuits shall be calculated for one computer. The computer load used for circuits shall be 600 VA. General receptacle loads shall be calculated in accordance with the National Electrical Code. Receptacles shall be mounted 380mm above finished floor.

b. Provide a general purpose duplex receptacle adjacent to sink in each bathroom. Receptacles shall have (GFI) ground fault interrupters.

1.10.7 Special Receptacles

Ground Fault Interrupter (GFI) receptacles shall be provided at all sink countertops, janitor's closet, wet locations or any other location required by the National Electrical Code. Weatherproof receptacles for exterior use, shall be mounted in a box with a gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening with (GFI). Exact location of the receptacles noted below shall be coordinated with the user during the design of this project. Provide NEMA 5-20R 20 amp,125 volt, 2-pole, 3-wire grounding type, duplex receptacles. Each receptacle shall be on a dedicated circuit and as described in the space data sheets but not limited to the folowing locations and as indicated elsewhere in this proposal.

a. Provide duplex receptacles for microwave, coffee maker and full size refrigerator in the staff room. All appliances shall provided and installed by the government.

b. Provide a duplex receptacle for each electric water cooler.

c. Provide duplex receptacles for the government furnished and government installed copier and fax machine.

d. Provide a duplex receptacle with ground fault interrupter on the exterior of the building adjacent to each exit door of the building. Mount receptacles 610mm above finished grade.

e. Provide two (2) 20 A, quad outlets, each on a dedicated circuit in the DOIM COMM. Room. One should be mounted on the plywood backboard and the other mounted on LAN Rack.

f. Provide duplex outlets for laboratory counter-top equally spaced 600mm on center for the entire length of the counters in the laboratory.

g. Provide one (1) dedicated NEMA 5--20R, 20 amp, 125 volt duplex receptacle for EMCS and DCC panels.

h. Provide one clock outlet as indicated in space data sheets. Clock outlets shall be single, 15 amp, 125 volt, 2-pole, 3-wire grounding type receptacles. Outlets shall be mounted 2135mm AFF. All locations should be coordinated with the user.

i. Provide duplex receptacles for computers as indicated in the space data sheets. A maximum of three duplex computer outlets shall be connected to a circuit. Circuits shall be sized using 600 volt-amp per computer. Seperate neutral conductors shall be provided with each circuit. Outlets shall be mounted adjacent to the Telephone/Data outlets. Maintain a separation of 160mm from the Telephone/Data outlets. Exact location of all Computer Outlets shall be verified and coordinated with the user during the design of the project.

j. Provide 5-20R-20A, 125V receptacle in ceiling of classroom

k. Provide 5-20R-20A, 125V receptacle for projection screen & switch with center off controls.

1.10.8 Other Loads

Contractor shall provide electrical power to the following loads either by receptacle or direct wired as applicable:

a. Closed Circuit Television (CCTV): Provide 4 -20 amp duplex receptacles, each on a dedicated circuit. Two shall be for CCTV backboard and one for a CCTV equipment cabinet. This equipment will be located in the comm room.

b. Intercom: Contractor shall provide power as required for Contractor provided installed intercom system.

d. Kitchen Equipment: Contractor shall provide power receptacles and connections as required for kitchen equipment in break room. A list of equipment is described in the space data sheet. Any equipment with a load requirement greater than 750 VA shall be on a dedicated circuit.

1.10.9 Architectural/Mechanical Connections

Contractor shall provide branch circuits, disconnect switches, magnetic starters, and all other related electrical equipment and material for all architectural, mechanical equipment and environmental equipment to be installed in the project (includes the facility and site). This shall include all HVAC units, unit heaters, pumps, exhaust fans, irrigation control panel and all other mechanical equipment in the facility. Disconnect switches shall be provided for all equipment that is not within site of the panel disconnecting means. All three phase motors shall have phase failure protectors. Designated sinks and toliets shall be controlled by passive infrared sensors hard wired to the building electrical distribution system. No batteries shall be allowed for this purpose. Contractor shall coordinate these electrical requirements with the architectural and mechanical requirements.

1.11 INTERIOR LIGHTING SYSTEM

The interior design shall be in accordance with the requirements in this section, the IES Handbook, the "Electrical Work, Interior" Specification - SECTION 16415, space data sheets and the requirements in this section. Light fixture selection and color shall be coordinated with the Architect and Interior Designer. All fixtures provided for this facility shall meet the requirements listed in the light fixture details. The details can be downloaded from the web site listed under Lighting Standards in the References section.

1.11.1 Task Lightingg

Fluorescent task lighting shall be provided as indicated on space data sheets. Fixtures shall meet the requirements for Corp Fixture Type FF1.

1.11.2 Conservation Requirements

Illumination levels, in conjunction with energy conservation, shall be obtained by the most life cycle cost-effective techniques including, but not limited to, the following:

a. Provide occupancy sensors as considered appropiate for the application and as coordinated with user during design of project. Occupancy sensor shall meet the requirements listed in the light fixture details. The details can be downloaded from the web site listed as Lighting Standards under the References heading.

b. Provide energy efficient lamps and solid-state electronic ballasts.

1.11.3 Fluorescent Fixtures

Fluorescent light fixtures with T8, 32 watt lamps shall be used in most areas of the building. All fixtures with open reflectors shall be of the self locking type or have a shield installed to prevent fluorescent light tubes from falling out. All ballasts shall be of the energy saving electronic type with power factor exceeding 90%. Lamps shall be broad spectrum and provide a warm color. Lamps shall be high efficiency with a minimum of 90 lumens per watt (32W lamp), have a color rendition index of 75 and have a color temperature of 3500K.

1.11.4 Incandescent or Lighting Fixtures

Incandescent lighting fixtures shall NOT be used.

1.11.5 Compact Fluorescent lighting fixturess

Compact fluorescent lighting fixtures shall be electronic ballast type.

1.11.6 Egress and Exit Lighting Fixtures

Egress and exit lighting design shall be in accordance with NFPA 101. Exit lights shall be green LED type XL1 - Corps of Engineers Lighting Standard. Det. Dwg. No. 40-06-04. Exit lighting shall flash upon initiation of the fire alarm system. Egress lighting power shall be provided from room fluorescent light fixtures unswitched leg with an emergency battery and lamp supply unit installed. Typical through out the facilities.

1.11.7 Wire Guards

Provide wire guards for all open type light fixtures.

1.12 INTERIOR COMMUNICATION SYSTEM

1.12.1 General

The Contractor shall prewire the building for a voice/data for Category 5e

compliant. All telephone/data outlets shall be provided with duplex 8-position jacks (RJ45), one telephone and one data. Cable used shall be EIA/TIA Category 5e, UTP solid copper station wire. Wire shall be routed in a minimum 27mm conduit installed in the walls to the cable tray. Conduit should include a nylon pull string for adding additonal cables in the future. Wire basket type tray shall be provided to route cables back to the Communications Room. Cable tray should also be used for routing CCTV and Intercom System cables. Cables for different systems shall be physically seperated by barriers. All communications circuits shall be continous and free of splices from communications room to outlet. Cable tray shall be sized in accordance with I3A standards. Conduit shall be used to bridge cable trays through fire rated walls. Ladder type cable racks shall be installed in Communications Room to route cables from cable tray to the communications rack and telephone backboard. Connect all telephone outlets to Type 110 cross connects mounted on telephone terminal backboard in the Communications Room. Data jacks shall be mounted to Category 5e Patch panels mounted in a free standing rack located in the Communications Room. Communications room layout shall conform to Figure 2-2 of I3A standard. All electronic devices (computers, file servers, hubs, concentrators, phones, etc.) are not part of this contract and will be installed by the user. Each facility design shall be in accordance with the Premises Distribution System Specification - SECTION 16710, Electrical Work, Interior Specification SECTION 16415, space data sheets and the requirements of this section. Testing shall be done in accordance with TSB-67, EIA/TIA-568A as required in Premise Distribution System Specification Section 16710 with all test results provided to the COR.

1.12.2 Telephone Terminal Backboard

Provide a 19 mm plywood backboard on one long wall and the back wall of the Communications Room. Provide surge arrestors and 110 type cross connect blocks for the incoming telephone conductors. The plywood telephone backboards shall be provided with a fire retardant coating. Contractor shall coordinate location of incoming telephone service with the location of the surge arrestors and cross connect blocks on the telephone backboard. See Special Receptacle section for power requirements. All underground conduits entering the Communication Room shall be stubbed up 150 mm above finished floor adjacent to the telephone backboard. All stubbed conduits shall be sealed with polyurethande foam duct seal.

1.12.3 Telephone Conductors/Conduits

Copper cables shall be 24 gauge, 4 pair, EIA-TIA-568A Category-5e, unshielded twisted pair (UTP) solid copper station cable. Terminate cables on jacks with EIA 568A standard for wiring. All telephone/data conductors shall be installed in 27mm conduits with bushings per Wiring Methods paragraph in this section.

1.12.4 Telephone/Data/LAN Outlets

Telephone/data/LAN outlets shall consist of one telephone jack and one data jack. Telephone and data outlets shall be installed in the same junction box. Telephone jacks shall be used for voice communication and data jacks shall be used for data communication. Each outlet shall be mounted 380mm above finished floor. All jacks shall be terminated using the T 568B standard. Provide telephone/data outlets at each of the locations indicated in the following paragraphs:

1.12.5 Telephone/Data Outlets

The location of outlets shall be as indicated on the space data sheets. Add outlets in office spaces of POL & Refueler maintenance over and above shown in the space data sheeets for maximum spacing between the outlets to not exceed 6ft.

1.12.6 Telephone Single Outlets

Location of single telephone outlet shall be as indicated on the space data sheets. Telephone single jacks shall be ivory in color. Outlets shall be mounted at 1220mm above finished floor. Wall plates shall be suitable for mounting standard wall phones.

1.12.7 LAN Rack

Contractor shall provide a free-standing rack in the Communication Room. See special receptacle paragraph for power requirements.

1.13 CROSS CONNECT CABLES

Provide 25 pair #24 AWG telephone cables with 50 pin connectors at each patch panel and punch down the other end of the cable at the cross-connect blocks. Support all telephone cables by cable racks installed in the Communications Room.

1.14 RJ45 PATCH PANELS

Provide RJ 45 patch panels for all data circuits in the project. Patch panels shall include 20% spare for future expansion.

1.15 FIBER-OPTIC PATCH PANELS

Incoming fiber-optic cables shall be terminated in rack mounted patch panel suitable for ST type connectors.

1.16 COMMUNICATION GROUNDING

All exposed non-current carrying metallic parts of the telephone equipment, cable sheaths, cable spices and terminals shall be grounded. Contractor shall provide a Master Ground Bus (MGB) in the Communication Room per Premises Distribution System - Specification Section 16710.

1.17 INTERCOM SYSTEM

In POL (with extension to service station), provide an intercom system which allows for individual room/area communication. The intent of such a system is for two way communication rather than general announcements or music. Locate system master panel at the control room with a slave panel, location of which as determined later during the design. Both the master and slave panels shall have the capability of zone selective or system wide distribution of announcements. System remotes shall be located as determined during design. Remotes shall be mounted at 1375mm above finished floor or grade and each shall be hands free operation.

1.18 INTRUSION DETECTION SYSTEM

No requirement for IDS has been identified for the buildings.

1.19 CLOSED CIRCUIT TELEVISION SYSTEM

1.19.1 CCTV Camera Locations

Provide a complete CCTV raceway system. Contractor shall provide conduit, cable tray, j-boxes, wireways and outlet boxes as required to support the user furnished and installed CCTV system. On site there is one existing camera which will remain. Extend cable from the existing camera to the POL bldg in underground conduit. Communications cable tray can be used inside the building for this system. Portion of cable tray used for CCTV shall be separated by a barrier. Camera shall will require a RG-59 and a 18/2 NTP cable or match existing. The minimum conduit size shall be 27mm.

1.19.2 Monitor Locations

Provide two connectors in control room. see space data sheet for more info. Exact location of monitor boxes shall be coordinated with the user during design. Coax from connectors shall be run in conduit.

1.19.3 CCTV Equipment Requirements

Conduit shall terminate at the power supply backboard located at the comm. room. All conduit ends shall be provided with bushings and labelled to identify rooms and equipment served. The comm room will contain a 610mm(w) x 1220 mm (h) backboard for CCTV power supplies and equipment. In additon space will be requried for a 1220mm (w) x 710mm (d) x 2130mm (h) government provided free standing cabinet. CCTV support equipment locations shall be verified and coordinated during the design of the project.

1.20 CABLE TELEVISION

Provide a 21mm conduit w/pullwire, outlet box and cover plate from the Ready room area to the above ceiling mounted cable tray. Coordinate outlet box location with the user. In the Communications Room provide a dedicated wall space, 915mm X 915mm backboard for cable television. Cable and connection will be by Others.

1.21 ENERGY MONITORING AND CONTROL SYSTEM (EMCS)

Provide power as required for all EMCS or DDC components (such as dampers, VAV boxes, control panels, etc.) requiring power. The EMCS software and hardware shall be modfied to incorporate the building into the system.

1.22 WIRING METHODS

Wiring shall conform to NFPA 70, Section 16415: ELECTRICAL WORK, INTERIOR, and the requirements of this section.

1.22.1 Power Conductors

Conductors shall be copper only. Aluminum conductors are not allowed. Minimum conductor size shall be #12 A.W.G. Conductors shall be installed in conduits. Power and lighting conductors shall be 600 volt, Type THHN (in dry locations), and THW or THWN (in wet locations).

1.22.2 Communication Conductors

Communication conductors shall be provided per paragraph Telephone Conductors of this section and Premises Distribution System, Specification Section 16710.

1.22.3 Conduits

Wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit, electrical metallic tubing, electrical intermediate metal conduit or rigid nonmetallic conduit. Plastic conduit, when used, shall be in accordance with Article 347 of the NEC. Raceways shall be concealed within finished walls, ceilings, and floors.

1.23 GROUNDING SYSTEM

The grounding system shall be designed in accordance with NEC Article 250 and the following criteria. In general, all metallic building components including reinforcing steel and miscellaneous metals shall be part of an electrically continuous ground system. Steel studs used in interior wall construction, T bars of the ceiling grid, diffusers of the air distribution system, and door hardware are exempt from this bonding requirement. Bonding shall be by exothermic welding or the brazing of a copper wire between components. Design shall be in accordance with Electrical Work, Interior Specification - SECTION 16415 and this section.

1.23.1 Communication Grounding System

Grounding for the main telephone service shall be provided by installing an insulated #6 copper grounding conductor in 27mm conduit from the Master Grounding Bus (located in the Communication Room) to the building service ground.

1.23.2 Grounding Conductors

A green equipment grounding conductor, sized in accordance with NFPA 70 shall be provided, regardless of the type of conduit. Equipment grounding bars shall be provided in all panelboards. The equipment grounding conductors shall be carried back to the service entrance grounding connection or separately derived grounding connection. Grounding conductors shall be provided in all branch (including lighting circuits) and feeder circuits.

1.23.3 Static Grounding

Static grounding requirements for the laboratory in POL bldg. shall be in accordance with section 16665A STATIC ELECTRICITY PROTECTION SYSTEM.

1.24 FIRE DETECTION AND ALARM SYSTEM

Design shall be in accordance with Section 13851: FIRE DETECTION AND ALARM, ADDRESSABLE, and the requirements of Section 01022: FIRE PROTECTION REQUIREMENTS.

1.25 TESTING

Contractor shall provide all testing required by all specifications listed in Divison 16. No testing requirements can be deleted from the master specifications.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 02000

DIVISION 02: SITE WORK - OUTLINE SPECIFICATIONS
02/02

PART 1 GENERAL

1.1 GENERAL REQUIREMENT

Contractor Edited Guide Specifications

The contractor shall edit and provide the following UFGS guide specifications for Division 02: SITE WORK÷. Refer to the BASE STANDARDS 01140 and 01012 for contractual guidance to be included in the edited specifications.

Section 02220, DEMOLITION

1. Oil/Water Separator (OWS) Removal and Disposal

As part of demolition of building 980, the Contractor shall remove and dispose of the underground OWS located on the west side of the building. Removal and disposal of the OWS shall be performed in accordance with the procedures of the American Petroleum Institute (API) Recommend Practice 1604, Removal and Disposal of Used Underground Petroleum Storage Tanks.

1.1 OWS Contents:

As part of the OWS removal and disposal, the Contractor shall be required to remove, collect, and dispose of the contents at an approved off-site disposal facility. Prior to removal of the contents, the Contractor shall collect a sample of the contents and analyze it for the parameters required by the off-site disposal facility. The contents of the OWS are anticipated to be a mixture of water and petroleum products. Potential petroleum products that may be contained in OWS are motor oil, jet fuel, mo gas, and diesel fuel. The Contractor shall not remove the content of the OWS or ancillary piping and equipment until a facility has been identified that is permitted and has agreed to accept the contents for disposal. The contractor shall assume that OWS contains 1,000 gallons of petroleum contaminated liquid requiring off-site disposal.

1.2 OWS and Ancillary Piping Removal:

The Contractor shall remove the OWS and all associated piping. This includes piping which extends from the building to the OWS and the sanitary sewer lateral extending from the OWS to the sanitary sewer main. The sanitary sewer lateral shall be cut off and capped within two feet from the main using an approved pipe cap.

1.3 Contaminated Soil Excavation:

The Contractor shall excavate only the amount of soil necessary to remove the OWS and associated piping or as directed by the Contracting Officer. During excavation, soil that is visually contaminated shall be segregated from soils that are not visually contaminated. Visually contaminated soil shall be stockpiled as described in paragraph: Stockpiling Contaminated Soil. After the OWS and piping have been removed, the Contractor shall remove visually

contaminated soil from below the OWS and piping at as directed by the Contracting Officer. The Contractor shall assume that there will be 100 cubic yards of petroleum contaminated soil requiring disposal at a permitted off-site disposal facility.

1.4 Stockpiling Contaminated Soil:

Excavated soil that shows signs of contamination shall be stockpiled separately from non-contaminated soils. The segregation of contaminated and non-contaminated shall be determined by visual inspection and the use of a photoionization detector (PID). Stockpiles shall be placed a safe distance away from the excavation. Both contaminated and non-uncontaminated stockpiles shall be placed on an impermeable geomembrane a minimum of 10 mils thick, and covered with a geomembrane a minimum of 6 mils thick. The geomembrane shall be placed to prevent the stockpiled soil from coming into contact with surface water run-off. The cover shall prevent rain or surface water from coming into contact with the contaminated soil, as well as limit the escape of the volatile constituents in the stockpile. Stockpiles shall be sampled in accordance with paragraph: Chemical Testing Requirements. Soil that is below the Kansas Petroleum Site Remediation Levels (TPH < 100 mg/kg, Benzene < 1.4 mg/kg, and 1,2-Dichloroethane < 8 mg/kg) shall used for backfill in the tank excavation prior to using borrow material. Soil that exceeds these limits shall be disposed of at a permitted off-site facility.

1.5 Soil Sampling in OWS and Piping Excavations

The provide documentation of any contamination that will remain in the ground after backfill of the excavations to remove the OWS and associated piping, the Contractor shall collect a 1 soil sample from below the OWS, 1 soil sample from the downgradient sidewall from the OWS excavation, and 1 soil sample for every 100 linear feet of excavation to remove the sanitary sewer piping. Samplings will be analyzed for the parameters and by the methods identified in Tables 1 and 2 respectively.

1.6 Health and Safety Requirements:

Demolition activities related to the OWS may present unique hazards to workers including chemical, fire, confined space, buried utilities, and excavation hazards. The Contractor's Accident Prevention Plan shall detail preventive measures and contain completed activity hazard analyses, as per EM 385-1-1, 01.A.09, that clearly delineate the methods and work practices that will minimize chemical and physical hazards related to removing combustible materials, cleaning, excavation, and demolition of the OWS and associated piping.

1.7 Chemical Testing Requirements:

1.7.1 Sampling and Analysis Plan (SAP)

The SAP shall be prepared in accordance with EM 200-1-3. The SAP shall be a two-part document that contains two distinct elements: Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP). Sections of the FSP and QAPP shall be cross-referenced. The SAP shall confirm the Contractor's understanding of the contract requirements for chemical data quality control, and shall describe procedures for field sampling and sample submittal for analysis, field chemical parameter measurement, data documentation, data assessment and data reporting requirements. The SAP shall delineate the methods the Contractor intends to use to accomplish the chemical quality control items to assure accurate, precise, representative, complete, legally

defensible and comparable data. The SAP shall describe all chemical parameter measurements for all matrices for all phases of the remediation contract. As a single interrelated document, the SAP shall be provided to field and laboratory personnel. The Contractor may propose original/innovative approaches to chemical parameter measurements for cost reduction and remediation efficiency by abbreviated sampling, contingency sampling and/or contingency analysis, indicator or tracer analysis, onsite analytical services, equivalency or screening methods. The SAP shall clearly identify the Contractor obtained laboratories. The Contractor shall furnish copies of the Government approved SAP to all laboratories and the Contractor's field sampling crew. The SAP shall address all levels of the investigation with enough detail to become a document which may be used as an audit guide for field and laboratory work.

1.7.1.1 Field Sampling Plan (FSP)

The FSP shall contain necessary technical detail and direction for the field personnel to understand sampling and field measurement requirements. The FSP shall provide a comprehensive description and full detail for personnel to perform all onsite activities required to attain project DQO, including: locations of samples, sampling procedures for onsite and offsite chemical analysis, summaries of analyses to be performed on samples, shipment of samples for offsite analyses, performance of onsite and offsite instrumental parameter measurements, data documentation and reporting requirements.

1.7.1.2 Quality Assurance Project Plan (QAPP)

The QAPP shall contain necessary technical detail and direction for field and laboratory personnel to understand project sample analysis, quality control and data reporting requirements, analytical methods, required detection limits, QC requirements, and data validation and reporting requirements.

1.7.2 Chemistry Data Package

The chemistry data package shall be produced and submitted to the Contracting Officer. The chemistry data package shall contain information to demonstrate that the project's Data Quality Objectives have been fulfilled. All the analytical results shall be a part of the chemistry data package.

Table 1. Sample Locations/Matrix

Location (#Samples)	Analyses1	Matrix
Excavation groundwater (Final as required by KDHE)	Benzene1,2-DCA2 Naphthalene	Water
Soil Samples for Excavation Contamination Documentation (2 for OWS, 1/100 feet of piping trench)	TPH VOCs TAL metals	Soil
Stockpiled Soil (1/100 cubic yards)	TPH VOCs TAL metals and any additional analyses required by the disposal facility	Soil
Tank Contents	As required by disposal facility	Liquid/Solid
Rinsate of sampling equipment,OWS, and piping	As required by disposal facility	Liquid
Imported Backfill - one composite sample per 500 cubic yards	TCL SVOC TCL VOC TCL PCB/Pest TAL Metals	Soil

1 - Analytical Methods specified in Table 2.

2 - 1,2 - dichloroethane.

TPH - Total Petroleum Hydrocarbons.

Table 2. Analytical Methods/Quantitation Limits

Analyte	Method		Reporting Limits	
	Solid/Soil	Liquid/Water	Solid/Soil1	Liquid/Water (ug/L)
TPH (gasoline range)	Iowa MethodOA-1 (gasoline range)	NA	As required by KDHE	NA
TPH (diesel range)	Iowa MethodOA-2 (diesel range)	NA	As required by KDHE	NA
SVOC TCL	EPA Method 8270C	NA	MDL	NA
TCL PCB/ Pesticides	EPA Method 8081	NA	35 ug/kg2	NA
TCL VOC	EPA Method 8260B	EPA Method 8260B (If groundwater encountered)	Detection limit secified by method	Detection limit secified by method
Metals	EPA Methods 6010A and 7000 series	NA	Detection limit specified by method	N/A

mg/kg - milligrams/kilograms.
ug/kg - micrograms/kilogram
ug/L - micrograms/liter
N/A - Not Applicable
TPH - total petroleum hydrocarbons.

1 - Estimated quantitation limits are on a wet weight basis. Actual sample data should be reported on a dry weight basis; the actual quantitation limits will therefore vary according to the % moisture of each sample.
2 - Detection limits for non-aqueous samples are highly matrix dependent. Estimates of soil detection limits are provided for reference only, and will not necessarily apply to the project-specific matrices

Section 02230, CLEARING AND GRUBBING

Section 02300, EARTHWORK

Section 02315, EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS

Section 02316, EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES

Section 02510, WATER DISTRIBUTION SYSTEM

Section 02555A, PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION

SYSTEM

Section 02556A, GAS DISTRIBUTION SYSTEM

Section 02620A, SUBDRAINAGE SYSTEM

Section 02630, STORM DRAINAGE SYSTEM

Section 02663, PAVEMENT MARKINGS

Section 02821, FENCING

Section 02921A, SEEDING

Section 02922A, SODDING

Section 02930, EXTERIOR PLANTING

Section 02935, EXTERIOR PLANT MAINTENANCE

1.1.1 Kansas Department of Transportation Specifications

The Contractor shall use The Kansas Department of Transportation, "STANDARD SPECIFICATIONS FOR STATE ROAD AND BRIDGE CONSTRUCTION" for the specification items listed in paragraph 1.3 below.

1.1.2 Government Edited Specifications

The contractor shall incorporate the following government-supplied, fully edited specification sections as part of the project design:

~~Section 02791, PLAYGROUND PROTECTIVE SURFACING~~

~~Section 02882, PLAYGROUND EQUIPMENT~~

1.2 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 D 977	(1991) Emulsified Asphalt
ASTM D 2027	(1976; R 1992) Cutback Asphalt (Medium-Curing Type)
ASTM D 2028	(1976; R 1992) Cutback Asphalt (Rapid-Curing Type)
ASTM D 2397	(1994) Cationic Emulsified Asphalt

CODE OF FEDERAL REGULATIONS (CFR)

28 CFR Part 36; Appendix A	(1994) Americans with Disabilities Act (ADA) Standards for Accessible Design
36 CFR 1191 RIN 3014 AA17	(1998) Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities; Building Elements Designed for Children's Use

1.3 Kansas Department of Transportation, "STANDARD SPECIFICATIONS FOR STATE ROAD AND BRIDGE CONSTRUCTION".

Measurement and Payment paragraphs in KDOT specifications shall not apply.

1.3.1 Material and Performance Criteria

A. Excavation for roads, parking lots, and other surfaced areas shall conform to state specification section 204.

Testing:
In-place field density testing and frequency of testing shall conform to state specifications. Field density tests are to be taken at a frequency not less than one test every 1,000 square meters per lift of embankment or subgrade. Laboratory density and moisture testing will be performed at a rate of one test per 500 cubic meters of material placed or when there is a change of material. During construction of embankments or fills, the working surface will be sloped to prevent the ponding of water. After completion, newly graded areas will be protected from traffic and erosion.

B. Embankments and fills: Embankments and fills shall be constructed and tested in accordance with the Kansas State Department of Transportation "STANDARD SPECIFICATIONS FOR STATE ROAD AND BRIDGE CONSTRUCTION", referred to herein as state specification. The latest edition and revisions of the state specification shall be used for all work.

C. Pre-construction testing requirements: All mix designs, and materials proposed for use in the work shall be tested initially for conformance to state specification requirements prior to delivering the materials to the project site. Certified copies of laboratory test reports shall verify that mix designs conform to state specification and the requirements specified herein. Certified copies of laboratory test reports shall verify that aggregate gradations, composition, and quality requirements, and other materials proposed for use in the work conform to state specification. A certified copy of each mix design and materials test reports, shall be submitted to: U.S. Army Corps of Engineers, CENWK-EC-GL for review. The above mix design and materials test report submittals shall be submitted during the project design. The mix design, and materials test report submittals, shall include names of companies and contractor's performing the mix design and testing, with a listing of all sources of materials and aggregates proposed for use in the work. The listing shall include a point of contact and telephone number for each material type and source.

D. Construction testing: Portland cement concrete, asphalt concrete mixtures shall be tested during construction in accordance with state specification, and certified laboratory reports shall be submitted to the Contracting Officer within 24 hours following completion of the test. In place density, compacted thickness, and gradation testing for

each course shall be accomplished in accordance with the requirements and testing frequency specified in the state specification. Where the state specification testing frequency for subgrade, aggregate courses, and surface courses is not defined or is greater than 1,000 square meters, a minimum testing requirement of 1,000 square meters for each course or lift shall be used. All testing required on each course or lift shall be accomplished prior to commencing construction of the next course or lift. A certified copy of each test report for all testing, shall be submitted to the contracting officer within 24 hours following completion of the test. The materials testing laboratory shall conform to the state requirements for testing laboratories.

E. Asphalt concrete shall conform to state specification section 605, PLANT MIX BITUMINOUS MIXTURE - COMMERCIAL GRADE. The grade of asphalt cement shall not be changed without an approved laboratory mix design. It shall also comply with KDOT Special Provisions 90M-197 Latest Revision and 90M-0196 Latest Revision. A certified refinery analysis from the proposed source shall be submitted with the mix design. Aggregates for asphalt concrete (bituminous mixtures) shall conform to state specification section 1103.

In addition the following requirements pertain:

The Total aggregate (coarse aggregate, fine aggregate, and mineral filler passing the 75 um (No. 22 sieve) shall contain not less than 85 percent crushed material. All bituminous mixtures shall contain an anti-stripping agent. AD-here LOF 65-00 LS as manufactured by ARR-MAZ Products, L.P. shall be added to the asphalt cement at the rate of 0,75% by weight of the asphalt cement. Other asphalt anti-stripping additives and their application rate may be used when proven equal after testing in accordance with ASSHTO T 283-89. Asphalt concrete mixtures shall be tested in accordance with ASSHTO T 283, and shall have a retained strength of at least 80 percent. Asphalt cement shall conform to ASSHTO-MPI Performance Graded Asphalt Binder PG 64-22. The asphalt concrete mix design shall conform to Asphalt Institute MS-2, sixth edition, Marshall Mix Design Method, 75 blow criteria. The mix design shall use the materials proposed for use in the work. The mix design shall be accomplished by a commercial testing laboratory conforming to the requirements of ASTM D 3666-96a.

The percentage of loss shall not be greater than 18 percent after five cycles when tested in accordance with ASTM C 88 using magnesium sulfate or 12 percent when using sodium sulfate. 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. 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. Fine aggregate shall consist of clean, sound, tough, durable particles. The aggregate particles shall be free from coatings of clay, 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 43.0 percent when tested in accordance with ASTM C 1252 Method A. Mineral Filler shall be nonplastic material meeting the requirements of ASTM D 242. The absorption shall be tested in accordance with State Specifications with a maximum limit of 4.0 percent.

Base course aggregates: Base course aggregates used for roads, parking lots, and other surfaced areas shall be crushed aggregate conforming to state specification subsection 1105, Type AB-1.

In addition the following requirements shall pertain:

The portion of the aggregate passing the 0.425mm sieve shall have a maximum limit on plasticity index of 5 and liquid limit of 25. The percent passing the .075mm sieve shall be between 0 to 10 percent by weight. The coarse aggregate shall not show more than 40 percent loss after 500 revolutions when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. The coarse aggregate shall not exhibit a loss greater than 18 percent weighted average, at five cycles, when tested for soundness in magnesium sulfate in accordance with ASTM C 88. The amount of flat and elongated particles shall not exceed 20 percent for the fraction retained on the 12.5mm sieve nor 20 percent for the fraction passing the 12.5mm sieve. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregate 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 mid sectional area of the face. When 2 fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Fine aggregate shall be natural sand or angular particles produced by crushing stone or gravel that meets the requirements for wear and soundness specified for coarse aggregate. The absorption shall be tested in accordance with State Specifications with a maximum limit of 4.0 percent. The Specific Gravity shall be tested in accordance with State Specifications with a minimum limit of 2.20.

The maximum density and optimum moisture content shall be determined in accordance with ASTM D 1557, Method D. Compaction shall continue until each layer has a degree of compaction that is at least 100 percent of laboratory maximum density through the full depth of the layer.

F. Bituminous Prime Coat
Bituminous Prime Coat shall conform to state specification section 612, and the requirements herein. Bituminous prime coat shall be: liquid asphalt conforming to the requirements of ASTM D 2027, designation MC-30 or MC-70, at the Contractor's option, except that only MC-30 shall be used on dense graded base courses if MC-70 does not adequately penetrate the base course material. In lieu of cut-back asphalt, the Contractor may use cationic emulsified asphalt conforming to the requirements of ASTM D 2397, designation CSS-1 or CSS-1h.

G. Bituminous Tack Coat
Unless otherwise directed or required, bituminous material shall be emulsified asphalt conforming to the requirements of ASTM D 977, designation SS-1 or SS-1h or cationic emulsified asphalt conforming to the requirements of ASTM D 2397, designation CSS-1 or CSS-1h.

H. Portland cement concrete construction: Concrete pavement construction shall conform to UFGS specification section 03300.

Steel Reinforcement for use in pavements shall conform to state

specifications, and to the requirements specified in other sections.

I. Base course aggregates used for roads, parking lots, and other surfaced areas shall be crushed aggregate conforming to state specification subsection 1105, Type AB-1.

J. Traffic Signage: Signs shall conform to state specification subsection 825.

1.4 Section 02555A, PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM

This guide specification covers the requirements for prefabricated underground distribution system for chilled water systems.

1.4.1 Underground Chilled Water Piping

Underground chilled water piping shall extend from the mechanical room to the packaged, air cooled, rotary screw liquid chiller as required in Section 01016, MECHANICAL REQUIREMENTS.

1.4.2 Low Temperature Hot Water and Dual Temperature Water

This guide specification also covers the requirements for prefabricated underground distribution system for low temperature hot water systems (less than 95 degrees C) and dual temperature water systems. Delete all requirements for low temperature hot water systems (less than 95 degrees C) and dual temperature water systems from this specification.

1.4.3 Casing Material

Casing material shall be non-metallic and shall be as recomended by the manufacturer of the piping system for use with the carrier pipe. When different materials are provided for the casing material and the carrier pipe, the contractor shall demostrate with manufacture's published data that differential material expansion rates between the casing material and the carrier pipe shall not lead to product failure.

1.5 Section 02556A, GAS DISTRIBUTION SYSTEM

This guide specification covers the requirements for natural or manufactured gas distribution systems designed in accordance with ASME B31.8.

1.5.1 Natural Gas

The facility is to be supplied with natural gas. Delete all references to liquefied petroleum gas (LPG) or manufactured gas systems from this specification.

1.5.2 Polyethylene Pipe

All underground natural gas piping shall be polyethylene pipe. Delete all references to other material types for underground gas piping from this specification.

1.6 SECTION 02620, SUBDRAINAGE SYSTEM

The contractor edited specification section shall include the following

material physical characteristics and performance criteria:

A. All specification submittals shall be designated "FIO.

B. Pipe specified shall be perforated plastic pipe.

C. Drainage aggregate shall conform to KDOT Standard Specification Section

D. Filter Fabric shall be

1.7 SECTION 02630, STORM DRAINAGE

1.7.1 Material and Performance Criteria

The contractor edited specification section shall include the following material physical characteristics and performance criteria:

A. All specification submittals shall be designated "FIO".

B. Submittals of pipe samples is not required.

1.8 SECTION 02831, FENCING

1.8.1 Material and Performance Criteria

The contractor edited specification section shall include the following material physical characteristics and performance criteria:

A. Chainlink fabric shall be either zinc or aluminum coated 9-gage wire woven in a 50 mm mesh. Tie wires shall be 9-gage galvanized steel wire.

B. All specification submittals shall be designated "FIO".

1.9 SECTION 02921A SEEDING and/or 02922A, SODDING

The contractor edited specification section shall include the following material physical characteristics and performance criteria:

1.9.1 Seeding and Sodding

Seed Mixture Mixture:	% Mixture	Kg per 100 Sq Meter
Turf Type Fescue Festuca arundinacea Bonsai (turf type fescue Finelawn 8855 dwarfvarieties) Shortstop Tomahawk Monarch Mustang Twilight Olympic Houndog Apache	100	2.5

Notes: Any of the seed varieties listed above may be used singularly or in combination.

Total	100%	2.5 kg/100 sq meter

Weed seed shall not exceed 1 percent by weight of the total mixture. Wet, moldy, or otherwise damaged seed shall be rejected. Seed mixing shall be performed by the seed supplier prior to delivery to the site. Minimum 85% pure live seed. Bulk quantities of seed shall be labeled.

-- End of Section --

SECTION 02620

SUBDRAINAGE SYSTEM
08/97

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 M 190	(1988) Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 252	(1994) Corrugated Polyethylene Drainage Tubing
AASHTO M 294	(1994) Corrugated Polyethylene Pipe, 305-to 915-mm (12-to 36 in.) Diameter

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 27/A 27M	(1996) Steel Castings, Carbon, for General Application
ASTM A 47	(1990; R 1995) Ferritic Malleable Iron Castings
ASTM A 48	(1994a) Gray Iron Castings
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 227/A 227M	(1993) Steel Wire, Cold-Drawn for Mechanical Springs
ASTM A 229/A 229M	(1993) Steel Wire, Oil-Tempered for Mechanical Springs
ASTM A 760/A 760M	(1995b) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 762/A 762M	(1995a) Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM B 745/B 745M	(1995) Corrugated Aluminum Pipe for Sewers and Drains
ASTM C 4	(1996) Clay Drain Tile
ASTM C 14	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe

~~ASTM C 55~~	~~(1996a) Concrete Brick~~
~~ASTM C 62~~	~~(1996) Building Brick (Solid Masonry Units Made from Clay or Shale)~~
~~ASTM C 139~~	~~(1996a) Concrete Masonry Units for Construction of Catch Basins and Manholes~~
~~ASTM C 150~~	~~(1996) Portland Cement~~
~~ASTM C 231~~	~~(1997) Air Content of Freshly Mixed Concrete by the Pressure Method~~
~~ASTM C 412~~	~~(1994) Concrete Drain Tile~~
~~ASTM C 425~~	~~(1996) Compression Joints for Vitrified Clay Pipe and Fittings~~
~~ASTM C 444~~	~~(1995) Perforated Concrete Pipe~~
ASTM C 478	(1996) Precast Reinforced Concrete Manhole Sections
~~ASTM C 654~~	~~(1995) Porous Concrete Pipe~~
~~ASTM C 700~~	~~(1996) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated~~
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 3034	(1994) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1992) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
~~ASTM F 405~~	~~(1996) Corrugated Polyethylene (PE) Tubing and Fittings~~
~~ASTM F 667~~	~~(1985) Large Diameter Corrugated Polyethylene Tubing and Fittings~~
ASTM F 758	(1993) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F 949	(1994) Poly(Vinyl Chloride) (PVC)

Corrugated Sewer Pipe With a Smooth Interior and Fittings

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-13 Certificates

Filter Fabric; ~~[_____]~~GA-RE. Pipe for Subdrains; ~~[_____]~~GA-RE.

Certifications from the manufacturers attesting that materials meet specification requirements. Certificates are required for drain pipe, drain tile, fittings, and filter fabric.

SD-14 Samples

Filter Fabric; ~~[_____]~~FIO-RE. Pipe for Subdrains; ~~[_____]~~FIO-RE.

Samples of filter fabric, pipe, and pipe fittings, before starting the work.

1.3 DELIVER, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with minimum handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. During shipment and storage, filter fabric shall be wrapped in burlap or similar heavy duty protective covering. The storage area shall protect the fabric from mud, soil, dust, and debris. Filter fabric materials that are not to be installed immediately shall not be stored in direct sunlight. Plastic pipe shall be installed within 6 months from the date of manufacture unless otherwise approved.

1.3.2 Handling

Materials shall be handled in such a manner as to insure delivery to the trench in sound undamaged condition. Pipe shall be carried and not dragged to the trench.

1.4 [Enter Appropriate Subpart Title Here]~~1.4 MEASUREMENT AND PAYMENT~~

~~1.4.1 Pipe Subdrains~~

~~The length of pipe installed will be measured from end to end along the centerlines without any deduction for the diameter of the manholes. Pipe will be paid for according to the number of linear meters of subdrains placed in the accepted work. Payment for bedding and filter materials, except filter fabric, will be included in the payment for the pipe subdrain system.~~

~~1.4.2 Blind or French Drains~~

~~Blind or french drains will be paid for by the linear meter and measured from end to end along the centerlines of the completed drains.~~

~~1.4.3 Manholes~~

~~Manholes to be paid for will be the number of manholes completed with base, rungs or ladders, frames, and covers or gratings (where specified) constructed in the accepted work.~~

~~1.4.4 Flushing and Observation Risers~~

~~Flushing and observation risers to be paid for will be the number of flushing and observation risers completed with frames and covers (where specified) constructed in the accepted work.~~

1.4.1 [Enter Appropriate Subpart Title Here]~~1.4.5 Filter Fabric~~

~~Filter fabric shall be measured for payment by the square [meter] [meter] in place. Overlapped joints and seams shall be measured as a single layer of cloth.~~

PART 2 PRODUCTS

2.1 PIPE FOR SUBDRAINS

Pipe for subdrains shall be of the types and sizes indicated.

~~2.1.1 Concrete Pipe~~

~~Concrete pipe shall be Class 1, 2, or 3 as indicated and shall conform to ASTM C 14 using ASTM C 150 portland cement Type [II] [V].~~

~~2.1.2 Clay Pipe and Perforated Clay Pipe~~

~~2.1.2.1 Clay Pipe~~

~~Clay pipe shall be either standard or extra strength as indicated and shall conform to ASTM C 700.~~

~~2.1.2.2 Perforated Clay Pipe~~

~~Perforated clay pipe shall be either standard or extra strength as indicated and shall conform to ASTM C 700. Plain-end pipe conforming to the strength and perforation requirements of ASTM C 700 will also be acceptable if provided with spring wire clips of approved type to maintain a taut but elastic joint between the sections of pipe when laid. Clips shall be constructed of not smaller than No. 9 hard-drawn or oil-tempered steel wire conforming to ASTM A 227/A 227M or ASTM A 229/A 229M, and shall be coated with an approved rust preventive coating. Wire clips shall withstand 25 cycles of alternate loading and unloading using a stressing force of 556 N (125 pounds). The permanent set resulting from this test shall be less than 5 percent, based on the original length of the fastener. Compression joints conforming to ASTM C 425 will also be acceptable.~~

~~2.1.3 Perforated Concrete Pipe~~

~~Perforated concrete pipe shall conform to ASTM C 444, Type [I] [II] perforations and to ASTM C 14, Class 1, 2, or 3 as indicated.~~

~~2.1.4 Perforated Corrugated Steel Pipe~~

~~Perforated corrugated steel pipe shall conform to ASTM A 760/A 760M, Type III. Sheet thickness of pipe shall be as indicated.~~

~~2.1.5 Perforated Corrugated Steel Pipe, Fully Bituminous Coated~~

~~Perforated corrugated steel pipe, fully bituminous coated, shall conform to ASTM A 760/A 760M, Type III, with a coating conforming to AASHTO M 190, Type A. Sheet thickness of pipe shall be as indicated.~~

~~2.1.6 Drain Tile~~

~~Clay drain tile shall conform to ASTM C 4 standard, extra quality or heavy duty as indicated. Concrete drain tile shall conform to ASTM C 412 standard, extra, heavy duty extra, or special quality as indicated.~~

~~2.1.7 Porous Concrete Pipe~~

~~Porous concrete pipe shall conform to ASTM C 654, standard or extra strength as indicated and using ASTM C 150 portland cement Type [II] [V].~~

~~2.1.8 Perforated Corrugated Aluminum Alloy Pipe~~

~~Perforated corrugated aluminum alloy pipe shall conform to ASTM B 745/B 745M, Type III, Class [1] [2]. Sheet thickness of pipe shall be as indicated.~~

~~2.1.9 Perforated Corrugated Aluminum Alloy Pipe, Fully Bituminous Coated~~

~~Perforated corrugated aluminum alloy pipe, fully bituminous coated shall conform to ASTM B 745/B 745M, Type III, Class [1] [2] with a bituminous coating conforming to AASHTO M 190, Type A.~~

2.1.1 [Enter Appropriate Subpart Title Here]~~2.1.10 Precoated Corrugated Steel Pipe~~

~~Precoated corrugated steel pipe shall conform to ASTM A 762/A 762M, Type III.~~

2.1.2 Plastic Pipe

Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.

2.1.2.1 [Enter Appropriate Subpart Title Here]~~2.1.11.1 Acrylonitrile-Butadiene-Styrene (ABS) Piping~~

~~Acrylonitrile-butadiene-styrene (ABS) piping and fittings shall conform to ASTM D 2751, with maximum SDR of 35.~~

2.1.2.2 Polyvinyl Chloride (PVC) Pipe and Fittings

Polyvinyl chloride (PVC) pipe and fittings shall conform to ~~[~~ASTM D 3034~~,]~~, Type PSM with a maximum SDR of 35, with flexible elastomeric seal joint or ASTM F 758, Type PS 46, or ~~[~~ASTM F 949~~,]~~ for corugated sewer pipe ~~[ASTM F 758, Type PS 46]~~.

~~2.1.11.3 Corrugated Polyethylene (PE) Pipe and Fittings~~

~~Use [ASTM F 405 for pipes 80 to 150 mm (3 to 6 inches) in diameter,~~

~~inclusive, ASTM F 667 for pipes 200 to 600 mm (8 to 24 inches) in diameter] [AASHTO M 252 for pipes 80 to 250 mm (3 to 10 inches), AASHTO M 294 for pipes 300 to 600 mm (12 to 24 inches) in diameter]. Fittings shall be manufacturer's standard type and shall conform to the indicated specification.~~

2.1.2.3 Pipe Perforations

Water inlet area shall be a minimum of 1,058.4 mm squared per linear meter ~~(0.5 square inch per linear foot).~~ Manufacturer's standard perforated pipe which essentially meets these requirements may be substituted with prior approval of the Contracting Officer.

a. Circular Perforations in Plastic Pipe: Circular holes shall be cleanly cut not more than 9.5 mm ~~(3/8 inch)~~ or less than 4.8 mm ~~(3/16 inch)~~ in diameter and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 76.2 mm ~~(3 inches)~~ center-to-center along rows. The rows shall be approximately 38.1 mm ~~(1-1/2 inches)~~ apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The rows shall be spaced over not more than 155 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.

b. Slotted Perforations in Plastic Pipe: Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots shall not exceed 3.2 mm ~~(1/8 inch)~~ nor be less than 0.8 mm ~~(1/32 inch)~~. The length of individual slots shall not exceed 31.75 mm ~~(1-1/4 inch)~~ on 80 mm ~~(3 inch)~~ diameter tubing, 10 percent of the tubing inside nominal circumference on 100 to 200 mm ~~(4 to 8 inch)~~ diameter tubing, and 63.5 mm ~~(2-1/2 inch)~~ on 250 mm ~~(10 inch)~~ diameter tubing. Rows of slots shall be symmetrically spaced so that they are fully contained in 2 quadrants of the pipe. Slots shall be centered in the valleys of the corrugations of profile wall pipe.

2.2 FILTER FABRIC

Filter fabric shall be a pervious sheet of polyester, nylon, or polypropylene filaments woven or otherwise formed into a uniform pattern with distinct and measurable openings. The filter fabric shall provide an equivalent opening size (AOS) no finer than the US Standard Sieve No. ~~[_____]~~70 and no coarser than the US Standard Sieve No. ~~[_____]~~100. AOS is defined as the number of the US Standard sieve having openings closest in size to the filter fabric openings. ~~[The percent open area provided shall not be less than [_____] percent and not more than [_____] percent. Percent open area is defined as the summation of open areas divided by the total area of the filter fabric and expressed as a percent.]~~ [The filaments shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, or vinylidene-chloride, and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure.~~]~~ The fabric shall have a minimum physical strength of ~~[_____]~~444.8 N per meter ~~([_____] pounds per inch)~~ in any direction when tested in accordance with ASTM D 5034 using the grab test method with 645.2 square mm ~~(1 square inch) jj~~jaws and a constant rate of travel of 304.8 mm

~~(12 inches)~~ per minute. Elongation at failure shall be between ~~[~~30~~]~~ ~~[_____]~~ and ~~[~~70~~]~~ ~~[_____]~~ percent. The fabric shall be constructed so that the filaments will retain their relative position with respect to each other. ~~[~~The edges of the fabric shall be selvaged or otherwise finished to prevent the outer material from pulling away from the fabric.~~]~~ ~~[The fabric shall be woven into a width that may be installed as shown without longitudinal seams.]~~

2.3 DRAINAGE STRUCTURES

2.3.1 Concrete

Except for precast concrete, reinforcement shall conform to the requirements for ~~[~~21~~]~~ ~~[_____]~~ MPa concrete in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. The concrete mixtures shall have air content, by volume of concrete, based on measurements made immediately after discharge from the mixer of ~~[~~5 to 7~~]~~ ~~[3 to 6]~~ percent when coarse-aggregate maximum size is 38.1 mm ~~(1-1/2 inches)~~ or smaller. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall be not less than 25.4 mm ~~(1 inch)~~ thick for covers and not less than 38.1 mm ~~(1-1/2 inches)~~ thick for walls and flooring. Concrete covering deposited directly against the ground shall be at least 76.2 mm ~~(3 inches)~~ thick between the steel and the ground. Expansion-joint filler material shall conform to ASTM D 1751 or ASTM D 1752. Exposed concrete surfaces, such as drainage structures that form a continuation of concrete curbs and gutters, shall be given a protective coating of linseed oil as specified in Section 02511 CONCRETE SIDEWALKS AND CURBS AND GUTTERS.

2.3.2 Mortar

Mortar for pipe joints and connections to other drainage structures shall be composed of one part by volume of portland cement and two parts of sand. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of injurious acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes from the time the ingredients are mixed with water.

2.3.3 Manholes and Appurtenances

2.3.3.1 Precast Reinforced Concrete Manhole Risers and Tops

Precast reinforced concrete manhole risers and tops shall conform to ASTM C 478.

~~2.3.3.2 Precast Concrete Segmental Blocks~~

~~Precast concrete segmental blocks shall conform to ASTM C 139 and shall be not more than 203.2 mm (8 inches) thick, not less than 203.2 mm (8 inches) long, and of such shape that the joints can be effectively sealed and bonded with cement mortar.~~

~~2.3.3.3 Precast Concrete Manhole Bases~~

~~If precast concrete manhole bases are used, the bases shall conform to ASTM C 478 and shall be of such a design as to effect suitable connection with influent and effluent lines and to provide a suitable base structure for riser sections.~~

~~2.3.3.4 Brick~~

~~Brick shall conform to ASTM C 62, Grade SW, or ASTM C 55, Grade S-I or S-II. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in the amount of not more than 25 percent by volume of cement.~~

~~2.3.3.5 Prefabricated Corrugated Metal~~

~~Steel manholes and risers shall be fabricated of at least [_____] gauge galvanized [and bituminous coated] corrugated metal.~~

~~2.3.3.6 Glass Fiber-Reinforced Polyester (FRP)~~

~~FRP manholes shall conform to ASTM D 3753.~~

~~2.3.3.7 Frames and Covers or Gratings~~

~~Frames and gratings, or frames and covers, except as otherwise permitted, shall be of either cast iron with tensile strength test not less than ASTM A 48 Class 25 or steel conforming to ASTM A 27/A 27M , Class 65-35. Weight, shape, and size shall be as indicated. Frames and covers not subjected to vehicular traffic or storage may be of malleable iron where indicated. The malleable-iron frames and covers shall conform to ASTM A 47 and shall be of the weight, shape, and size indicated.~~

~~2.3.3.8 Steel Ladder~~

~~A steel ladder shall be provided where the depth of a manhole exceeds 3.66 m (12 feet). The ladder will be not less than 400 mm (16 inches) in width, with 19.1 mm (3/4 inch) diameter rungs spaced 304.8 mm (12 inches) apart. The two stringers shall be a minimum 9.5 mm (3/8 inch) thick and 50.8 mm (2 inches) wide. Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 1.83 m (6 feet) apart vertically, and shall be so installed as to provide at least 152.4 mm (6 inches) of space between the wall and the rungs. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123. The wall along the line of the ladder shall be vertical for its entire length.~~

2.4 SUBDRAIN FILTER AND BEDDING MATERIAL

Subdrain filter and bedding material shall be washed sand, sand and gravel, crushed stone, crushed stone screenings, or slag composed of hard, tough, durable particles free from adherent coatings. Filter material shall not contain corrosive agents, organic matter, or soft, friable, thin, or elongated particles and shall be evenly graded between the limits specified in TABLE I. Gradation curves will exhibit no abrupt changes in slope denoting skip or gap grading. Filter materials shall be clean and free from soil and foreign materials. Filter blankets found to be dirty or otherwise contaminated shall be removed and replaced with material meeting the specific requirements, at no additional cost to the Government.

TABLE I. FILTER GRADATION

Sieve Designation	~~Percent by Weight Passing~~ ~~Gradation A~~	~~Gradation B~~	~~Gradation C~~ Percent by Weight Passing
38 mm (1-1/2 inch)			100
25.0 mm (1 inch)			95-100
12.5 mm (1/2 inch)			25-60
4.75 mm (No. 4)			0-10
75um (No. 200)			0-2

PART 3 EXECUTION

3.1 EXCAVATION AND BEDDING FOR SUBDRAIN SYSTEMS

Trenching and excavation, including the removal of rock and unstable material, shall be in accordance with Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Bedding material shall be placed in the trench as indicated or as required as replacement materials used in those areas where unstable materials were removed. Compaction of the bedding material shall be as specified for cohesionless material in Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.2 ~~MANHOLES AND~~ FLUSHING AND OBSERVATION RISERS

~~3.2.1 Manholes~~

~~Manholes shall be installed complete with frames and covers or gratings at the locations and within the limits and sizes indicated. Manholes shall be constructed of one of the materials specified for manholes in paragraph DRAINAGE STRUCTURES. Joints shall be completely filled and shall be smooth and free of surplus mortar or mastic on the inside of the structure. Brick manholes shall be plastered with 12.7 mm (1/2 inch) of mortar over the entire outside surface of the walls. Brick for square or rectangular structures shall be laid in stretcher courses with a header course every sixth course. Brick for round structures shall be laid radially with every sixth course laid as a stretcher course. Ladders shall be installed in manholes as indicated. Base for manholes shall be either precast or cast-in-place concrete.~~

3.2.1 Flushing and Observation Risers

Flushing and observation riser pipes with frames and covers shall be installed at the locations indicated. Risers shall be constructed of precast concrete~~, vitrified clay,~~ or ~~[~~galvanized~~] [bituminous coated]~~ corrugated metal pipe. Joining of riser pipes to the subdrain system shall be as indicated.

3.3 INSTALLATION OF FILTER FABRIC AND PIPE FOR SUBDRAINS

3.3.1 Installation of Filter Fabric

3.3.1.1 Overlaps on Perforated or Slotted Pipes

One layer of filter fabric shall be wrapped around perforated or slotted

collector pipes in such a manner that longitudinal overlaps of fabric are in unperforated or unslotted quadrants of the pipes. The overlap shall be at least 50 mm. The fabric shall be secured to the pipe in such a manner that backfill material will not infiltrate through any fabric overlaps.

3.3.1.2 Installation on Open-Joint Pipe

One layer of filter fabric shall be wrapped around open joints. The overlap should be at least 50 mm. The fabric shall be secured to the pipe in such a manner that backfill material will not infiltrate through the overlap or the edges of the fabric to either side of the open joint.

3.3.1.3 Trench Lining and Overlaps

Trenches to be lined with filter fabric shall be graded to obtain smooth side and bottom surfaces so that the fabric will not bridge cavities in the soil or be damaged by projecting rock. The fabric shall be laid flat but not stretched on the soil, and it shall be secured with anchor pins. Overlaps shall be at least ~~[_____]~~25 mm, and anchor pins shall be used along the overlaps.

3.3.2 Installation of Pipe for Subdrains

3.3.2.1 Pipelaying

Each pipe shall be carefully inspected before it is laid. Any defective or damaged pipe shall be rejected. No pipe shall be laid when the trench conditions or weather is unsuitable for such work. Water shall be removed from trenches by sump pumping or other approved methods. The pipe shall be laid to the grades and alignment as indicated. The pipe shall be bedded to the established gradeline. Perforations shall be centered on the bottom of the pipe. Pipes of either the bell-and-spigot type or the tongue-and-groove type shall be laid with the bell or groove ends upstream. All pipes in place shall be approved before backfilling.

3.3.2.2 Jointings

~~a. Nonperforated Concrete and Clay Pipe: Pipe shall be laid with 3.2 to 6.4 mm (1/8 to 1/4 inch) opening between the ends of the pipe or as required by spacing lugs constructed in the pipe. Mortar shall be placed in the joint at three points and pressed firmly into place to hold the pipe securely in line. The mortar shall be the full depth of the bell or groove and approximately 25.4 (1 inch) in width, and shall be located at the third points around the joint with the top point at the center of the pipe. The inside of the pipe shall be free of excess mortar.~~

~~b. Perforated Concrete and Clay Pipe: The pipe shall be laid with closed joints with positive provision for centering each section of the pipe in the bell or groove of the previously placed section. Plain-end perforated clay pipe sections shall be securely fastened together with spring wire clips furnished by the pipe manufacturer.~~

~~c. Perforated Corrugated Metal Pipe or Bituminous Coated, Perforated Corrugated Metal Pipe: The sections of perforated corrugated metal pipe or bituminous coated, perforated corrugated metal pipe shall be securely fastened together with standard connecting bands furnished by the manufacturer of the pipe.~~

~~d. Drain Tile: Drain tile shall be bedded as provided for bell-and-spigot or tongue-and-groove types of pipe and laid with open joints of approximately 3.2 mm (1/8 inch) width but not over 6.4 mm (1/4 inch) width. Drain tile shall be protected against the entrance of filter material into the line by the use of filter fabric.~~

~~e. Porous Concrete Pipe: Porous concrete pipe shall be installed with mortar joints.~~

~~f. Perforated Asbestos-Cement Pipe: Couplings shall be of the sleeve type suitable for holding the pipe firmly in alignment without the use of sealing compounds or gaskets. Tapered couplings will be acceptable.~~

~~g. Bituminous Coated or Uncoated Semicircular Steel Pipe: Coupling bands shall consist of an uncorrugated top and bottom section fabricated to fit around two adjacent pieces of pipe. Coupling bands shall be bolted together with four bolts.~~

~~h. Bituminous Coated or Uncoated Corrugated Aluminum Pipe: If aluminum pipe is to be connected to dissimilar metal, the connection shall be insulated by bituminous coating or other nonconductive material. Standard joints between corrugated aluminum pipe shall be securely fastened with standard connecting bands furnished by the manufacturer of the pipe.~~

~~i. Acrylonitrile-Butadiene-Styrene (ABS): Solvent cement or elastomeric joints for ABS pipe shall be in accordance with ASTM D 2751. Dimensions and tolerances shall be in accordance with TABLE II of ASTM D 2751.~~

~~j~~a. Polyvinyl Chloride (PVC) Pipe: Joints shall be in accordance with the requirements of ASTM D 3034, ASTM D 3212, or ASTM F 949.

~~k. Perforated Corrugated Polyethylene Pipe: Perforated corrugated polyethylene drainage pipe shall be installed in accordance with the manufacturer's specifications and as specified herein. A pipe with physical imperfections shall not be installed. No more than 5 percent stretch in a section will be permitted.~~

3.4 INSTALLATION OF AND BACKFILLING FOR BLIND OR FRENCH DRAINS

Filter material shall be placed as indicated and compacted as specified for cohesionless materials in Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Filter material shall extend to a suitable outlet or to an outlet through a pipeline as indicated. Overlying backfill material shall be placed and compacted as specified in Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.5 INSTALLATION OF FILTER MATERIAL AND BACKFILLING FOR SUBDRAINS

After pipe for subdrains has been laid, inspected, and approved, filter material shall be placed around and over the pipe to the depth indicated. The filter material shall be placed in layers not to exceed 200 mm thick, and each layer shall be ~~[saturated by flooding] [~~thoroughly compacted by mechanical tampers to obtain the required density. Compaction of filter material and the placement and compaction of overlying backfill material

shall be in accordance with the applicable provisions specified in Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.6 TESTS

3.6.1 Pipe Test

Strength tests of pipe shall conform to field service test requirements of the ~~Federal Specification,~~ ASTM specification~~, or AASHTO specification~~ covering the product (paragraph PIPE FOR SUBDRAINS).

~~3.6.2 JP-4 Fuel Resistance Test~~

~~Five unaged fabric samples, 97 to 107 mm by 147 to 157 mm shall be immersed in JP-4 fuel at room temperature for a period of 7 days. Each sample then shall be tested for tensile strength and elongation in accordance with ASTM D 5034. The strength of the fabric in any direction shall be no less than 85 percent of the strength specified in paragraph FILTER FABRIC.~~

-- End of Section --

SECTION 02714A

DRAINAGE LAYER
07/01

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 29/C 29M	(1997) Bulk Density ("Unit Weight") and Voids in Aggregate
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 D 5~~	~~(1997) Penetration of Bituminous Materials~~
ASTM D 75	(1987; R 1997) Sampling Aggregates
~~ASTM D 140~~	~~(2000) Sampling Bituminous Materials~~
~~ASTM D 946~~	~~(1982; R 1999) Penetration-Graded Asphalt Cement for Use in Pavement Construction~~
~~ASTM D 1250~~	~~(1980; R 1997el) Petroleum Measurement Tables~~
~~ASTM D 1856~~	~~(1995a) Recovery of Asphalt From Solution By Abson Method~~
~~ASTM D 2172~~	~~(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures~~
ASTM D 2487	(2000) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
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 3381~~	~~(1982; R 1999) Viscosity-Graded Asphalt Cement for Use in Pavement Construction~~
ASTM D 4791	(1999) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E 548	(1994el) General Criteria Used for Evaluating Laboratory Competence

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-03 Product Data

Waybills and Delivery Tickets; ~~[~~_____~~]~~ _, ~~[~~_____~~]~~RE

Certified waybills and delivery tickets for all aggregates materials actually used.

SD-06 Test Reports

Sampling and Testing; ~~[~~_____~~]~~G, ~~[~~_____~~]~~RE

Copies of field test results within 24 hours of completion of tests.

Approval of Materials; G, ~~[~~_____~~]~~EC-GD

Material sources and material test results prior to field use.

Evaluation; ~~[~~_____~~]~~G, ~~[~~_____~~]~~RE

Test section construction report.

1.2 ~~UNIT PRICES~~NOT USED

~~1.3.1 Waybills and Delivery Tickets~~

~~Copies of waybills and delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, the Contractor shall file certified waybills and certified delivery tickets for all aggregates, bituminous, and cementitious materials actually used.~~

~~1.3.2 Measurement~~

~~Deductions will be made for any material wasted, unused, rejected, or used~~

~~for the convenience of the Contractor.~~

~~1.3.2.1 Aggregate Drainage Layer Material~~

~~The quantity of aggregate drainage layer material completed and accepted shall be measured in cubic meters . The volume of aggregate drainage layer material in place and accepted shall be determined by the average job thickness obtained in accordance with paragraph THICKNESS CONTROL and the dimensions indicated.The choke stone shall be considered as part of the drainage layer thickness and shall not be measured separately.~~

~~1.3.2.2 Bituminous or Cement Stabilized Drainage Layer~~

~~The quantity of bituminous or cement stabilized drainage layer material completed and accepted shall be measured in metric tons , excluding the weight of the asphalt or portland cement used in the mix.~~

~~1.3.2.3 Bituminous Material~~

~~The quantity of asphalt cement used in the bituminous stabilized mix shall be measured by the number of liters of material used in the accepted work corrected to liters at 16 degrees C (60 degrees F) in accordance with ASTM D 1250.~~

~~1.3.2.4 Cementitious Material~~

~~The quantity of portland cement used in the cement stabilized mix shall be measured by the number of 50 kilogram units of cement used in the accepted work.~~

~~1.3.3 Payment~~

~~The quantities of drainage layer aggregates and bituminous or cementitious materials as specified above will be paid for at the contract unit prices, which will constitute full compensation for the construction and completion of the drainage layer, including the test section, and the furnishing of all other necessary labor and incidentals.~~

1.4 SYSTEM DESCRIPTION

The Contractor shall build a drainage layer under the pavements as indicated on drawings and the drainage layer shall consist of Rapid Draining Material (RDM.

1.3 FIELD COMPACTION

Field compaction requirements shall be based on the results of a test section constructed by the Contractor, using the materials, methods, and equipment proposed for use in the work. The test section shall meet the requirements of paragraph TEST SECTION.

1.4 EQUIPMENT

1.4.1 General Requirements

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times.

1.4.2 Placement Equipment

An asphalt paving machine shall be used to place drainage layer material. Alternate methods may be used if it can be demonstrated in the test section that these methods obtain the specified results.

1.4.3 Compaction Equipment

A dual or single smooth 10 ton (min.) vibratory drum roller which provides a maximum compactive effort without crushing the drainage layer aggregate shall be used to compact drainage layer material.

~~1.6.4 Bituminous Mixing Plant~~

~~The bituminous mixing plant shall be an automatic or semiautomatic controlled, commercially manufactured unit capable of producing a bituminous stabilized aggregate mixture consistent with the job-mix formula (JMF). Drum mixers shall be prequalified at the production rate to be used during full scale operations. The prequalification tests shall include extraction methods in accordance with ASTM D 2172 and recovery of the asphalt cement in accordance with ASTM D 1856. The penetration of the recovered asphalt binder shall not be less than 60 percent of the original penetration in accordance with ASTM D 5.~~

~~1.6.5 Cementitious Mixing Plant~~

~~The cementitious mixing plant shall be an automatic or semiautomatic controlled, commercially manufactured unit capable of producing a cement stabilized aggregate mixture consistent with the job mix formula determined by the Government. Aggregate and cement shall be dry mixed sufficiently to prevent cement balls from forming when water is added.~~

1.5 WEATHER LIMITATION

Drainage layer material shall be placed when the atmospheric temperature is above 2 degrees C . Areas of completed drainage layer or underlying courses that are damaged by freezing, rainfall, or other weather conditions or by contamination from sediments, dust, dirt, or foreign material shall be corrected by the Contractor to meet specified requirements.

1.6 SAMPLING AND TESTING

1.6.1 General Requirements

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 of his own, approval of such facilities shall be based on compliance with ASTM E 548, and no work requiring testing will 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. Drainage layer materials shall be tested to establish compliance with the specified requirements.

1.6.2 Sampling

Aggregate samples shall be taken in accordance with ASTM D 75. ~~Bituminous samples shall be taken in accordance with ASTM D 140. Bituminous or cement stabilized mixture samples shall be taken using methods approved by the Contracting Officer.~~

1.6.3 Test Methods

1.6.3.1 Sieve Analyses

Sieve analyses shall be made in accordance with ASTM C 117 and ASTM C 136.

1.6.3.2 Density Tests

Field density tests for RDM drainage layers shall be made in accordance with ASTM D 2922 by Direct Transmission Method for the full depth of the lift. When using this method, ASTM D 3017 shall be used to determine the moisture content of the aggregate drainage layer material. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph "Calibration" of ASTM D 2922, on each different type of material being tested at the beginning of a job and at intervals as directed by the Contracting Officer.

1.6.3.3 Soundness Test

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

1.6.3.4 Los Angeles Abrasion Test

Los Angeles abrasion tests shall be made in accordance with ASTM C 131.

1.6.3.5 Flat or Elongated Particles Tests

Flat and/or elongated particles tests shall be made in accordance with ASTM D 4791.

1.6.3.6 Fractured Faces Tests

When aggregates are supplied from crushed gravel, approved test methods shall be used to assure the aggregate meets the requirements for fractured faces in paragraph AGGREGATES.

~~1.8.3.7 Bitumen Extraction~~

~~Bitumen extraction tests shall be made in accordance with ASTM D 2172.~~

1.6.4 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis including 0.02 mm size material.

b. Flat and/or elongated particles

c. Fractured Faces

d. Los Angeles abrasion.

e. Soundness.

1.6.5 Testing Frequency

1.6.5.1 Aggregate Drainage Layer

Field density and moisture content tests shall be performed at a rate of at least one test for every ~~20200~~500 square meters or fraction thereof for each ~~turning pad and other areas as shown, of~~ completed area and not less than one test for each day's production. Sieve analyses shall be performed at a rate of at least one test for every ~~[200~~1000 square meters or fraction thereof, of completed area or fraction thereof. Soundness tests, Los Angeles abrasion tests, fractured faces tests and flat and/or elongated particles tests shall be performed at the rate of one test for every ~~12,0300 square meters~~2,000 or fraction thereof, of production.

~~1.8.5.2 Stabilized Layer~~

~~Sieve analyses shall be performed on aggregates prior to addition of asphalt or portland cement, at a rate of at least one test for every [6000] [_____] square meters of completed area and not less than one test for each days production. Extraction tests on bituminous stabilized material shall be made at the same frequency. Soundness tests, Los Angeles abrasion tests, fractured faces tests, and flat and/or elongated particles tests shall be performed at the rate of one test for every 12,000 square meters of production.~~

1.6.6 Approval of Materials

1.6.6.1 Aggregate

The aggregate source shall be selected at least ~~[60] [_____]~~ days prior to field use in the test section. Tentative approval of the source will be based on certified test results to verify that materials proposed for use meet the contract requirements. Final approval of both the source and the material will be based on test section performance and tests for gradation, soundness, Los Angeles abrasion, flat and/or elongated particles tests and fractured faces tests. For aggregate drainage layer materials, these tests shall be performed on samples taken from the completed and compacted drainage layer course within the test section. ~~For bituminous or cement stabilized drainage layer material, these tests shall be performed on aggregate samples taken prior to addition of bituminous or cementitious material and subsequent placement in the test section.~~

~~1.8.6.2 Bituminous or Cementitious Materials~~

~~Bituminous or cementitious sources and certified material test results shall be submitted for approval not less than [60] [_____] days prior to field use in the test section.~~

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregates shall consist of clean, sound, hard, durable, angular particles of crushed stone, or crushed gravel which meet the specification requirements. The aggregates shall be free of silt, ~~and~~ clay, and shale as defined by ASTM D 2487, vegetable matter, and other objectionable materials or coatings.

2.1.1 Aggregate Quality

The aggregate shall have a soundness loss not greater than 18 percent weighted average at 5 cycles when tested in magnesium sulfate in accordance with ASTM C 88. The aggregate shall have a percentage of loss on abrasion not to exceed 40 after 500 revolutions as determined by ASTM C 131. The percentage of flat and/or elongated particles shall be determined by ASTM D 4791 with the following modifications. The aggregates shall be separated into 2 size fractions. Particles greater than 12.5 mm sieve and particles passing the 12.5 mm sieve and retained on the 4.75 mm sieve. The percentage of flat and/or elongated particles in either fraction shall not exceed 20. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. When the aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements. When the aggregate is supplied from crushed gravel it shall be manufactured from gravel particles, 90 percent of which by weight are retained on the maximum-size sieve listed in TABLE I. In the portion retained on each sieve specified, the crushed gravel 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 face. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as 2 fractured faces.

2.1.2 Gradation Requirements

Drainage layer aggregates shall be well graded within the limits specified in TABLE I.

TABLE I. GRADATION OF DRAINAGE LAYER MATERIAL

Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	Rapid draining Material (RDM)
37.50 mm	100
25.00 mm	70-100
19.00 mm	55-100
12.50 mm	40-80
9.50 mm	30-65
4.75 mm	10-50
2.36 mm	0-25
1.18 mm	0-5

NOTE 1: The values are based on aggregates of uniform specific gravity, and the percentages passing the various sieves may require appropriate correction by the Contracting Officer when aggregates of varying specific gravities are used.

NOTE 2: For RDM, the coefficient of uniformity (CU) shall be greater than 3.5. (CU = D60/D10). The contractor is responsible for adjusting the RDM gradation within the ranges listed in Table I to provide a stable construction surface for the proposed equipment and method of transporting materials.

~~2.1 GOVERNMENT APPROVAL~~

~~Asphalt or cement stabilized material will require Government notification and delivery of approved materials in accordance with paragraph BITUMINOUS OR CEMENT STABILIZED JOB-MIX FORMULA.~~

~~2.3 BITUMINOUS MATERIALS~~

~~Asphalt cement to be mixed with aggregates shall conform to [ASTM D 946 Penetration Grade [____]] [ASTM D 3381 viscosity Grade AASHTO MP 1PG [____]]. In addition, the asphalt cement shall show a negative spot when subjected to the spot test in accordance with AASHTO T 102, using the standard naphtha specified.~~

~~2.4 CEMENTITIOUS MATERIALS~~

~~Portland cement to be mixed with aggregates shall conform to [ASTM C 150, Type I, IA, II or IIA] [ASTM C 595M , Type IS or IS (A)].~~

~~2.5 BITUMINOUS OR CEMENT STABILIZED JOB-MIX FORMULA~~

~~The bituminous stabilized mix shall consist of a mixture of OGM and a minimum of 2 percent asphalt cement by weight. Tolerances for bituminous stabilized material shall be maintained for field production at plus or minus 0.25 percent for asphalt cement and plus or minus 14 degrees C for mixing temperatures. The cement stabilized mix shall consist of OGM and a minimum of 90 kg of portland cement per cubic meter with a water/cement ratio of 0.37. Based on the test section performance, the Contractor shall be responsible for adjustments (increases) in asphalt cement or portland cement quantities to ensure the stabilized drainage layer will not rut or be disturbed by the Contractor's proposed paving method. The Contractor shall submit a job-mix formula (JMF) with the test section report for Contracting Officer approval.~~PART 3 EXECUTION

3.1 STOCKPILING AGGREGATES

Aggregates shall be stockpiled at locations designated by the Contracting Officer. Stockpile areas shall be cleared and leveled prior to stockpiling aggregates. Aggregates shall be stockpiled to prevent segregation and contamination. Aggregates obtained from different sources shall be stockpiled separately.

3.2 TEST SECTION

3.2.1 Data

A test section shall be constructed to evaluate the ability to carry traffic, including placement of overlaying material and the constructability of the drainage layer including required mixing, placement, and compaction procedures. Test section data will be used by the Contracting Officer to validate the required number of compaction passes given in paragraph Compaction Requirements and the field dry density

requirements for full scale production.

3.2.2 Scheduling

The test section shall be constructed a minimum of ~~[~~30~~]~~ ~~[_____]~~ days prior to the start of full scale production to provide sufficient time for an evaluation of the proposed materials, equipment and procedures including Government QA testing.

3.2.3 Location and Size

The test section shall be placed ~~[~~inside the production paving limits ~~][outside production paving limits in an area with similar subgrade and subbase conditions approved by the Contracting Officer]~~. The underlying courses and subgrade preparation, required for the pavement section, shall be completed, inspected and approved in the test section prior to constructing the drainage layer. The test section shall be a minimum of ~~[~~30 ~~] [_____]~~ m long and two full paving lanes wide side by side.

3.2.4 Initial Testing

Certified test results, to verify that the materials proposed for use in the test section meet the contract requirements, shall be provided by the Contractor and approved by the Contracting Officer prior to the start of the test section.

3.2.5 Mixing, Placement, and Compaction

Mixing, placement, and compaction shall be accomplished using equipment meeting the requirements of paragraph EQUIPMENT. Compaction equipment speed shall be no greater than 2.4 km/hour. Compaction shall start from the outside edges of the paving lane and proceed to the centerline of the lift being placed. The roller shall stay a minimum of one half the roller width from the outside edge of the drainage layer being placed until the desired density is obtained. The outside edge shall then be rolled.

3.2.6 Procedure

3.2.6 RDM Aggregate Drainage Layer Tests

The test section shall be constructed with aggregate in a wet state so as to establish a correlation between number of roller passes and dry density achievable during field production. Three separate areas within the test section shall be designated, each area shall be tested for density, moisture, and gradation. All testing shall be completed in the middle third of the test section being placed. Density and moisture content tests shall be conducted in accordance with ASTM D 2922 and ASTM D 3017. Sieve analysis tests shall be conducted on samples, taken adjacent to the density test locations. One set of tests (i.e. density, moisture, and sieve analysis) shall be taken before the third compaction pass and after each subsequent compaction pass at three separate locations as directed by the Contracting Officer. A pass shall be considered the movement of a roller over the drainage layer area for one direction only. Compaction for the RDM shall consist of a maximum of 5 passes in the vibrating state and one final pass in the static state. Compaction passes and density readings shall continue until the difference between the average dry densities of any two consecutive passes is less than or equal to 16 kg per cubic meter.

~~3.2.6.2 Bituminous/Cement Stabilized Drainage Layer~~

~~The test section shall be constructed with the same equipment used for production. Three separate areas within the test section shall be designated for sampling. All testing shall be completed in the middle third of the test section being placed. Visual examination of each sample shall be made by the contracting officer to determine if and when crushing of aggregate occurs. One sample shall be taken by the contractor before compaction and after each subsequent compaction pass at three separate locations as directed by the Contracting Officer. Compaction shall continue for a maximum of 6 passes. A pass shall be considered the movement of a roller over the drainage layer area for one direction only. Placement procedures and equipment shall be as described herein. The contracting officer shall determine the number of passes required for compaction from the test section.~~

~~3.2.6.3 OGM with Choke Stone~~

~~The test section shall be constructed with aggregate in a moist state. When the OGM gradation is used, density testing shall not be required, only gradation testing shall be required. Three separate areas within the test section shall be designated for sampling. All testing shall be completed in the middle third of the test section being placed. The maximum number of passes per lift shall be 8. A pass shall be considered the movement of a roller over the drainage layer area for one direction only. Placement procedures and equipment shall be as described herein. Sieve analysis tests shall be conducted on samples. One set of sieve tests shall be taken before the third compaction pass and after each subsequent compaction pass at three separate locations as directed by the Contracting Officer. Compaction for the OGM shall consist of first 5 passes in the vibrating state and one final pass in the static state. The contracting officer shall determine the number of passes required for production from the results of the test section. If choke stone is used to stabilize the surface of OGM, the choke stone shall be placed after final static compaction of the OGM. The choke stone shall be spread in a thin layer no thicker than 13 mm and worked into the surface of the OGM using two additional passes of a vibratory roller and wetting. Sieve testing is not required after the compaction of the choke stone.~~

3.2.7 Evaluation

Within 10 days of completion of the test section, the Contractor shall submit to the Contracting Officer a Test Section Construction Report complete with all required test data and correlations. The Contracting Officer will evaluate the data and validate the required number of passes of the roller, the need for a final static pass of the roller, and provide the dry density for field density control during construction.

3.3 PREPARATION OF UNDERLYING COURSE

Prior to constructing the drainage layer, the underlying course shall be cleaned of all foreign materials. During construction, the underlying course shall contain no frozen material. The underlying course shall conform to Section 02721 SUBBASE COURSES. Ruts or soft yielding spots in the underlying courses 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 specified density. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in

a satisfactory condition until the drainage layer is placed.

3.4 TRANSPORTING MATERIAL

3.4.1 Aggregate Drainage Layer Material

Aggregate drainage layer material shall be transported to the site in a manner which prevents segregation and contamination of materials.

~~3.4.2 Bituminous Stabilized Material~~

~~Bituminous stabilized material shall be transported from the mixing plant to the site in trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of the stabilized material to the truck beds. Excessive releasing agent shall be drained prior to loading. Each load shall be covered with canvas or other approved material of ample size to protect the stabilized material from the weather and to prevent loss of heat. Loads that have crusts of cold, unworkable material or have become wet will be rejected. Hauling over freshly placed material will not be permitted.~~

~~3.4.3 Cement Stabilized Material~~

~~Cement stabilized material shall be transported from the mixing plant to the site in trucks equipped with protective covers. Loads that have crusts of unworkable material or have become excessively wet will be rejected. Hauling over freshly placed material will not be permitted.~~

3.5 PLACING

3.5.1 General Requisites

Drainage layer material shall be placed on the underlying course in lifts of uniform thickness using equipment meeting the requirements of paragraph EQUIPMENT. When a compacted layer 150 mm or less in thickness is required, the material shall be placed in a single lift. When a compacted layer in excess of 150 mm is required, the material shall be placed in lifts of equal thickness. No lift shall exceed 150 mm or be less than 75 mm when compacted. The lifts when compacted after placement shall be true to the grades or levels required with the least possible surface disturbance. Where the drainage layer is placed in more than one lift, the previously constructed lift shall be cleaned of loose and foreign material. Such adjustments in placing procedures or equipment shall be made to obtain true grades and minimize segregation and degradation of the drainage layer material. ~~Choke stone used to stabilize the surface of the OGM shall be spread in a thin layer no thicker than 13 mm. The OGM shall be brought to grade and the choke stone placed and rolled as described in paragraph; TEST SECTION.~~

3.5.2 ~~Placement of Stabilized Material~~NOT USED

~~Bituminous stabilized material having temperatures less than 80 degrees C when dumped into the asphalt paving machine will be rejected. The paving machine shall be adjusted so that the surface of the lift being laid will be smooth and continuous without tears and pulls. Irregularities in alignment of the lift left by the paving machine shall be corrected by~~

~~trimming directly behind the machine. Immediately after trimming, the edges of the lift shall be thoroughly compacted by a method approved by the Contracting Officer. Distortion of the lift during tamping will not be permitted. If more than one lift is required, the longitudinal joint in one lift shall offset that in the lift immediately below by at least 300 mm; however, the joint in the top layer shall be at the centerline of the pavement. Transverse joints in one layer shall be offset by at least 600 mm from transverse joints in the previous layer. Transverse joints in adjacent strips shall be offset a minimum of 3 meters.At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed.~~

3.5.3 ~~Placing Adjacent Stabilized Strips~~NOT USED

~~The stabilized material shall be placed in consecutive adjacent strips having a minimum width of 3 meters, except where edge lanes require strips less than 3 meters to complete the area. In placing adjacent strips, the screed of the paving machine shall overlap the previously placed strip 75 to 100 mm and shall be sufficiently high so that compaction will produce a smooth, dense joint. The stabilized material placed on the edge of the previously placed strip by the paver shall be pushed back to the edge of the strip being placed. Excess stabilized material shall be removed and wasted.~~

3.5.4 Hand Spreading

In areas where machine spreading is impractical, drainage layer material shall be spread by hand. The material shall be spread uniformly in a loose layer to prevent segregation. The material shall conform to the required grade and thickness after compaction.

3.6 COMPACTION REQUIREMENTS

Compaction shall be accomplished using rollers meeting the requirements of paragraph EQUIPMENT and operating at a rolling speed of no greater than 2.4 km per hour. Each lift of drainage material, including shoulders when specified under the shoulders, shall be compacted with the number of passes of the roller as follows: RDM material shall use 4 passes in the vibratory state and one in the static. ~~Cement or Bituminous stabilized OGM material shall use 3 passes in the vibratory state and one in the static state. OGM stabilized with choke stone shall use 4 passes in the vibratory state on OGM and 2 additional roller passes on the choke stone in the vibratory state with wetting.~~The Contracting Officer will validate the number of roller passes after the test section is evaluated and before production starts. In addition, a minimum field dry density, as specified by the Contracting Officer, shall be maintained. If the required field dry density is not obtained, the number of roller passes shall be adjusted in accordance with paragraph DEFICIENCIES. Aggregate shall be compacted in a moisture state as determined in the test section. Excessive rolling resulting in crushing of aggregate particles shall be avoided. ~~Choke stone used to stabilize the surface of the OGM shall be worked into the surface of the OGM by two passes of a vibratory roller and wetting. Compaction of bituminous stabilized material shall begin immediately when the material has cooled to 77 degrees C. Not more than 30 minutes shall elapse between the start of moist mixing of cement stabilized material and the start of field compaction and field compaction shall be completed within 60 minutes.~~ —In all places not accessible to the rollers, the drainage layer material shall be compacted with mechanical hand operated tampers.

3.7 FINISHING

The top surface of the drainage layer shall be finished after final compaction as determined from the test section. Adjustments in rolling and finishing procedures shall be made to obtain grades and minimize segregation and degradation of the drainage layer material.

~~3.8 CURING OF CEMENT STABILIZED MATERIAL~~

~~The completed cement stabilized drainage layer shall be cured with water for a period of 12 hours following completion of compaction. Curing operations shall commence within 3 hours after compaction. Curing shall consist of one of the following: 1) Sprinkling the surface of the drainage layer with a fine spray of water every 2 hours for the required 12 hour period, 2) by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap, 3)Impervious sheet curing.Curing water shall be applied so that the cement paste on the surface of the mixture will not be eroded. Water trucks will not be permitted on the completed cement stabilized drainage layer. Impervious sheeting curing shall consist of all surfaces being thoroughly wetted and then completely covered with the sheeting. Sheeting shall be at least 450 mm wider than the stabilized drainage layer 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 to prevent displacement so that it remains in contact with the surface 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 of holes appear during the curing period~~

3.8 EDGES OF DRAINAGE LAYER

Shoulder material shall be placed along the edges of the drainage layer course in a quantity that will compact to the thickness of the layer being constructed. At least 10.3 m width of the shoulder shall be rolled and compacted simultaneously with the rolling and compacting of each lift of the drainage layer.

3.8 SMOOTHNESS TEST

The surface of the top lift shall not deviate more than 10 mm ~~(3/8 inch)~~ when tested with either a ~~3.05 m (10 foot) or~~ 3.66 m ~~(12 foot)~~ straightedge applied parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding 10 mm shall be corrected in accordance with paragraph DEFICIENCIES.

3.9 THICKNESS CONTROL

The completed thickness of the drainage layer shall be within 13 mm of the thickness indicated. Thickness shall be measured at intervals providing at least one measurement for each 500 square meters of drainage layer. Measurements shall be made in test holes at least 75 mm in diameter~~ unless the contractor can demonstrate, for COR approval, that a steel rod pushed through the drainage layer clearly stops at the material interface~~. Where the measured thickness is more than 13 mm deficient, such areas shall be corrected in accordance with paragraph DEFICIENCIES. Where the measured thickness is 13 mm more than indicated, it will be considered as conforming to the requirements plus 13 mm, provided the surface of the drainage layer is within 13 mm of established grade. The average job

thickness shall be the average of all job measurements as specified above but within 8 mm of the thickness shown on the drawings.

3.10 DEFICIENCIES

3.10.1 Grade and Thickness

Deficiencies in grade and thickness shall be corrected so that both grade and thickness tolerances are met. Thin layers of material shall not be added to the top surface of the drainage layer to meet grade or increase thickness. If the elevation of the top of the drainage layer is more than 13 mm above the plan grade it shall be trimmed to grade and finished in accordance with paragraph FINISHING. If the elevation of the top surface of the drainage layer is 13 mm or more below the required grade, the surface of the drainage layer shall be scarified to a depth of at least 75 mm, new material shall be added, and the layer shall be blended and recompacted to bring it to grade. Where the measured thickness of the drainage layer is more than 13 mm deficient, such areas shall be corrected by excavating to the required depth and replaced with new material to obtain a compacted lift thickness of at least 75 mm. The depth of required excavation shall be controlled to keep the final surface elevation within grade requirements and to preserve layer thicknesses of materials below the drainage layer.

3.10.2 Density

Density shall be considered deficient if the field dry density test results are below the dry density specified by the Contracting Officer. If the densities are deficient, the layer shall be rolled with 2 additional passes of the specified roller. If the dry density is still deficient, work will be stopped until the cause of the low dry densities can be determined and reported to the Contracting Officer.

3.10.3 Smoothness

Deficiencies in smoothness shall be corrected as if they are deficiencies in grade or thickness. All tolerances for grade and thickness shall be maintained while correcting smoothness deficiencies.

-- End of Section --

SECTION 02721A

SUBBASE COURSES
03/97

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 T 180	(1997) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop

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	(1996) 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	(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 2487	(1998) Classification of Soils for

	Engineering Purposes (Unified Soil Classification System)
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 4318	(1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

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-03 Product Data

Equipment

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

Waybills and Delivery Tickets; ~~[_____]~~ _, ~~[_____]~~RE

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all aggregates actually used.

SD-06 Test Reports

Sampling and Testing; ~~[_____]~~G, ~~[_____]~~RE

Copies of ~~initial and~~ in-place test results, testing during construction.

Sampling and Testing; G, EC-GD

Copies of material test reports for approval of source and material for use in the work, submit at least 30 days prior to use in the work.

1.3 [Enter Appropriate Subpart Title Here]~~1.3 UNIT PRICES~~

~~1.3.1 Measurement~~

~~1.3.1.1 Area~~

~~The quantity of [subbase] [and] [select-material subbase] course completed and accepted as determined by the Contracting Officer shall be measured in~~

~~square meters.~~

~~1.3.1.2 Volume~~

~~The quantity of [subbase] [and] [select-material subbase] course completed and accepted as determined by the Contracting Officer will be measured in cubic meters. The volume of material in-place and accepted will be determined by the average job thickness obtained in accordance with paragraph THICKNESS CONTROL and the dimensions shown.~~

~~1.3.1.3 Weight~~

~~The tonnage of [subbase] [and] [select-material subbase] course material shall be the number of metric tons of aggregate, [placed and accepted in the completed course] [placed in authorized stockpiles] as determined by the Contracting Officer. Deductions will be made for any material wasted, unused, rejected, or used for convenience of the Contractor, and for water exceeding specified amount at time of weighing.~~

~~1.3.2 Payment~~

~~1.3.2.1 Course Material~~

~~Quantities of [subbase] [and] [select-material subbase] course, determined as specified in paragraph Measurement, will be paid for at the respective contract unit prices, which shall constitute full compensation for the construction and completion of the [subbase] [and] [select-material subbase] course.~~

~~1.3.2.2 Stabilization~~

~~Cohesionless subgrades or select subbase courses to be stabilized, as specified in paragraph PREPARATION OF UNDERLYING MATERIAL, will be paid as a special item on the tonnage basis including extra manipulation as required.~~

~~1.3.3 Waybills and Delivery Tickets~~

~~Copies of waybills and delivery tickets shall be submitted during the progress of the work. Before the final statement is allowed, the Contractor shall file certified waybills and certified delivery tickets for all aggregates actually 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~~]~~, or ~~[~~AASHTO T 180, Method D~~]~~. In this specification, degree of compaction shall be a percentage of laboratory maximum density.

1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved testing laboratory in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Tests shall be performed at the specified frequency. No work requiring testing will be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements.

1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.4.2 Tests

1.4.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with ~~[~~ASTM C 117 and ASTM C 136~~]~~ ~~[~~ and~~]~~ ~~[~~ASTM D 422~~]~~. Sieves shall conform to ASTM E 11.

1.4.2.2 Liquid Limit and Plasticity Index

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

1.4.2.3 Moisture-Density Determinations

The maximum density and optimum moisture shall be determined in accordance with ~~[~~ASTM D 1557~~]~~ or ~~[~~AASHTO T 180, Method D~~]~~. (ASTM D 1557 will be used for maximum density determinations if the anticipated material gradation would contain less than 30% retained on the 3/4 inch sieve. AASHTO T 180, Method D will be used for the maximum density determinations if the anticipated material gradation would contain more than 30% retained on the 3/4 inch sieve.)

1.4.2.4 Density Tests

Density shall be field measured in accordance with ~~[~~ASTM D 1556~~.~~ (the~~The~~ base plate, as shown in the drawing shall be used~~.]~~), ~~[~~ASTM D 2167~~.]~~, or ~~[~~ ASTM D 2922. The calibration curves shall be checked and adjusted, using 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. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration, in ASTM D 2922, on each different type of material to be tested at the beginning of a job and at intervals as directed.~~]~~

1.4.2.5 Soundness Test

Soundness tests shall be accomplished on subbase course material in accordance with ASTM C 88.

1.4.2.6 Wear Test

Wear tests shall be made on subbase course material in conformance with ASTM C 131.

1.4.3 Testing Frequency

1.4.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed

material meets all specified requirements prior to installation.

a. Sieve Analysis ~~[~~including~~] [not including]~~ (0.02 mm) size material
b. Liquid limit and plasticity index moisture-density relationship
c. ~~[~~Wear~~]~~
d. ~~[_____]~~Soundness~~.~~

1.4.3.2 In-Place Tests

One of each of the following tests shall be performed on samples taken from the placed and compacted ~~[~~subbase~~] [and] [select-material subbase]~~ course. Samples shall be taken for each ~~[_____]~~500 square meters of each layer of material placed in each area.

a. Sieve Analysis ~~[~~including~~] [not including]~~ (0.02 mm) size material
b. Field Density
c. Moisture liquid limit and plasticity index

1.4.4 Approval of Material

The source of the material shall be selected ~~[_____] days~~ prior to the time the material will be required in the work. No material shall be used in the work until results of the material testing has been reviewed and approved. 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 subbase course.

1.5 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 2 degrees C. When the temperature falls below 2 degrees C, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

1.6 EQUIPMENT

All plant, equipment, and tools used in the performance of the work will be subject to approval 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, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Subbase Course

Aggregates shall consist of crushed stone or ~~slag,~~ gravel, ~~shell~~screenings, sand, or other sound, durable, approved materials processed and blended or naturally combined. Aggregates shall be durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. Material retained on the 4.75 mm sieve shall have a percentage of wear not to exceed ~~50~~40 percent after 500 revolutions when tested as specified in ASTM C 131, and have a loss not greater than 18 percent weighted average at 5 cycles when tested for soundness in magnesium sulfate in accordance with ASTM C 88. The percent of flat and/or

elongated particles shall not exceed 20 in the fraction retained on the 12.5 mm sieve and in the fraction passing the 12.5 mm sieve. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the requirements set forth herein. In the portion retained on each sieve specified, the crushed gravel 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 face. When 2 fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as 2 fractured faces. Aggregate shall be reasonably uniform in density and quality. The specified gradation requirements shall apply to the completed subbase course. The aggregates shall have a maximum size of ~~50 mm~~ and shall be continuously well graded within the limits specified ~~in TABLE 1~~as follows. Sieves shall conform to ASTM E 11. ~~Aggregates shall have a maximum size of [_____] mm and shall be within the limits specified as follows:~~

Maximum Allowable Percentage by Weight
Passing Square-Mesh Sieve

Sieve Designation	No. 1	~~No. 2~~	~~No. 3~~	~~No.4~~
2 mm	50	~~80~~	~~--~~	~~85~~
0.075 mm	15	~~15~~	~~15~~	~~15~~

~~[~~Particles having diameters less than 0.02 mm shall not be in excess of 3 percent by weight of the total sample tested as determined in accordance with ASTM D 422.~~]~~ The portion of any blended component and of the completed course passing the 0.425 mm shall be either nonplastic or shall have a liquid limit not greater than 25 and a plasticity index not greater than 5.~~2.1.2 Select-Material Subbase Course~~

~~Materials shall consist of selected soil or other materials from field excavation, stockpiles, or other sources. Material shall be free from lumps and balls of clay and from organic and other objectionable matter. Not more than 25 percent by weight shall pass the 0.075 mm sieve. The portion of material passing the 0.425 mm sieve shall have a liquid limit less than 35 and a plasticity index less than 12. The maximum particle size shall not exceed 75 mm.[Particles having diameters less than 0.02 millimeter shall not be in excess of 3 percent by weight of the total sample tested as determined in accordance with ASTM D 422.]~~

PART 3 EXECUTION

3.1 STOCKPILING MATERIAL

Prior to stockpiling of material, 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 on the cleared and leveled areas designated by the Contracting Officer so as to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.2 PREPARATION OF UNDERLYING MATERIAL

Prior to constructing the ~~[~~subbase~~] [or] [select-material subbase]~~ course, the underlying course or subgrade shall be cleaned of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. Ruts, or soft yielding spots, in the underlying courses, subgrade areas having inadequate compaction, and deviations of the surface from the specified requirements, shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. ~~[~~For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the subbase course. Stabilization shall be accomplished by mixing subbase-course material into the underlying course, and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements for the underlying course.~~]~~ The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the subbase course is placed.

3.3 GRADE CONTROL

The finished and completed subbase course shall conform to the lines, grades, and cross sections shown. The lines, grades, and cross sections shown shall be maintained by means of line and grade stakes placed by the Contractor at the work site.

3.4 MIXING AND PLACING MATERIALS

The materials shall be mixed and placed to obtain uniformity of the ~~[~~subbase ~~] [and] [select-material subbase]~~ material at the water content specified. The Contractor shall make such adjustments in mixing or placing procedures or in equipment as may be directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory subbase course.

3.5 LAYER THICKNESS

The compacted thickness of the completed course shall be as indicated. When a compacted layer of 150 mm 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.

3.6 COMPACTION

Each layer of the ~~[~~subbase course~~] [and] [select-material subbase]~~ shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus ~~[_____]~~2 percent of optimum water content, as determined from laboratory tests, as specified in paragraph SAMPLING AND TESTING. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer is compacted through the full depth to at least ~~[_____]~~100 percent of laboratory maximum density. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase

water content, and to ensure a satisfactory subbase course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

~~3.8 PROOF ROLLING~~

~~Areas designated on the drawings to be proof rolled shall receive an application of 30 coverages with a heavy pneumatic-tired roller having four or more tires abreast, each tire loaded to a minimum of 13.6 metric tons and inflated to a minimum of 1.035 MPa. A coverage is defined as the application of one tire print over the designated area. In the areas designated, proof rolling shall be applied to the top layer of the subbase course. Water content of the top layer of the subbase course shall be maintained such that the water content is within plus or minus [_____] percent of optimum water content, as determined from laboratory tests, as specified in paragraph SAMPLING AND TESTING. Any material in the subbase courses or underlying materials indicated to be unsatisfactory by the proof rolling shall be removed, dried, and recompacted, or removed and replaced with satisfactory materials.~~

3.7 EDGES

Approved material shall be placed along the edges of the ~~[~~subbase~~] [and] [select-material subbase]~~ course in such quantity as will compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, at least a 300 mm width of the shoulder shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the subbase course, as directed.

3.8 SMOOTHNESS TEST

The surface of each layer shall not show deviations in excess of 10 mm when tested with a 3.6 m ~~(12 foot)~~ straightedge applied parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding this amount shall be corrected by removing material, replacing with new material, or reworking existing material and compacting, as directed.

3.9 THICKNESS CONTROL

The completed thickness of the ~~[~~subbase~~] [and] [select-material subbase]~~ course shall be in accordance with the thickness and grade indicated on the drawings. The thickness of each course shall be measured at intervals providing at least one measurement for each 400 square meters or part thereof of subbase course. The thickness measurement shall be made by test holes, at least 75 mm in diameter through the course. The completed subbase course shall not be more than 13 mm deficient in thickness nor more than 13 mm above or below the established grade. Where any of these tolerances are exceeded, the Contractor shall correct such areas by scarifying, adding new material of proper gradation or removing material, and compacting, as directed. Where the measured thickness is 13 mm or more thicker than shown, the course will be considered as conforming with the specified thickness requirements plus 13 mm. The average job thickness shall be the average of the job measurements as specified above but within 6 mm of the thickness shown.

3.10 MAINTENANCE

The ~~[~~subbase~~] [and] [select-material subbase]~~ course shall be maintained in a satisfactory condition until accepted. The subbase course shall be protected from changes in moisture content. The Contractor shall maintain the moisture content of the subbase course until the next overlying course of material is placed.

-- End of Section --

SECTION 02722A

~~AGGREGATE AND/OR~~ GRADED-CRUSHED AGGREGATE BASE COURSE
05/01

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 T 180	(1997) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457 mm (18-in) Drop
AASHTO T 224	(1996) Correction for Coarse Particles in the Soil Compaction Test

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 127	(1988; R 1993el) Specific Gravity and Absorption of Course Aggregate
ASTM C 128	(1997) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1556	(2000) 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 2487	(2000) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
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 4318	(2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Graded-crushed Aggregate Base Course

Graded-crushed aggregate (GCA) base course is well graded, crushed, durable aggregate uniformly moistened and mechanically stabilized by compaction. ~~GCA is similar to ABC, but it has more stringent requirements and it produces a base course with higher strength and stability.~~

1.2.2 Degree of Compaction

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 or AASHTO T 180, Method D and corrected with AASHTO T 224~~]~~.

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

Plant, Equipment, and Tools; ~~[~~_____~~]~~ __, ~~[~~_____~~]~~RE

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

Waybills and Delivery Tickets; ~~[~~_____~~]~~ _, ~~[~~_____~~]~~RE

Copies of waybills and delivery tickets during the progress of the work. Before the final statement is allowed, the Contractor shall file certified waybills and certified delivery tickets for all aggregates actually used.

SD-06 Test Reports

Sampling and testing; ~~[_____]~~G, ~~[_____]~~EC-GD

Certified copies of initial material test results for approval of source and material not less than 30 days before material is required for the work.

Field Density Tests; ~~[_____]~~G, ~~[_____]~~RE

Calibration curves and related test results prior to using the device or equipment being calibrated. Certified copies of initial material test results for approval not less than 30 days before material is required for the work. Copies of field test results within ~~[~~24~~]~~ ~~[_____]~~ hours after the tests are performed. ~~Certified copies of test results for approval not less than [30] [_____] days before material is required for the work.~~

1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by a testing laboratory approved in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements; testing shall be performed at the specified frequency. The Contracting Officer may specify the time and location of the tests. Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of the tests.

1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.4.2 Tests

The following tests shall be performed in conformance with the applicable standards listed.

1.4.2.1 Sieve Analysis

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

1.4.2.2 Liquid Limit and Plasticity Index

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

1.4.2.3 Moisture-Density Determinations

The maximum density and optimum moisture content shall be determined in accordance with ASTM D 1557 or AASHTO T 180, Method D and corrected with AASHTO T 224. To maintain the same percentage of coarse material, the "remove and replace" procedure as described in the NOTE 8 in Paragraph 7.2 of AASHTO T 180 shall be used.

1.4.2.4 Field Density Tests

Density shall be field measured in accordance with ~~[~~ASTM D 1556~~]~~, ~~[~~ASTM D 2167~~]~~, or ~~[~~ASTM D 2922~~]~~. ~~[~~For the method presented in ASTM D 1556 the base plate as shown in the drawing shall be used.~~]~~ ~~[~~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. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration of ASTM D 2922, on each different type of material being tested at the beginning of a job and at intervals as directed.~~]~~

1.4.2.5 Wear Test

Wear tests shall be made on ~~[ABC] [and] [~~GCA~~]~~ course material in conformance with ASTM C 131.

1.4.2.6 Soundness

Soundness tests shall be made on GCA in accordance with ASTM C 88.

~~1.5.2.7 Weight of Slag~~

~~Weight per cubic meter of slag shall be determined in accordance with ASTM C 29/C 29M on the [ABC] [and] [GCA] course material.~~

1.4.3 Testing Frequency

1.4.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis ~~[~~including 0.02 mm size material~~]~~.

b. Fractured Faces.

c. Flat and/or elongated particles

d. Liquid limit and plasticity index.

e. Moisture-density relationship.

f. Wear.

g. ~~[~~Soundness~~]~~.

~~f. [Weight per cubic meter of Slag].~~

~~g. [_____].~~

1.4.3.2 In Place Tests

Each of the following tests shall be performed on samples taken from the placed and compacted ~~[ABC] [and] [~~GCA~~]~~. Samples shall be taken and tested at the rates indicated.

a. Density tests shall be performed on every lift of material placed and at a frequency of one set of tests for every ~~[250~~300 square meters~~] [_____]~~, or portion thereof, of completed area. Also, one test per 25 square yards, or fraction there of, of each layer of material placed and compacted by hand-operated equipment.

b. Sieve Analysis ~~[~~including 0.02 mm size material~~]~~ shall be performed for every ~~[~~300 metric tons~~] [_____]~~, or portion thereof, of material placed.

c. Liquid limit and plasticity index tests shall be performed at the same frequency as the sieve analysis.

1.4.4 Approval of Material

The source of the material shall be selected ~~[_____] days~~ prior to the time the material will be required in the work. Material shall not be permitted for use in the work, until testing has been completed and the material approved. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted ~~[ABC] [and] [~~GCA~~]~~.

1.5 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 2 degrees C. When the temperature falls below 2 degrees C, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

1.6 PLANT, EQUIPMENT, AND TOOLS

All plant, equipment, and tools used in the performance of the work will be subject to approval 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, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 2 PRODUCTS

2.1 AGGREGATES

The ~~[ABC] [and] [~~GCA~~]~~ shall consist of clean, sound, durable particles of crushed stone or crushed gravel, crushed recycled concrete, angular sand,

or other approved material. ~~[ABC shall be free of lumps of clay, organic matter, and other objectionable materials or coatings.]~~ [GCA shall be free of silt, ~~and~~ clay, and shale as defined by ASTM D 2487, organic matter, and other objectionable materials or coatings.~~]~~ The portion retained on the 4.75 mm sieve shall be known as coarse aggregate; that portion passing the 4.75 mm sieve shall be known as fine aggregate.

2.1.1 Coarse Aggregate

Coarse aggregates shall be angular particles of uniform density. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

a. Crushed Gravel: Crushed gravel shall be manufactured by crushing gravels, and shall meet all the requirements specified below.

b. Crushed Stone: Crushed stone shall consist of freshly mined quarry rock, and shall meet all the requirements specified below.

c. Crushed Recycled Portland Cement Concrete: Crushed recycled concrete shall consist of previously hardened portland cement concrete or other concrete containing pozzolanic binder material. The recycled material shall be free of all reinforcing steel, bituminous concrete surfacing, and any other foreign material and shall be crushed and processed to meet the required gradations for coarse aggregate. Crushed recycled concrete shall meet all other applicable requirements specified below.

~~d. Crushed Slag: Crushed slag shall be an air-cooled blast-furnace product having an air dry unit weight of not less than 1045 kg/cubic meter as determined by ASTM C 29/C 29M, and shall meet all the requirements specified below.~~2.1.1.1 Graded-Crushed Aggregate Base Course

GCA coarse aggregate shall not show more than ~~[40] [50]~~ percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. GCA coarse aggregate shall not exhibit a loss greater than ~~[40] [50]~~18 percent weighted average, at five cycles, when tested for soundness in magnesium sulfate in accordance with ASTM C 88. The amount of flat and elongated particles shall not exceed 20 percent for the fraction retained on the 12.5 mm sieve nor 20 percent for the fraction passing the 12.5 mm sieve. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregate 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 piece. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Crushed gravel shall be manufactured from gravel particles 90 percent of which by weight are retained on the maximum size sieve listed in TABLE 1.

2.1.2 Fine Aggregate

Fine aggregates shall be angular particles of uniform density. When the fine aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements.

2.1.2.1 Graded-Crushed Aggregate Base Course

GCA fine aggregate shall consist of angular particles produced by crushing stone, slag, recycled concrete, or gravel that meets the requirements for wear and soundness specified for GCA coarse aggregate. ~~[~~Fine aggregate shall be produced by crushing only particles larger than 4.75 mm sieve in size. The fine aggregate shall contain at least 90 percent by weight of particles having two or more freshly fractured faces in the portion passing the 4.75 mm sieve and retained on the 2 mm sieve, and in the portion passing the 2 mm sieve and retained on the 0.425 mm sieve.~~]~~ ~~[Fine aggregate shall be manufactured from gravel particles 95 percent of which by weight are retained on the 12.5 mm sieve.]~~

2.1.3 Gradation Requirements

The specified gradation requirements shall apply to the completed base course. The aggregates shall have a maximum size of ~~[_____]~~1.5 mm and shall be continuously well graded within the limits specified in TABLE 1. Sieves shall conform to ASTM E 11.

TABLE 1. GRADATION OF AGGREGATES

Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	~~No. 1~~	No. 2	~~No. 3~~
50.0 mm	~~100~~	---	~~----~~
37.5 mm	~~70-100~~	100	~~----~~
25.0 mm	~~45-80~~	60-100	~~100~~
12.5 mm	~~30-60~~	30-65	~~40-70~~
4.75 mm	~~20-50~~	20-50	~~20-50~~
2.00 mm	~~15-40~~	15-40	~~15-40~~
0.425 mm	~~5-25~~	5-25	~~5-25~~
0.075 mm	~~0-8~~	0-8	~~0-8~~

NOTE 1: Particles having diameters less than 0.02 mm shall not be in excess of 3 percent by weight of the total sample tested.

NOTE 2: The values are based on aggregates of uniform specific gravity. If materials from different sources are used for the coarse and fine aggregates, they shall be tested in accordance with ASTM C 127 and ASTM C 128 to determine their specific gravities. If the specific gravities vary by more than 10 percent, the percentages passing the various sieves shall be corrected as directed by the Contracting Officer.

2.1.4 Liquid Limit and Plasticity Index

Liquid limit and plasticity index requirements shall apply to the completed course and shall also apply to any component that is blended to meet the required gradation. The portion of any component or of the completed course passing the 0.425 mm sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the ~~[ABC] [or] [~~GCA~~]~~ is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF AGGREGATE SOURCES

~~[Aggregate sources shall be cleared, stripped and excavated to working depths producing excavation faces that are as nearly vertical as practicable for the materials being excavated. Strata of unsuitable materials overlying or occurring in the deposit shall be wasted. Methods of operating aggregate sources, and the processing and blending of the materials, shall be changed or modified if necessary to obtain material conforming to the specified requirements. Upon completion of the work, aggregate sources shall be conditioned to drain readily and be left in a satisfactory condition.] [~~Aggregates shall be obtained from offsite sources. ~~]~~

3.3 STOCKPILING MATERIAL

Prior to stockpiling of material, 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 on the cleared and leveled areas designated by the Contracting Officer to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.4 PREPARATION OF UNDERLYING COURSE

Prior to constructing the ~~[ABC] [and] [~~GCA~~]~~, the surface of the underlying course ~~or subgrade~~ shall be cleaned of all foreign substances. At the time of construction of the ~~[ABC] [and] [~~GCA~~]~~, the underlying course shall contain no frozen material. The surface of the underlying course ~~or subgrade~~ shall meet specified compaction and surface tolerances. The underlying course shall conform to ~~[Section 02300 EARTHWORK] [~~Section 02721 SUBBASE COURSES~~]~~. Ruts or soft yielding spots in the underlying courses, 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 specified density requirements. ~~For cohesionless underlying courses containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the [ABC] [and] [GCA]. Stabilization shall be accomplished by mixing [ABC] [or] [GCA] into the underlying course and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements of the underlying course.~~ The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the ~~[ABC] [and] [~~GCA~~]~~ is placed.

3.5 INSTALLATION

3.5.1 Mixing the Materials

The coarse and fine aggregates shall be mixed in a stationary plant, or in a traveling plant or bucket loader on an approved paved working area. The Contractor shall make adjustments in mixing procedures or in equipment as directed to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to insure a satisfactory ~~[ABC] [and] [~~GCA~~]~~ meeting all requirements of this specification.

3.5.2 Placing

The mixed material shall be placed on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. When a compacted layer 150 mm or less in thickness is required, the material shall be placed in a single layer. When a compacted layer in excess of 150 mm is required, the material shall be placed in layers of equal thickness. No layer shall exceed 150 mm or less than 75mm when compacted. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the ~~[ABC] [and] [~~GCA~~]~~ is placed in more than one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable ~~[ABC] [and] [~~GCA~~]~~.

3.5.3 Grade Control

The finished and completed ~~[ABC] [and] [~~GCA~~]~~ shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required ~~[ABC] [and] [~~GCA ~~]~~ thickness so that the finished ~~[ABC] [and] [~~GCA~~]~~ with the subsequent surface course will meet the designated grades.

3.5.4 Edges of Base Course

The ~~[ABC] [and] [~~GCA~~]~~ shall be placed so that the completed section will be a minimum of ~~[1.5] [_____]~~0.3 m wider, on all sides, than the next layer that will be placed above it. Additionally, approved fill material shall be placed along the outer edges of ~~[ABC] [and] [~~GCA~~]~~ in sufficient quantities to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 600 mm width of this material to be rolled and compacted simultaneously with rolling and compacting of each layer of ~~[ABC] [and] [~~GCA~~]~~. If this base course material is to be placed adjacent to another pavement section, then the layers for both of these sections shall be placed and compacted along this edge at the same time.

3.5.5 Compaction

Each layer of the ~~[ABC] [and] [~~GCA~~]~~ shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus ~~[_____]~~2 percent of the optimum water content determined from laboratory tests as specified in paragraph SAMPLING AND TESTING. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not

accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer has a degree of compaction that is at least ~~[~~100~~] [_____]~~ percent of laboratory maximum density through the full depth of the layer. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory ~~[ABC] [and] [~~GCA~~]~~. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.5.6 Thickness

Compacted thickness of the aggregate course shall be ~~[~~as indicated~~] [[_____] mm.]~~. No individual layer shall exceed 150 mm nor be less than 75 mm in compacted thickness. The total compacted thickness of the ~~[ABC] [and] [~~GCA~~]~~ course shall be within 13 mm of the thickness indicated. Where the measured thickness is more than 13 mm deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 13 mm thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm of the thickness indicated. The total thickness of the ~~[ABC] [and] [~~GCA~~]~~ course shall be measured at intervals in such a manner as to ensure one measurement for each ~~[500] [_____]~~500 square meters of base course. Measurements shall be made in 75 mm diameter test holes penetrating the base course.

3.5.7 Finishing

The surface of the top layer of ~~[ABC] [and] [~~GCA~~]~~ shall be finished after ~~[~~final compaction~~] [and] [proof rolling]~~ by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of ~~[ABC] [and] [~~GCA~~]~~ is 13 mm or more below grade, then the top layer should be scarified to a depth of at least 75 mm and new material shall be blended in ~~[~~and compacted~~] [, compacted and proof rolled]~~ to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, reworked and recompacted or it shall be replaced as directed.

3.5.8 Smoothness

The surface of the top layer shall show no deviations in excess of 10 mm when tested with a ~~[3.05] [~~3.66~~]~~ meter straightedge. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at ~~[~~15~~] [_____]~~ meter intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.6 TRAFFIC

~~[Traffic shall not be allowed on the completed [ABC] [and] [GCA] course]. [~~Completed portions of the ~~[ABC] [and] [~~GCA~~]~~ course may be opened to limited

construction traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.~~]~~

3.7 MAINTENANCE

The ~~[ABC] [and] [~~GCA~~]~~ shall be maintained in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any ~~[ABC] [and] [~~GCA~~]~~ that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of ~~[ABC] [and] [~~GCA~~]~~ that is damaged shall be reworked or replaced as necessary to comply with this specification.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Any unsuitable materials that must be removed shall be disposed of ~~[~~as directed~~] [in waste disposal areas indicated]~~. No additional payments will be made for materials that must be replaced.

-- End of Section --

SECTION 02741A

HOT-MIX ASPHALT (HMA) FOR ROADS
09/99

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 TP_53	(1998; Interim 1999) Determining Asphalt Content of Hot Mix Asphalt by the Ignition Method
AASHTO T 168	(1991) Sampling Bituminous Paving Mixtures
AASHTO T 248	(1984) Reducing Field Samples of Aggregate to Testing Size
AASHTO T 283	(1989) Resistance of Compacted Bituminous Mixtures to Moisture Induced Damage

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 127	(1988) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1988) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion

	and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 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 75	(1998) Sampling Aggregates
ASTM D 140	(1998) Sampling Bituminous Materials
ASTM D 242	(1995) Mineral Filler for Bituminous Paving Mixtures
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

~~STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION (CDT)~~

~~CDT Test 526~~	~~(1978) Operation of California Profilograph and Evaluation of Profiles~~

U.S. ARMY CORPS OF ENGINEERS (USACE)

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, ~~[_____]~~EC-GD.

Submittals for asphalt cement binder and aggregate test reports shall be included in the mix design submittal. Submit for approval

at least 30 days before material is required for the work.

Proposed JMF.

Contractor Quality Control; G; [_____]RE.

Quality control plan.

~~Material Acceptance and Percent Payment; G, [_____].~~

~~Acceptance test results and pay calculations.~~

~~SD-04 Samples~~

~~Asphalt Cement Binder; [_____], [_____].~~

~~(20 L)(sample for mix design verification.~~

~~Aggregates; [_____], [_____].~~

~~Sufficient materials to produce [90 kg] [of blended mixture for mix design verification.~~

Material Acceptance; G, RE.

Acceptance test results.

SD-06 Test Reports

Aggregates; G, [_____]EC-GD.

Certified copies of initial material test results for approval of source and material not less than 30 days before material is required for the work.

QC Monitoring; [_____]G, [_____]RE.

Aggregate and QC test results.

SD-07 Certificates

Asphalt Cement Binder; G, [_____]EC-GD.

Copies of certified test data. Submit with mix design submittal.

Testing Laboratory; [_____]G, [_____]RE.

Certification of compliance.

Plant Scale Calibration Certification

1.4 ~~METHOD OF MEASUREMENT~~NOT USED

~~The amount paid for will be the number of metric tons of hot-mix asphalt mixture used in the accepted work. Hot-mix asphalt mixture shall be weighed after mixing, and no separate payment will be made for weight of asphalt cement material incorporated herein.~~

1.5 ~~BASIS OF PAYMENT~~NOT USED

~~Quantities of [intermediate-][[and] wearing-]course mixtures, determined as~~

~~specified above, will be paid for at respective contract unit prices or at reduced prices adjusted in accordance with paragraph MATERIAL ACCEPTANCE AND PERCENT PAYMENT. Payment shall constitute full compensation for furnishing all materials, equipment, plant, and tools; and for all labor and other incidentals necessary to complete work required by this section of the specification.~~

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 3 hours.

(2) The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 8 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, 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. The total aggregate (coarse aggregate, fine aggregate, and the material passing the No. 200 sieve) shall contain not less than 80 percent crushed material for intermediate course and surface course. All aggregate test results and samples shall be submitted to the Contracting Officer at least ~~14~~30 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. The percentage of loss shall not be greater than 18 percent after five cycles when tested in accordance with ASTM C 88 using magnesium sulfate ~~[or 12 percent when using sodium sulfate]~~.

c. At least ~~75~~80 percent by weight of coarse aggregate shall have at least two or more fractured faces when tested in accordance with COE CRD-C 171. The area of each fractured face shall be at least 80 percent of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between planes of fractures shall be at least 30 degrees to count as two fractured faces. Fractured faces shall be produced by crushing.

d. 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.

2.1.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, tough, durable particles including natural sand or crushed stone or gravel that meets the requirements for wear and soundness specified for coarse aggregate. Fine aggregate produced by crushing gravel shall have at least 90 percent by weight of crushed particles having two or more fractured faces in the portion retained on the . This requirement shall apply to the material before blending with natural sand when blending is necessary. The aggregate particles shall be free from coatings of clay, 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 43.0 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, and the following additional requirements. At least 50 percent of the mineral filler shall be hydrated lime, limestone dust, or portland cement conforming to ASTM C 150 Type I or II. However, in areas where long service has shown that there has been no problem with stripping when the proposed aggregates are used, this additional requirement may be waived by the Contracting Officer when requested in writing.

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. The Contractor shall be responsible for furnishing a combined aggregate which will produce a bituminous mixture meeting the specified requirements. Aggregate gradations which fail to produce a bituminous mixture conforming to the specified requirements shall be rejected and replaced with a satisfactory aggregate gradation at no additional cost to the Government No extension of time shall be allowed due to any delay caused by such replacement.

Table 2. Aggregate Gradations

Sieve Size, mm	~~Gradation 1~~ ~~Percent Passing~~ by Mass	~~Gradation 2~~Intermediate Course Percent Passing by Mass	~~Gradation 3~~Surface Course Percent Passing by Mass
25.0	~~100~~	~~---~~100	---
19.0	~~76-96~~	95-100	100
12.5	~~68-88~~	---	---
9.5	~~60-82~~	70-90	79-94
4.75	~~45-67~~	---	60-77
2.36	~~32-54~~	28-58	44-62
1.18	~~22-44~~	---	---
0.60	~~15-35~~	12-36	22-39
0.30	~~9-25~~	---	---
0.15	~~6-18~~	---	---
0.075	~~3-6~~	2-7	2-7

2.2 ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to ~~[ASTM D 3381 Table 2, Viscosity Grade [_____]] [~~AASHTO MP 1 Performance Grade (PG) ~~[_____]] [ASTM D 946 penetration grade [_____]]~~64-22. 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~~30 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.~~ The Tensile Strength Ratio (TSR) of the composite mixture, shall be determined in accordance with ASTM D 4867/D 4867M or AASHTO T 283. The test specimens shall be conditioned by the freezing and thawing method. The Tensile Strength Ratio (TSR) shall be at least 80. If the Tensile Strength Ratio (TSR) is less than 80, 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 80. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost. Mix design Tensile Strength Ratio (TSR)testing shall be accomplished on the design mix without an anti-stripping agent and with the proposed anti-stripping agent, the results of both tests shall be submitted with the mix design. ~~Sufficient materials to produce 90 kg of blended mixture shall be provided to the Contracting Officer for verification of mix design at least 14 days prior to construction of test section.~~ When the water absorption of any aggregate in the mixture exceeds 1.25 percent as determined by ASTM C 127 and ASTM C 128, the material for the theoretical specific gravity ASTM D 2041 and for the Marshall specimens shall be cured at 135 degrees C for 2 hours in a closed oven after the mix is produced in the laboratory. The plant-produced mixture shall not be tested until the mix is 2 hours old. The mixture shall not be reheated.

At the option of the contractor a currently used DOT superpave hot mix may be used in lieu of developing a new hot mix design study as described herein. The superpave volumetric mix shall be designed in accordance with AASHTO MP 2.

2.3.1 JMF Requirements

The job mix formula shall be submitted in writing by the Contractor for approval at least ~~14~~30 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.

~~s. Percentage and properties (asphalt content, binder properties, and aggregate properties) of reclaimed asphalt pavement (RAP) in accordance with paragraph RECYCLED HOT-MIX ASPHALT, if RAP is used.~~

Table 3. Marshall Design Criteria

Test Property	~~75 Blow Mix~~	50 Blow Mix
Stability, newtons minimum	~~*8000~~	~~*~~ (Note 1) ~~4450~~5300
Flow, 0.25 mm	~~8-16~~	~~—~~ 8-18
Air voids, percent	~~3-5~~	~~—~~ 3-5
Percent Voids in mineral aggregate (VMA), ~~(minimum)~~		(Note 2)
~~Gradation 1~~	~~13.0~~	~~13.0~~
~~Gradation 2~~	~~14.0~~	~~14.0~~
~~Gradation 3~~	~~15.0~~	~~15.0~~
TSR, minimum percent	~~75~~	~~—~~ ~~75~~ 80

* Note 1: This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.

Note 2: The minimum VMA percent shall conform to the requirements specified in Table 5.3, Chapter 5 of the Asphalt Institute Manual MS-2, sixth edition. Calculate VMA in accordance with AI MS-2, based on ASTM D 2726 bulk specific gravity for the aggregate.

Note 3: When the absorption is high the mixture will be tender until the asphalt is absorbed into the aggregate. Therefore, it may be beneficial to silo the mixture at the plant for a time. This is more important when the truck haul is short.

Note 4: Extraction tests shall be accomplished in accordance with ASTM D 2172. ~~This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.~~

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~~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
Temperature of mixing	14 degrees C

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.

~~2.4 RECYCLED HOT MIX ASPHALT~~

~~Recycled HMA shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. The RAP shall be of a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP chunk size shall not exceed 50 mm. The recycled HMA mix shall be designed using procedures contained in AI MS-2 and AI MS-22. The job mix shall meet the requirements of paragraph MIX DESIGN. The amount of RAP shall not exceed 30 percent.~~

~~2.4.1 RAP Aggregates and Asphalt Cement~~

~~The blend of aggregates used in the recycled mix shall meet the requirements of paragraph AGGREGATES. The percentage of asphalt in the RAP shall be established for the mixture design according to ASTM D 2172 using the appropriate dust correction procedure.~~

~~2.4.2 RAP Mix~~

~~The blend of new asphalt cement and the RAP asphalt binder shall meet the [penetration] [viscosity] [dynamic shear rheometer at high temperature and bending beam at low temperature] requirements in paragraph ASPHALT CEMENT BINDER. The virgin asphalt cement shall not be more than two standard asphalt material grades different than that specified in paragraph ASPHALT CEMENT BINDER.~~

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/or~~]~~ ~~[~~tack coat~~]~~ 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~~40 - ~~150~~80 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, and conformance to the JMF. Random sampling shall be in accordance with procedures contained in ASTM D 3665. If laboratory test results demonstrate that the pavement conforms to the specified requirements, the test section shall remain as part of the project pavement. If test results fail to meet the JMF, 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)	Conform to the JMF
Stability, newtons ~~(Average of 3 specimens)~~(Individual Test Result)	~~[4450] [8000]~~5300 minimum
Flow, 0.25 mm (Average of 3 specimens)	~~[8 - 16] [~~8 - 18~~]~~
Mat Density, Percent of Marshall ~~(Average of 4 Random Cores)~~(Individual Test Result)	~~95.0~~97.0 - 100.5
Joint Density, Percent of Marshall (Individual Test Result)	~~95.0~~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. To deliver mix to the paver for road construction, the Contractor shall use a material transfer vehicle which shall be operated to produce continuous forward motion of the paver.

3.7.2 Placing

Intermediate course, or any layer of surface shall not be left uncovered by the subsequent course for more than 5 days, weather permitting. Material trucks hauling materials other than asphaltic concrete or tack coat shall not travel on previously constructed layers of asphalt concrete until the final surface course is constructed. 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. After preliminary smoothness tests, rolling shall continue until density is obtained in all portions of each course of not less than 97.0 percent and not more than 100.5 percent of laboratory compacted Marshall specimens in the mat. 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. Joints shall have a density of not less than 95.5 and not more than 100.5 percent percent of laboratory compacted Marshall specimens. Contact surfaces of previously constructed pavements, curbs, gutters, manholes, and other areas as shown, shall be tack coated. The tack coat shall be applied far enough in advance of placement of the paving mixture to insure adequate curing of the tack coat, and shall be protected from damage or contamination of the tack coated surface.

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.

3.9.3 Edges of Pavement

Edges of pavement adjacent to the shoulders shall be trimmed neatly to line. Shoulder material not less than wide (except as otherwise shown) shall be placed against and to the full height of the pavement surface as soon as practicable after final rolling has been completed and the pavement has sufficiently hardened.

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

All quality control sampling and testing shall be the Contractor's responsibility and shall be in accordance with specified requirements. All sampling and testing shall be performed by a commercial testing laboratory with the capability of performing all of the testing specified herein and shall be supervised by a registered professional engineer. The Contractor may elect to establish testing facilities of his own. However, the

Contractor's laboratory shall have the capability of performing all the testing specified herein. No work requiring testing will be permitted until the Contractor's facilities have been inspected and approved. The Contractor's testing laboratory shall be supervised by a registered professional engineer. The first inspection of the facilities shall be at the expense of the Government and any subsequent inspections required because of failure of the first inspection will be at the expense of the Contractor. Such costs will be deducted from the total amount due the Contractor. The Government may perform verification tests as considered necessary. 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

Test for asphalt content initially at start of each days hot mix production. Following the start up test, tests to determine asphalt content ~~will~~shall be performed ~~per lot~~with each Marshall test ~~(a lot is defined in paragraph MATERIAL ACCEPTANCE AND PERCENT PAYMENT)~~ 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 TP 53 or 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

Aggregate gradations shall be ~~determined a minimum of twice per lot~~tested initially at start of each days hot mix production. Following the start up test, a minimum of once per every of asphalt concrete produced, or fraction thereof per day of paving. A minimum of two tests and a maximum

of three tests shall be performed per day of paving. Gradations for extracted samples shall be determined 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. Additional gradation tests shall be made when new material is delivered to the plant.

Prior to production two gradation tests of hot bin material for conventional plants, or total aggregate material from the final feed belt for the dryer-drum mixer for dry-drum plants, during trial runs performed 10 days before start of production of paving mixtures. Additional tests shall be required whenever adjustments to the plant are made.

3.10.3.3 Temperatures

Temperatures shall be ~~checked at least four times per lot~~tested initially at start of each days hot mix production. Following the start up test, a minimum of once per every of asphalt concrete produced, or fraction thereof per day of paving. A minimum of two tests shall be performed per day of paving, 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 lot~~tested initially at start of each days hot mix production. Following the start up test, test to determine moisture content shall be performed with each aggregate gradation test 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 lot~~tested initially at start of each days hot mix production. Following the start up test, test to determine moisture content shall be performed with each aggregate gradation test 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 lot~~initially at start of each days hot mix production. Following the start up test, a minimum of once per every of asphalt concrete produced, or fraction thereof per day of paving. The mix shall be tested a minimum of two sets per day and a maximum of 4 sets per day of paving. ~~and compacted into s~~Specimens shall be compacted, using ~~[~~50~~] [~~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 Pavement Thickness

The Contractor shall conduct the necessary checks and tests to ensure the compacted thickness of pavement for each course conform to specified requirements and as shown on the drawings.

3.10.3.9 Grade and Smoothness

The Contractor shall conduct the necessary checks and tests to ensure the grade and smoothness conform to specified requirements and as shown on the drawings~~requirements are met in accordance with paragraph MATERIAL ACCEPTANCE AND PERCENT PAYMENT~~.

3.10.3.10 Additional Testing

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

3.10.3.11 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 Control Charts~~

~~For process control, the Contractor shall establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 6, as a minimum. These control charts shall be posted as directed by the Contracting Officer and shall be kept current at all times. The control charts shall identify the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 6 applicable to the test parameter being plotted, and the Contractor's test results. Target values from the JMF shall also be shown on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, the Contractor shall take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, the Contractor shall halt production until the problem is solved. The Contractor shall use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Decisions concerning mix modifications shall be made based on analysis of the results provided in the control charts. The Quality Control Plan shall indicate the appropriate action which shall be taken to bring the process into control when certain parameters exceed their Action Limits.~~

(Table 6. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

Parameter to be Plotted	Running Average of Individual Samples		Last Four Samples	
	Action Limit	Suspension Limit	Action Limit	Suspension Limit
4.75 mm sieve, Cumulative % Passing, deviation from JMF target; plus or minus values	6	8	4	5
0.6 mm sieve, Cumulative % Passing, deviation from JMF target; plus or minus values	4	6	3	4
0.075 mm sieve, Cumulative % Passing, deviation from JMF target; plus or minus values	1.4	2.0	1.1	1.5
Stability, newtons (minimum)				
75 Blow JMF	8000	7560	8440	8000
50 Blow JMF	4450	4000	4900	4450
Flow, 0.25 mm				
75 Blow JMF	8 min. 16 max.	7 min. 17 max.	9 min. 15 max.	8 min. 16 max.
50 Blow JMF	8 min. 18 max.	7 min. 19 max.	9 min. 17 max.	8 min. 18 max
Asphalt content, % deviation from JMF target; plus or minus value	0.4	0.5	0.2	0.3
Laboratory Air Voids, % deviation from JMF target value	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Mat Density, % of Marshall density	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Joint Density, % of Marshall density	No specific action and suspension limits set since this parameter is used to determine percent payment)			

3.11 Material Acceptance

Sampling and tTesting for acceptability of work shall be the Contractor's responsibility, and shall be accomplishedwill be performed by an independent laboratory hired by the Contractor. Test results and payment calculations 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] [4 hours of production][8 hours of production],

or fraction thereof when a partial day of production occurs. Samples of each lot of paving shall be taken by noon of the following day and results of tests reported to the Contracting Officer by the end of that day. ~~Where appropriate, adjustment in payment for individual~~Acceptance of lots of hot-mix asphalt will be made based on in-place density, pavement thickness, laboratory air voids, grade and smoothness in accordance with the following paragraphs. 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 and pavement thickness, each lot will be divided into four equal sublots. The Contractor shall furnish a power saw or core drill and labor for cutting samples and shall immediately replace the pavement. Cores shall be at least in diameter, and sawed samples shall be at least on each side. Sample holes shall have all surfaces tack coated. Hot-mix bituminous mix shall be placed and compacted in the sample hole to the satisfaction of the Contracting Officer. The finished surface of the repaired sample hole shall match the surface elevation of the adjacent pavement.

~~3.11.1 Percent Payment~~

~~When a lot of material fails to meet the specification requirements for 100 percent pay as outlined in the following paragraphs, that lot shall be removed and replaced, or accepted at a reduced price which will be computed by multiplying the unit price by the lot's pay factor. The lot pay factor is determined by taking the lowest computed pay factor based on either laboratory air voids, in-place density, grade or smoothness (each discussed below). At the end of the project, an average of all lot pay factors will be calculated. If this average lot pay factor exceeds 95.0 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by the lot's pay factor. For any lots which are less than 2000 metric tons , a weighted lot pay factor will be used to calculate the average lot pay factor.~~

3.11.1 Sublot Sampling

One random mixture sample for determining laboratory air voids, theoretical maximum density, and for any additional testing the Contracting Officer desires, will be taken from a loaded truck delivering mixture to each sublot, or other appropriate location for each sublot. All samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D 3665 and employing tables of random numbers or computer programs. Laboratory air voids will be determined from three laboratory compacted specimens of each sublot sample in accordance with ASTM D 1559. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

3.11.2 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.

3.11.3 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 sublot sample using ASTM D 2041. Laboratory air void calculations for each sublot will use the latest theoretical maximum density values obtained, either for that sublot or the previous sublot. The mean absolute deviation of the four laboratory air void contents (one from each sublot) from the JMF air void content will be evaluated ~~and a pay factor determined from Table 7~~. All laboratory air void tests will be completed and reported within 24 hours after completion of construction of each lot.

~~3.11.5 Mean Absolute Deviation~~

~~An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined from 4 random samples of a lot (where 3 specimens were compacted from each sample). The average laboratory air voids for each sublot sample are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:~~

~~Mean Absolute Deviation = (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7 - 4.0|/4~~

~~= (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45~~

~~The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 7 that the lot's pay factor based on laboratory air voids, is 100 percent.~~

~~Table 7. Pay Factor Based on Laboratory Air Voids~~

~~Mean Absolute Deviation of Lab Air Voids from JMF~~	~~Pay Factor, %~~
~~0.60 or less~~	~~100~~
~~0.61 - 0.80~~	~~98~~
~~0.81 - 1.00~~	~~95~~
~~1.01 - 1.20~~	~~90~~
~~Above 1.20~~	~~reject (0)~~

3.11.4 In-place Density and Thickness

3.11.4.1 General Density and Thickness Requirements

For determining in-place pavement density and thickness, one random core ~~will~~shall be taken ~~by the Government~~ from the mat (interior of the lane) ~~of each sublot~~, and one random core ~~will be~~ taken from ~~the l~~each longitudinal and transverse joint (immediately over the joint) ~~)~~ of each sublot. Each random core ~~will~~shall be the 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 and pavement thickness determinations. The compacted thickness shall conform to the thickness

shown on the drawings.

~~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). The average in-place mat density and joint density for a lot are determined and compared with Table 8 to calculate a single pay factor per lot based on in-place density, as described below. First, a pay factor for both mat density and joint density are determined from Table 8. The area associated with the joint is then determined and will be considered to be 3 m wide times the length of completed longitudinal construction joint in the lot. This area will not exceed the total lot size. The length of joint to be considered will be that length where a new lane has been placed against an adjacent lane of hot-mix asphalt pavement, either an adjacent freshly paved lane or one paved at any time previously. The area associated with the joint is expressed as a percentage of the total lot area. A weighted pay factor for the joint is determined based on this percentage (see example below). The pay factor for mat density and the weighted pay factor for joint density is compared and the lowest selected. This selected pay factor is the pay factor based on density for the lot. When the Marshall density on both sides of a longitudinal joint is different, the average of these two densities will be used as the Marshall density needed to calculate the percent joint density. All density results for a lot will be completed and reported within 24 hours after the construction of that lot.~~

~~Table 8. Pay Factor Based on In-place Density~~

~~Average Mat Density (4 Cores)~~	~~Pay Factor, %~~	~~Average Joint Density (4 Cores)~~
~~97.9 or 100~~	~~100.0~~	~~96.4 or above~~
~~97.8 or 100.1~~	~~99.9~~	~~96.3~~
~~97.7~~	~~99.8~~	~~96.2~~
~~97.6 or100.2~~	~~99.6~~	~~96.1~~
~~97.5~~	~~99.4~~	~~96.0~~
~~97.4 or 100.3~~	~~99.1~~	~~95.9~~
~~97.3~~	~~98.7~~	~~95.8~~
~~97.2 or 100.4~~	~~98.3~~	~~95.7~~
~~97.1~~	~~97.8~~	~~95.6~~
~~97.0 or 100.5~~	~~97.3~~	~~95.5~~
~~96.9~~	~~96.3~~	~~95.4~~
~~96.8 or 100.6~~	~~94.1~~	~~95.3~~
~~96.7~~	~~92.2~~	~~95.2~~
~~96.6 or 100.7~~	~~90.3~~	~~95.1~~
~~96.5~~	~~87.9~~	~~95.0~~
~~96.4 or 100.8~~	~~85.7~~	~~94.9~~
~~96.3~~	~~83.3~~	~~94.8~~
~~96.2 or 100.9~~	~~80.6~~	~~94.7~~
~~96.1~~	~~78.0~~	~~94.6~~
~~96.0 or 101.0~~	~~75.0~~	~~94.5~~
~~below 96.0or above 101.0~~	~~0.0 (reject)~~	~~below 94.5~~

~~3.11.6.3 Pay Factor Based on In-place Density~~

~~An example of the computation of a pay factor (in I-P units only) based on~~

~~in-place density, is as follows: Assume the following test results for field density made on the lot: (1) Average mat density = 97.2 percent (of lab density). (2) Average joint density = 95.5 percent (of lab density). (3) Total area of lot = 30,000 square feet. (4) Length of completed longitudinal construction joint = 2000 feet.~~

~~a. Step 1: Determine pay factor based on mat density and on joint density, using Table 8:~~

~~Mat density of 97.2 percent = 98.3 pay factor.~~

~~Joint density of 95.5 percent = 97.3 pay factor.~~

~~b. Step 2: Determine ratio of joint area (length of longitudinal joint x 10 ft) to mat area (total paved area in the lot): Multiply the length of completed longitudinal construction joint by the specified 10 ft. width and divide by the mat area (total paved area in the lot).~~

~~(2000 ft. x 10 ft.)/30000 sq.ft. = 0.6667 ratio of joint area to mat area (ratio).~~

~~c. Step 3: Weighted pay factor (wpf) for joint is determined as indicated below:~~

~~wpf = joint pay factor + (100 - joint pay factor) (1 - ratio)~~
~~wpf = 97.3 + (100-97.3) (1-.6667) = 98.2%~~

~~d. Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller:~~

~~Pay factor for mat density: 98.3%. Weighted pay factor for joint density: 98.2%~~

~~Select the smaller of the two values as pay factor based on density: 98.2%~~

3.11.5 Grade

The final wearing surface of 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. When more than 5 percent of all measurements made within a lot are outside the 15 mm tolerance~~, the pay factor based on grade for that lot will be 95 percent~~. In areas where the grade exceeds the tolerance~~ by more than 50 percent~~, 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.

3.11.6 Surface Smoothness

The Contractor shall ~~use [one] [both] of the following methods to test and~~ evaluate the surface 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. ~~The profilograph method shall be used for all longitudinal and transverse testing, except where the runs would be less than 60 m in length and the ends where the straightedge shall be used.~~ 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.

3.11.6.1 ~~Bituminous Intermediate Course~~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~~ 3.66 m straightedge.

Table 9. Straightedge Surface Smoothness--Pavements

Pavement Category	Direction of Testing	Tolerance, mm
Intermediate Course	Longitudinal	6
	Transverse	6
Surface Course	Longitudinal	3
	Transverse	6

~~b. Profilograph Testing: The finished surfaces of the pavements shall have no abrupt change of 3 mm or more, and all pavement shall have a Profile Index not greater than specified in Table 10 when tested with an approved California-type profilograph. If the extent of the pavement in either direction is less than 60 m , that direction shall be tested by the straightedge method and shall meet requirements specified above.~~

~~Table 10. Profilograph Surface Smoothness--Pavements~~

~~Pavement Category~~	~~Direction of Testing~~	~~Maximum Specified Profile Index (mm/km)~~
~~All Paved Areas~~	~~Longitudinal~~	~~140~~

3.11.6.2 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. Separate testing of individual sublots is not required. 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 Payment Adjustment for Smoothness~~

~~a. Straightedge Testing. Location and deviation from straightedge for all measurements shall be recorded. When between 5.0 and 10.0 percent of all measurements made within a lot exceed the tolerance specified in paragraph Smoothness Requirements above, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness, will be 95 percent. When more than 10.0 percent of all measurements exceed the tolerance, the computed pay factor will be 90 percent. When between 15.0 and 20.0 percent of all measurements exceed the tolerance, the computed pay factor will be 75 percent. When 20.0 percent or more of the measurements exceed the tolerance, the lot shall be removed and replaced at no additional cost to the Government. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 50 percent, shall be corrected by diamond grinding to meet the specification requirements above or shall be removed and replaced at no additional cost to the Government.~~

~~b. Profilograph Testing. Location and data from all profilograph measurements shall be recorded. When the Profile Index of a lot exceeds the tolerance specified in paragraph Smoothness Requirements above by 16 mm/km , but less than 32 mm/km, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 32 mm/km , but less than 47 mm/km, the computed pay factor will be 90 percent. When the Profile Index exceeds the tolerance by 47 mm/km , but less than 63 mm/km, the computed pay factor will be 75 percent. When the Profile Index exceeds the tolerance by 63 mm/km or more, the lot shall be removed and replaced at no additional cost to the Government. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 79 mm/km or more, shall be corrected by grinding to meet the specification requirements above or shall be removed and replaced at no additional cost to the Government.~~

~~c. Bumps ("Must Grind" Areas). Any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm in height shall be reduced by diamond grinding until they do not exceed 7.5 mm when retested. Such grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. The following will not be permitted: (1) skin patching for correcting low areas, (2) planing or milling for correcting high areas. At the Contractor's option, pavement areas, including ground areas, may be rechecked with the profilograph in order to record a lower Profile Index.~~

3.12 PROTECTION OF PAVEMENT

After final rolling of the pavement for the intermediate and surface course, no vehicular traffic of any kind shall be permitted on the pavement course until the pavement has cooled and hardened for at least 8 hours.

-- End of Section --

SECTION 02748A

BITUMINOUS TACK AND PRIME COATS
01/98

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 M 20	(1970; R 1996) Penetration Graded Asphalt Cement
AASHTO M 81	(1992; R 1996) Cut-Back Asphalt (Rapid-Curing Type)
AASHTO M 82	(1975; R 1996) Cut-Back Asphalt (Medium-Curing Type)
AASHTO M 226	(1980; R 1996) Viscosity Graded Asphalt Cement
AASHTO T 40	(1978; R 1996) Sampling Bituminous Materials

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 140	(200) Sampling Bituminous Materials
ASTM D 946	(1982; R 1999) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 977	(1998) Emulsified Asphalt
ASTM D 1250	(1980; R 1997el) Petroleum Measurement Tables
ASTM D 2026	(1972; R 1997) Cutback Asphalt (Slow-Curing Type)
ASTM D 2027	(1976; R 1997) Cutback Asphalt (Medium-Curing Type)
ASTM D 2028	(1976; R 1997) Cutback Asphalt (Rapid-Curing Type)
ASTM D 2397	(1998) Cationic Emulsified Asphalt
ASTM D 2995	(1999) Determining Application Rate of Bituminous Distributors

ASTM D 3381 (1992; R 1999) Viscosity-Graded Asphalt Cement for Use in Pavement Construction

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-03 Product Data; , RE

Waybills and Delivery Tickets

Waybills and delivery tickets, during progress of the work.

SD-06 Test Reports

Sampling and Testing; G, RE

Copies of all test results for bituminous materials, within 24 hours of completion of tests. Certified copies of the manufacturer's test reports indicating compliance with applicable specified requirements, not less than ~~[~~30~~]~~ ~~[_____]~~ days before the material is required in the work.

1.3 PLANT, EQUIPMENT, MACHINES AND TOOLS

1.3 General Requirements

Plant, equipment, machines and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times.

1.4 Bituminous Distributor

The distributor shall have pneumatic tires of such size and number to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. The distributor shall be designed and equipped to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

1.5 Power Brooms and Power Blowers

Power brooms and power blowers shall be suitable for cleaning the surfaces to which the bituminous coat is to be applied.

1.6 WEATHER LIMITATIONS

Bituminous coat shall be applied only when the surface to receive the bituminous coat is dry. Bituminous coat shall be applied only when the atmospheric temperature in the shade is 10 degrees C or above and when the temperature has not been below 2 degrees C for the 12 hours prior to application.

PART 2 PRODUCTS

2.1 TACK COAT

~~[Cutback asphalt] [Asphalt] [~~Emulsified asphalt~~]~~ shall conform to ~~[ASTM D 2028] [ASTM D 946] [ASTM D 3381] [~~ASTM D 977~~]~~ ~~[~~or ASTM D 2397~~] or [AASHTO M 81] [AASHTO M 20] [AASHTO M 226]~~, Grade ~~[_____]~~SS-1, SS-1H, CSS-1, or CSS-1H.

2.2 PRIME COAT

~~[~~Cutback asphalt~~] [Emulsified asphalt]~~ shall conform to ~~[ASTM D 977] [ASTM D 2026] [~~ASTM D 2027~~] [ASTM D 2028] [ASTM D 2397]~~ or ~~[AASHTO M 81] [~~AASHTO M 82~~]~~, Grade ~~[_____]~~MC-30 or MC-70.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

Immediately before applying the bituminous coat, all loose material, dirt, clay, or other objectionable material shall be removed from the surface to be treated. The surface shall be dry and clean at the time of treatment.

3.2 APPLICATION RATE

The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contracting Officer.

3.2.1 Tack Coat

Bituminous material for the tack coat shall be applied in quantities of not less than 0.20 liter nor more than 0.70 liter per square meter of pavement surface.

3.2.2 Prime Coat

Bituminous material for the prime coat shall be applied in quantities of not less than 0.70 liter nor more than 1.80 liters per square meter of pavement surface.

3.3 APPLICATION TEMPERATURE

3.3.1 Viscosity Relationship

Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 square mm/sec, kinematic. The temperature viscosity relation shall be furnished to the Contracting Officer.

3.3.2 Temperature Ranges

The viscosity requirements shall determine the application temperature to be used. The following is a normal range of application temperatures:

Liquid Asphalts

[SC-250	75-132 degrees C]
[MC-30	29-87 degrees C]
[MC-70	50-107 degrees C]
[MC-250	75-132 degrees C]
[RC-70	50-90 degrees C*]
[RC-250	75-12 degrees C*]

Paving Grade Asphalts

Penetration Grades

[200-300	plus 130 degrees C]
[120-150	plus 132 degrees C]
[85-100	plus 137 degrees C]

Viscosity Grades

[AC 2.5	plus 132 degrees C]
[AC 5	plus 137 degrees C]
[AC 10	plus 137 degrees C]
[AR 1000	plus 135 degrees C]
[AR 2000	plus 140 degrees C]
[AR 4000	plus 143 degrees C]

Emulsions

[RS-1	20-60 degrees C]
[MS-1	20-70 degrees C]
[HFMS-1	20-70 degrees C]
[SS-1	20-70 degrees C]
[SS-1h	20-70 degrees C]
[CRS-1	52-85 degrees C]
[CSS-1	20-70 degrees C]
[CSS-1h	20-70 degrees C]

*These temperature ranges exceed the flash point of the material and care should be taken in their heating.

3.4 APPLICATION

3.4.1 General

Following preparation and subsequent inspection of the surface, the bituminous coat shall be applied at the specified rate with uniform distribution over the surface to be treated. All areas and spots missed by the distributor shall be properly treated with the hand spray. Until the succeeding layer of pavement is placed, the surface shall be maintained by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, clean dry sand shall be spread to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the

equipment shall be permitted within 8 meters of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions. All traffic, except for paving equipment used in constructing the surfacing, shall be prevented from using the underlying material, whether primed or not, until the surfacing is completed. The bituminous coat shall conform to all requirements as described herein.

3.4.2 Prime Coat

The prime coat will be required if it will be at least seven days before ~~a~~ the ~~surfacing (A~~asphalt ~~cement~~concrete hot mix ~~concrete)~~pavement layer is constructed on the underlying ~~(~~base course~~, etc)compacted~~ material. The type of liquid asphalt and application rate will be as specified herein. The Contractor shall protect the underlying course from ~~any~~ damage (water, traffic, etc.) until the ~~surfacing~~asphalt concrete pavement is placed. ~~If the Contractor places the surfacing within seven days, the choice of protection measures or actions to be taken is at the Contractor's option.~~ Damage to the underlying material caused by lack of, or inadequate, protection shall be repaired ~~(recompacted~~ or replaced~~)~~ by approved methods at no additional cost to the Government. If the Contractor options to use the prime coat, it shall be applied as soon as possible after consolidation of the underlying material. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper. Immediately after application, the building paper shall be removed and destroyed.

3.4.3 Tack Coat

Tack coat shall be applied at the locations shown on the drawings.

3.5 CURING PERIOD

Following application of the bituminous material and prior to application of the succeeding layer of pavement, the bituminous coat shall be allowed to cure and to obtain evaporation of any volatiles or moisture. ~~[~~Prime coat shall be allowed to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course.~~]~~

3.6 FIELD QUALITY CONTROL

Samples of the bituminous material ~~[shall be tested for compliance with the applicable specified requirements. A sample shall be obtained and tested by the Contractor for every [[_____] metric tons] [[_____] liters] of bituminous material used] [~~used shall be obtained by the Contractor as directed, under the supervision of the Contracting Officer. The sample ~~may~~ will be retained and tested by the Government at no cost to the Contractor~~]~~.

3.7 SAMPLING AND TESTING

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

3.7.1 Sampling

The samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140 or AASHTO T 40. Sources from which bituminous materials are to be obtained shall be selected and notification furnished the Contracting Officer within 15 days after the award of the contract.

3.7.2 Calibration Test

The Contractor shall furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibration shall be made with the approved job material and prior to applying the bituminous coat material to the prepared surface. Calibration of the bituminous distributor shall be in accordance with ASTM D 2995.

3.7.3 Trial Applications

Before providing the complete bituminous coat, three lengths of at least 30 meters for the full width of the distributor bar shall be applied to evaluate the amount of bituminous material that can be satisfactorily applied.

3.7.3.1 Tack Coat Trial Application Rate

Unless otherwise authorized, the trial application rate of bituminous tack coat materials shall be applied in the amount of 0.20 liters per square meter. Other trial applications shall be made using various amounts of material as may be deemed necessary.

3.7.3.2 Prime Coat Trial Application Rate

Unless otherwise authorized, the trial application rate of bituminous materials shall be applied in the amount of 1.10 liters per square meter. Other trial applications shall be made using various amounts of material as may be deemed necessary.

3.7.4 Sampling and Testing During Construction

Quality control sampling and testing shall be performed as required in paragraph FIELD QUALITY CONTROL.

<&

SECTION 02754A

CONCRETE PAVEMENTS FOR SMALL PROJECTS
07/01

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 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	(1999) Standard Specifications for Structural Concrete
ACI 305R	(1999) Hot Weather Concreting

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 184/A 184M	(1996) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615/A 615M	(2000) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 31/C 31M	(2000) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1999ael) Concrete Aggregates
ASTM C 39/C 39M	(1999) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94/C 94M	(2000) Ready-Mixed Concrete
ASTM C 123	(1998) Lightweight Particles in Aggregate
ASTM C 143/C 143M	(2000) Slump of Hydraulic Cement Concrete
ASTM C 150	(1999a) Portland Cement
ASTM C 192/C 192M	(2000) 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	(2000) Air-Entraining Admixtures for Concrete
ASTM C 494/C 494M	(1999a) Chemical Admixtures for Concrete
ASTM C 595	(2000a) Blended Hydraulic Cements
ASTM C 618	(2000) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 666	(1997) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C 881	(1999) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 989	(1999) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1077	(1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1260	(1994) Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
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

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 130	(1989) Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing 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 READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1996) Concrete Plant Standards

1.2 SYSTEM DESCRIPTION

This section is intended to stand alone for construction of concrete (rigid) pavement. However, where the construction covered herein interfaces with other sections, the construction at each interface shall conform to the requirements of both this section and the other section, including tolerances for both.

1.3 ~~MEASUREMENT AND PAYMENT~~NOT USED

~~1.3.1 Measurement~~

~~The quantity of concrete to be paid for will be the volume of concrete in cubic meters including monolithic curb, where required, placed in the completed and accepted pavement. Concrete will be measured in place in the completed and accepted pavement only within the neat line dimensions shown in the plan and cross section. No deductions will be made for rounded edges or the space occupied by embedded items or voids.~~

~~1.3.2 Payment~~

~~Payment will be made at the contract price per cubic meter for the scheduled item. Payment will constitute full compensation for furnishing all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement. No separate payment will be made for any cementitious materials, admixtures, steel reinforcement, dowels or tie bars, or for any joint materials.~~

1.4 ACCEPTABILITY OF WORK

The pavement will be accepted on the basis of tests made by the Government and by the Contractor or its suppliers, as specified herein. The Government may, at its discretion, make check tests to validate the results of the Contractor's testing. Concrete samples shall be taken by the Contractor at the placement to determine the slump, air content, and strength of the concrete. Test cylinders shall be made for determining conformance with the strength requirements of these specifications and, when required, for determining the time at which pavements may be placed into service. All air content measurements shall be determined in accordance with ASTM C 231. All slump tests shall be made in accordance with ASTM C 143/C 143M. All test cylinders shall be 150 by 300 mm cylinders and shall be fabricated in accordance with ASTM C 192/C 192M, using only steel molds, cured in accordance with ASTM C 31/C 31M, and tested in accordance with ASTM C 39/C 39M. 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. The Contractor shall furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory.

1.4.1 Evaluation Sampling

Sampling, testing, and mixture proportioning shall be performed by a commercial Testing Laboratory, conforming with ASTM C 1077. The individuals who sample and test concrete and concrete constituents shall be certified as American Concrete Institute (ACI) Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete shall be certified as ACI Concrete Construction Inspector, Level II. All mix design, weekly quality control reports, smoothness reports, and project certification reports shall be signed by a Registered Engineer.

1.4.2 Surface Testing

Surface testing for surface smoothness ~~[~~, edge slump~~]~~ and plan grade shall be performed as indicated below by the Testing Laboratory. The measurements shall be properly referenced in accordance with paving lane identification and stationing, and a report given to the Government within 24 hours after measurement is made. A final report of surface testing, signed by a Registered Engineer, containing all surface measurements and a description of all actions taken to correct deficiencies, shall be provided to the Government upon conclusion of surface testing.

1.4.2.1 Surface Smoothness Requirements

The finished surfaces of the pavements shall have no abrupt change of 3 mm or more, and all pavements shall be within the tolerances specified in Table 1 when checked with the straightedge.

TABLE 1
STRAIGHTEDGE SURFACE SMOOTHNESS--PAVEMENTS

Pavement Category	Direction of Testing	Tolerances mm
~~Runways and Taxiways~~	~~Longitudinal~~	~~3~~
	~~Transverse~~	~~6.5~~
~~Calibration Hardstands & Compass Swinging Bases~~	~~Longitudinal~~	~~3~~
	~~Transverse~~	~~3~~
~~All Other Airfield and Helicopter Paved Areas~~	~~Longitudinal~~	~~6.5~~
	~~Transverse~~	~~6.5~~
Roads and Streets	Longitudinal	5
	Transverse	6.5
Tank Hardstands, Parking Areas, Open Storage Areas	Longitudinal	6.5
	Transverse	6.5

1.4.2.2 Surface Smoothness Testing Method

The surface of the pavement shall be tested with the straightedge to identify all surface irregularities exceeding the tolerances specified above. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines approximately 4.5 m apart. 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 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.

1.4.3 Edge Slump Testing and Conformance

When slip-form paving is used, not more than 15 percent of the total free edge ~~[of any 255 mm or thicker slab]~~ of the slipformed portion of the pavement, shall have an edge slump exceeding 6 mm and no slab shall have an edge slump exceeding 9 mm. Edge slump shall be determined as above for

surface smoothness, at each free edge of each slipformed paving lane constructed. Measurements shall be made at 1.5 to 4.5 m spacings, and as directed. When edge slump exceeding the limits specified above is encountered on either side of the paving lane, additional straightedge measurements shall be made, if required, to define the linear limits of the excessive slump. The concrete for the entire width of the paving lane within these limits of excessive edge slump shall be removed and replaced. Adding concrete or paste to the edge or otherwise manipulating the plastic concrete after the sliding form has passed, or patching the hardened concrete, shall not be used as a method for correcting excessive edge slump.

1.4.4 Plan Grade Testing and Conformance

The finished surface of the pavements shall conform, within the tolerances shown in Table 1, to the lines, grades, and cross sections shown. The finished surface of new abutting pavements shall coincide at their juncture. The finished surface of ~~airfield runway, taxiway, and apron pavements shall vary not more than 12 mm above or below the plan grade line or elevation indicated. The surfaces of other~~ pavements shall vary not more than 18 mm above or below the plan grade line or elevation indicated. Each pavement category shall be checked by the Contractor for conformance with plan grade requirements by running lines of levels at intervals to determine the elevation at each joint intersection.

1.5 PRECONSTRUCTION TESTING OF MATERIALS

The Contractor shall not be entitled to any additional payment or extension of time because of delays caused by sampling and testing additional sources, or samples, necessitated by failure of any samples. Aggregates shall be sampled and tested by the Test Laboratory and shall be representative of the materials to be used for the project. Test results, signed by a Registered Engineer, shall be submitted ~~[120] [45~~30] ~~[_____]~~ days before commencing paving. No aggregate shall be used unless test results show that it meets all requirements of these specifications, including compliance with ASTM C 33, and ASTM C 1260, and deleterious materials limitations.

1.6 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; ~~[_____]~~ G, ~~[_____]~~RE

Manufacturer's literature on the concrete plant; mixing equipment; hauling equipment; placing and finishing, and curing equipment; at least ~~7~~30 days prior to start of paving.

Paving; ~~[_____]~~ G, ~~[_____]~~RE

Paving Schedules at least 7 days prior to start of paving.

Mixture Proportions; G, ~~[_____]~~EC-GD

The report of the Contractor's mixture proportioning studies showing the proportions of all ingredients and supporting information and certified laboratory test reports on aggregate and other materials that will be used in the manufacture of concrete, at least ~~14~~30 days prior to commencing concrete placing operations. Submittal shall include strength test data and analysis for compressive strength, concrete average strength, and manufacturers certification of compliance for admixtures.

Materials; G, RE

Manufacturers certificate of compliance demonstrating compliance with specified requirements for admixtures, curing compound, joint materials, reinforcing, dowels and tie bars, and epoxy resin.

1.7 EQUIPMENT

1.7.1 Batching and Mixing

The batching plant shall conform to NRMCA CPMB 100, the equipment requirements in ASTM C 94/C 94M, and as specified. Water shall not be weighed or measured cumulatively with another ingredient. All concrete materials batching shall meet ASTM C 94/C 94M requirements. Mixers shall be ~~[~~stationary mixers~~]~~ or ~~[~~truck mixers (truck mixers may be used for fixed form placements only)~~]~~. ~~[~~Truck mixers shall not be used for mixing paving concrete for slipform placements.~~]~~ Batching, mixers, mixing time, permitted reduction of mixing time, and concrete uniformity shall meet the requirements of ASTM C 94/C 94M, and shall be documented in the initial weekly QC Report.

1.7.2 Transporting Equipment

Transporting equipment shall be in conformance with ASTM C 94/C 94M and as specified herein. Concrete shall be transported to the paving site in rear-dump trucks, in truck mixers designed with extra large blading and rear opening specifically for low slump concrete, or in agitators. Bottom-dump trucks shall not be used for delivery of concrete.

1.7.3 Delivery Equipment

When concrete transport equipment cannot operate on the paving lane, side-delivery transport equipment consisting of self-propelled moving conveyors shall be used to deliver concrete from the transport equipment and discharge it in front of the paver. Front-end loaders, dozers, or similar equipment shall not be used to distribute the concrete.

1.7.4 Paver-Finisher

The paver-finisher shall be a heavy-duty, self-propelled machine designed specifically for paving and finishing high quality pavement. ~~[The paver-finisher shall weigh at least 3280 kg per m of lane width, and shall be powered by an engine having at least 15000 W per meter of lane width.]~~ The paver-finisher shall spread, consolidate, and shape the plastic concrete to the desired cross section in one pass. The paver-finisher shall be equipped with a full width "knock-down" auger, capable of operating in both directions, which will evenly spread the fresh concrete in front of the screed or extrusion plate. Immersion vibrators shall be gang mounted at the front of the paver on a frame equipped with suitable controls so that all vibrators can be operated at any desired depth within

the slab or completely withdrawn from the concrete. The vibrators shall be automatically controlled so that they will be immediately stopped as forward motion of the paver ceases. The spacing of the immersion vibrators across the paving lane shall be as necessary to properly consolidate the concrete, but the clear distance between vibrators shall not exceed 750 mm, and the outside vibrators shall not exceed 300 mm from the edge of the lane. The paver-finisher shall be equipped with a transversely oscillating screed or an extrusion plate to shape, compact, and smooth the surface.

1.7.4.1 Paver-Finisher with Fixed Forms

The paver-finisher shall be equipped with wheels designed to ride on the forms~~, ~~. ~~keep it~~The paver-finisher shall be designed to stay aligned with the forms, and to spread the concrete without causing~~preventing~~ deformation, displacement, or misalignment of the forms.

1.7.4.2 Slipform Paver-Finisher

The slipform paver-finisher shall be automatically controlled and crawler mounted with padded tracks. Horizontal alignment shall be electronically referenced to a taut wire guideline. Vertical alignment shall be electronically referenced on both sides of the paver to a taut wire guideline, to an approved laser control system, or to a ski operating on a completed lane. Control from a slope-adjustment control or control operating from the underlying material shall not be used.

1.7.4.3 Other Types of Finishing Equipment

~~[~~Bridge deck finishers ~~shall~~may be used for pavements 250 mm or less in thickness, where longitudinal and transverse surface smoothness tolerances are 6.5 mm ~~or greater.]~~ Clary screeds or other rotating tube floats ~~will~~ shall not be allowed on the project.

1.7.5 Curing Equipment

Equipment for curing is specified in paragraph CURING.

1.7.6 Texturing Equipment

Texturing equipment shall be as specified below.

1.7.6.1 Fabric Drag

A fabric drag shall consist of a piece of fabric material as wide as the lane width securely attached to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. The material shall be wide enough to provide 300 to 450 mm dragging flat on the pavement surface. ~~[~~The fabric material shall be clean, reasonably new burlap, kept clean and saturated during use~~] [The fabric material shall be an artificial turf fabricated of a plastic material]~~.

~~1.7.6.2 Deep Texturing Equipment~~

~~Texturing equipment shall consist of [a stiff bristled broom] [a comb with spring wire tines] [spring strips which will produce true, even grooves] forming a drag at least 1.2 m long. This drag shall be mounted in a wheeled frame spanning the paving lane and constructed to mechanically pull the drag in a straight line across the paving lane perpendicular to the centerline.~~

1.7.7 Sawing Equipment

Equipment for sawing joints and for other similar sawing of concrete shall be standard diamond-tip-bladed concrete saws mounted on a wheeled chassis.

1.7.8 Straightedge

The Contractor shall furnish and maintain at the job site one 4 m straightedge for testing concrete surface smoothness. The straightedge shall be constructed of aluminum or magnesium alloy and shall have blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Straightedges shall have handles for operation on the pavement.

PART 2 PRODUCTS

2.1 CEMENTITIOUS MATERIALS

Cementitious materials shall be ~~[~~portland cement, ~~[and pozzolan]] [~~ portland-pozzolan cement, ~~] [portland blast-furnace slag cement]~~or ~~[only~~ portland cement in combination with ~~[~~pozzolan~~]~~ or ~~[~~ground granulated blast furnace slag, ~~]]~~ and shall conform to ~~appropriate~~the specifications listed below.

2.1.1 Portland Cement

Portland cement shall conform to ASTM C 150 ~~[~~Type II, low-alkali~~] [Type V, low-alkali]~~.

~~2.1.2 High-Early-Strength Portland Cement~~

~~High-early-strength cement shall conform to ASTM C 150 Type III, with C3A limited to [5] [8] percent, [low-alkali].~~

2.1.2 Blended Cements

Blended cement shall conform to ASTM C 595 Type ~~[~~IP, meeting the mortar expansion requirements.

2.1.3 Pozzolan (Fly Ash)

Fly ash shall conform to ASTM C 618 Class C or F, including all the supplementary optional physical and chemical requirements. Loss on ignition shall not exceed 3 percent. Fly ash, when used to mitigate alkali-aggregate reactivity, shall have a Calcium Oxide (CaO) content of less than 8 percent. Fly ash shall conform to EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

2.1.4 Ground Granulated Blast-Furnace Slag (GGBF Slag)

Ground granulated blast-furnace slag shall conform to ASTM C 989 Grade 120.

2.2 AGGREGATES

Aggregates shall consist of clean, hard, uncoated particles meeting the quality and gradation requirements of ASTM C 33, and the other requirements specified herein. Coarse aggregate shall have a satisfactory service

record of at least 5 years successful service in three paving projects or, if a new source is used, shall meet the requirements when tested for resistance to freezing and thawing. Aggregate not having a satisfactory demonstrable service record shall have a durability factor of 50 or more when subjected to freezing and thawing in concrete in accordance with ASTM C 666 Procedure A. Optionally, coarse aggregate shall comply with the Kansas Department of Transportation (KDOT) Durability Class 2 requirements. A list of sources designated by KDOT as meeting the durability requirements for Class 2 aggregates may be obtained from KDOT by contacting the KDOT Research Materials Laboratory, 2300 Van Buren, Topeka, Kansas 66611. The State freeze-thaw durability testing of aggregate sources may be used provided the testing was accomplished within the past 3 years prior to use in the paving.

2.2.1 Aggregate Sources

Fine and coarse aggregates proposed for use in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate reactivity in accordance with ASTM C 1260. Test results shall have a measured expansion equal to or less than 0.08 percent at 16 days after casting. Should the test data indicate an expansion greater than 0.08 percent, the aggregate(s) shall be rejected, or additional testing, using a modified version of ASTM C 1260, shall be performed by the Contractor as described below. ASTM C 1260 shall be modified as follows to include one of the following options:

a. Utilize the Contractor's proposed low alkali portland cement and Class F fly ash in combination for the test proportioning. Class F fly ash shall contain less than 8 percent Calcium Oxide (CaO) and shall be used in the range of 25 to 40 percent of the total cementitious material by mass. The quantity shall be determined that will meet all the requirements of these specifications and which will lower the expansion equal to or less than ~~0.1~~0.08 percent at 16 days after casting.

b. Utilize the Contractor's proposed low alkali portland cement and ground granulated blast furnace (GGBF) slag in combination for the test proportioning. GGBF slag shall be used in the range of 40 to 50 percent of the total cementitious material by mass. The quantity shall be determined that will meet all the requirements of these specifications and which will lower the expansion equal to or less than ~~0.1~~0.08 percent at 16 days after casting.

c. Change the source or type of cement or try using a blended cement conforming to ASTM C 595 and meeting the mortar expansion requirement. The replacement cement shall be selecteded that will meet all the requirements of these specifications and which will lower the expansion equal to or less than 0.08 percent at 16 days after casting.

If any of the above options does not lower the expansion equal to or less than ~~0.1~~0.08 percent at 16 days after casting, the aggregate(s) shall be rejected and the Contractor shall submit new aggregate sources for retesting. The results of the testing shall be submitted to the Contracting Officer for evaluation and acceptance.

2.2.1 Coarse Aggregate

Coarse aggregate shall consist of ~~[~~crushed~~]~~ or ~~[~~uncrushed~~]~~ gravel, crushed stone, or a combination thereof. ~~[Aggregate used for paving compass~~

~~calibration hardstands shall be free of materials having magnetic properties.] [Coarse aggregate used for paving power check pads shall be limestone, dolomite, or basalt, or another aggregate if that aggregate has a proven service record demonstrating that it will not cause thermal distress from jet blast.]~~ The nominal maximum size of the coarse aggregate shall be ~~[~~19.0~~] [25.0] [27.5]~~ mm~~.~~, and shall conform to the gradation in ASTM C 33. ~~When the nominal maximum size is greater than 25.0 mm, the aggregates shall be furnished in two ASTM C 33 size groups, No. 67 and No. 4.~~ The ~~amount of deleterious material in each size of~~quality of coarse aggregate shall ~~not exceed the limits shown in~~conform to ASTM C 33 Class ~~1N, 4M or 4~~5S, except that abrasion loss shall be less than 40 percent. In addition coarse aggregate shall conform to the~~depending on the weathering region, and the~~ following limits:

a. Lightweight particles 1.0 max. percent by mass (ASTM C 123).

b. Other soft particles 2.0 max. percent by mass (COE CRD-C 130).

c. Total of all deleterious 5.0 max. percent by mass (substances listed in ASTM C 33 and above, exclusive of material finer than 0.075 mm sieve).

d. The separation medium for lightweight particles shall have a density of 2.0 Mg/cubic meters.

2.2.2 Fine Aggregate

Fine aggregate shall consist of natural sand, manufactured sand, or a combination of the two, and shall be composed of clean, hard, durable particles. ~~[Aggregate used for paving compass calibration hardstands shall be free of materials having magnetic properties.] All f~~Fine aggregate shall conform to the ~~be composed of clean, hard, durable particles meeting~~ quality and gradation ~~the~~ requirements of ASTM C 33~~ and the requirements herein. The amount of deleterious material in the fine aggregate shall not exceed the limits in ASTM C 33,and shall not exceed the~~ except the limit on coal and lignite shall not exceed 0.25 percent, and shall conform to the following limits:

a. Lightweight particles (ASTM C 123) 1.0 percent max. by mass using a medium with a density of 2.0 Mg/cubic meter.

b. The total of all deleterious material types, listed in ASTM C 33 and above, shall not exceed 3.0 percent of the mass of the fine aggregate.

2.3 CHEMICAL ADMIXTURES

Air-entraining admixture shall conform to ASTM C 260. An accelerator shall be used only when specified in paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES and shall not be used to reduce the amount of cementitious material used. Accelerator shall conform to ASTM C 494/C 494M Type C. Calcium chloride and admixtures containing calcium chloride shall not be used. A water-reducing or retarding admixture shall meet the requirements of ASTM C 494/C 494M. Type ~~G~~F or ~~H~~G admixtures are not allowed.

2.4 CURING MATERIALS

Membrane forming curing compound shall be a white pigmented compound

conforming to COE CRD-C 300. Burlap shall be new or shall be clean material never used for anything other than curing concrete.

2.5 WATER

Water for mixing and curing shall be clean, potable, and free of injurious amounts of oil, acid, salt, or alkali.

2.6 JOINT MATERIALS

2.6.1 Expansion Joint Material

Expansion joint filler shall be a preformed material conforming to ~~[~~ASTM D 1751~~]~~ or ~~[~~ASTM D 1752 ~~Type [I] [II] [III]]~~. Expansion joint filler shall be 20 mm thick. The expansion joint filler material shall be certified by the manufacturer to be compatible with the joint sealants used in the work. Do not use bituminous joint filler if joint sealer is non-bituminous.

2.6.2 Slip Joint Material

Slip joint material shall be 6 mm thick expansion joint filler conforming to ASTM D 1751 or ASTM D 1752. The expansion joint filler material shall be certified by the manufacturer to be compatible with the joint sealants used in the work. Do not use bituminous joint filler if joint sealer is non-bituminous.

~~2.6.3 Contraction Joint Inserts~~

~~Sawable contraction joint inserts shall conform to COE CRD-C 540. [Nonsawable contraction joint inserts shall have sufficient stiffness to permit placement in plastic concrete without deviation from a straight line and shall conform to the physical requirements of COE CRD-C 540, with the exception of resistance to sawing. Material for polyvinyl chloride inserts shall conform to COE CRD-C 572.] No metal inserts of any kind shall be used.~~

2.7 REINFORCING

2.7.1 General

Reinforcing bars shall conform to ASTM A 615/A 615M Grade ~~[_____]~~60. Bar mats shall conform to ASTM A 184/A 184M. Reinforcement shall be free from loose, flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce the bond with concrete.

2.7.1.1 Welded Wire Mesh

Wire mesh reinforcement shall conform to ASTM A 185. Use of rolled mesh is specifically prohibited. Wire mesh shall be supplied in flat sheets.

~~2.7.2 Steel Fiber Reinforcing~~

~~Minimum ultimate tensile strength of the fibers shall be 345 MPa. The maximum aspect ratio (length divided by diameter) shall not exceed 100. Fibers longer than 60 mm shall not be used. The fibers shall be deformed and shall be furnished in small bundles adhered with water soluble glue.~~

2.8 DOWELS AND TIE BARS

2.8.1 Dowels

Dowels shall be single piece, plain (non-deformed) steel bars conforming to ASTM A 615/A 615M Grade ~~60~~60 or higher. Dowels shall be free of loose, flaky rust and loose scale and shall be clean and straight.

2.8.2 Tie Bars

Tie bars shall be deformed steel bars conforming to ASTM A 615/A 615M Grade ~~[_____]~~60. Grade ~~60~~60 or higher shall not be used for bars that are bent and straightened during construction.

2.9 EPOXY RESIN

All epoxy-resin materials shall be two-component materials conforming to ASTM C 881, Class as appropriate for each application temperature to be encountered; except, that in addition, the materials shall meet the following requirements:

a. Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.

b. Material for use as patching for complete filling of spalls, wide cracks, and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.

c. Material for injecting cracks shall be Type IV, Grade 1.

d. Material for bonding freshly mixed portland cement concrete, mortar, or freshly mixed epoxy resin concrete to hardened concrete shall be Type V, Grade as approved.

2.10 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

Specified compressive strength, f'c, for concrete is ~~[_____]~~5,000 MPa at 28 days. Maximum allowable water-cementitious material ratio is ~~[~~0.45. The water-cementitious material ratio is based on absolute volume equivalency, where the ratio is determined using the weight of cement for a cement only mix, or using the total volume of cement plus pozzolan converted to an equivalent weight of cement by the absolute volume equivalency method described in ACI 211.1. The concrete shall be air-entrained with a total air content of ~~[~~6~~]~~ ~~[~~4~~]~~ plus or minus 1 percent. The maximum allowable slump of the concrete shall be 75 mm for pavement constructed with fixed forms. ~~[~~For slipformed pavement, the maximum allowable slump shall be 30 mm. ~~]~~ 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. 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.

2.11 MIXTURE PROPORTIONS

2.11.1 Composition

Concrete shall be composed of cementitious material, water, fine and coarse aggregates, and admixtures. The cementitious material shall be portland cement, blended cement, or only portland cement in combination with

pozzolan or ground granulated blast-furnace slag. Fly ash, if used with non alkali-reactive aggregates, shall consist of not less than 15 percent of the cementitious material by mass and not more than 35 percent. GGBF slag, if used with non alkali-reactive aggregates, shall consist of not less than 20 percent of the cementitious material by mass and not more than 50 percent. If Class F fly ash or GGBF slag is required to mitigate potential alkali-aggregate reactivity, the percentage by mass determined from the modified ASTM C 1260 testing shall be used in the mixture proportioning studies. The total cementitious material content shall be at least ~~310~~280 kg/cubic meter. Admixtures shall consist of air entraining and water-reducing admixtures, and may also include an accelerator or retarder as approved or directed. Water-reducer shall be used only at the dosage determined during mixture proportioning studies. High range water-reducing admixtures and admixtures to produce flowable concrete shall not be used. No substitutions shall be made in the materials used in the mixture proportions without additional tests to show that the quality of the concrete is satisfactory.

2.11.2 Concrete Mixture Proportioning Studies

Trial design batches, mixture proportioning studies, and testing shall be the responsibility of the Contractor, and shall be performed by the Test Laboratory and signed by a Registered Engineer. No concrete pavement shall be placed until the Contracting Officer has approved the Contractor's mixture proportions. All materials used in mixture proportioning studies shall be representative of those proposed for use on the project. If there is a change in materials, additional mixture design studies shall be made using the new materials. Trial mixtures having proportions, slumps, and air content suitable for the work shall be based on methodology described in ACI 211.1. At least three different water-cementitious ratios, which will produce a range of strength encompassing that required on the project, shall be used. Laboratory trial mixtures shall be proportioned for maximum permitted slump and air content. Maximum sand content shall be 40 percent of the total aggregate SSD weight. Aggregate quantities shall be based on the mass in a saturated surface dry condition.

2.11.3 Mixture Proportioning Procedure

The Contractor shall perform the following:

a. Fabricate, cure and test 6 test cylinders per age for each mixture at 7 and 28 days.

b. Using the average strength for each w/(c+p), plot the results from each of the three mixtures on separate graphs for w/(c+p) versus 28-day strength.

c. From the graphs select a w/(c+p) which will produce a mixture giving a 28-day strength equal to the required strength determined in accordance with the following paragraph.

2.11.4 Average Strength Required for Mixtures

In order to ensure meeting, during production, the strength requirements specified, the mixture proportions selected shall produce a required average strength, f'cr, exceeding the specified strength, f'c, in accordance with procedures in Chapter 3 of ACI 301, "Proportioning."

PART 3 EXECUTION

3.1 CONDITIONING OF UNDERLYING MATERIAL

Underlying material, ~~[subgrade] [base course] [subbase course],~~ upon which concrete is to be placed shall be clean, damp, and free from debris, waste concrete or cement, frost, ice, and standing or running water. After the underlying material has been prepared for concrete placement, no equipment shall be permitted thereon.

3.2 WEATHER LIMITATIONS

3.2.1 Hot Weather Paving

The temperature of concrete shall not exceed 32 degrees C. Steel forms, dowels and reinforcing shall be cooled prior to concrete placement when steel temperatures are greater than 49 degrees C.

3.2.2 Cold Weather Paving

The ambient temperature of the air at the placing site and the temperature of surfaces to receive concrete shall be not less 5 degrees C. The temperature of the concrete when placed shall be not less than 10 degrees C.

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, chemical admixture conforming to ASTM C 494/C 494M Type C or E may be used provided it contains no calcium chloride.~~]~~ Calcium chloride shall not be used at any time. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 10 degrees C for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period. Pavement damaged by freezing shall be completely removed and replaced at the Contractor's expense as specified in paragraph, REPAIR, REMOVAL, AND REPLACEMENT OF SLABS.

3.3 CONCRETE PRODUCTION

3.3.1 General Requirements

Concrete shall be deposited in front of the paver within 45 minutes from the time cement has been charged into the mixing drum, except that if the ambient temperature is above 32 degrees C, the time shall be reduced to 30 minutes. Every load of concrete delivered to the paving site shall be accompanied by a batch ticket from the operator of the batching plant. Tickets shall show at least the mass, or volume, of all ingredients in each batch delivered, ~~[~~the water meter and revolution meter reading on truck mixers~~]~~ and the time of day. Tickets shall be delivered to the placing foreman who shall keep them on file and deliver them to the Government daily.

3.3.2 Transporting and Transfer-Spreading Operations

Non-agitating equipment shall be used only on smooth roads and for haul time less than 15 minutes. ~~[No equipment shall be allowed to operate on the prepared and compacted underlying material in front of the paver-finisher.]~~ [Equipment shall be allowed to operate on the underlying material only if no damage is done to the underlying material and its degree of compaction. Any disturbance to the underlying material that does occur shall be corrected before the paver-finisher reaches the location of the disturbance and the equipment shall be replaced or procedures changed

to prevent any future damage.] [Additional water may be added to truck mixers to bring the slump within the specified range provided the mixture water-cement ratio is not exceeded.]

3.4 PAVING

Pavement shall be constructed with paving and finishing equipment utilizing [fixed forms] or [slipforms].

3.4.1 Consolidation

The paver vibrators shall be inserted into the concrete not closer to the underlying material than 50 mm. The vibrators or any tamping units in front of the paver shall be automatically controlled so that they shall be stopped immediately as forward motion ceases. Excessive vibration shall not be permitted. Concrete in small, odd-shaped slabs or in locations inaccessible to the paver mounted vibration equipment shall be vibrated with a hand-operated immersion vibrator. Vibrators shall not be used to transport or spread the concrete.

3.4.2 Operation

When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provisions shall be made to prevent damage to the previously constructed pavement, including keeping the existing pavement surface free of any debris, and placing rubber mats beneath the paver tracks. Transversely oscillating screeds and extrusion plates shall overlap the existing pavement the minimum possible, but in no case more than 200 mm.

3.4.3 Required Results

The paver-finisher shall be operated to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The paver-finishing operation shall produce a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities. It shall produce only a very minimum of paste at the surface. Multiple passes of the paver-finisher shall not be permitted. The equipment and its operation shall produce a finished surface requiring no hand finishing, other than the use of cutting straightedges, except in very infrequent instances. No water, other than true fog sprays (mist), shall be applied to the concrete surface during paving and finishing.

3.4.4 Fixed Form Paving

Forms shall be steel, except that wood forms may be used for curves having a radius of 45 m or less, and for fillets. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. The base width of the form shall be not less than eight-tenths of the vertical height of the form, except that forms 200 mm or less in vertical height shall have a base width not less than the vertical height of the form. Wood forms for curves and fillets shall be adequate in strength and rigidly braced. Forms shall be set on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Forms shall not be set on blocks or on built-up spots of underlying material. [Forms for overlay pavements and for other locations where forms must be set on existing pavements shall be held securely in place with stakes or by other approved methods. Holes in existing pavements for form stakes shall

~~be carefully drilled without cracking or spalling the existing pavement. Prior to setting forms for paving operations, the Contractor shall demonstrate the proposed form setting procedures at an approved location and shall not proceed further until the proposed method is approved.]~~ Forms shall remain in place at least 12 hours after the concrete has been placed. Forms shall be removed without injuring the concrete.

3.4.5 Slipform Paving

The slipform paver shall shape the concrete to the specified and indicated cross section in one pass, and shall finish the surface and edges so that only a very minimum amount of hand finishing is required. Dowels shall not be installed by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete.

3.4.6 Placing Reinforcing Steel

Reinforcement shall be positioned on suitable chairs securely fastened to the subgrade prior to concrete placement, or may be placed on an initial layer of consolidated concrete, with the subsequent layer placed within 30 minutes of the first layer placement. ~~[If reinforcing for Continuously Reinforced Concrete Pavement (CRCP) is required, the entire operating procedure and equipment proposed shall be submitted for approval at least 30 days prior to proposed start of paving.]~~

3.4.7 Placing Dowels and Tie Bars

Dowels shall be installed with alignment not greater than 1 mm per 100 mm. Except as otherwise specified below, location of dowels shall be within a horizontal tolerance of plus or minus 15 mm and a vertical tolerance of plus or minus 5 mm. The portion of each dowel intended to move within the concrete or expansion cap shall be painted with one coat of rust inhibiting primer paint, and then oiled just prior to placement. ~~[~~Dowels~~]~~ ~~[~~and tie bars~~]~~ in joints shall be omitted when the center of the ~~[~~dowel~~]~~ or ~~[~~tie bar~~]~~ is located within a horizontal distance from an intersecting joint equal to or less than one-fourth of the slab thickness.

3.4.7.1 Contraction Joints

~~[~~Dowels~~]~~ ~~[~~and~~]~~ ~~[~~tie bars~~]~~ as shown in longitudinal and transverse contraction joints within the paving lane shall be held securely in place by means of rigid metal basket assemblies. The ~~[~~dowels~~]~~ ~~[~~and tie bars~~]~~ shall be welded to the assembly or held firmly by mechanical locking arrangements that will prevent them from becoming distorted during paving operations. The basket assemblies shall be held securely in the proper location by means of suitable anchors.

3.4.7.2 Construction Joints-Fixed Form Paving

Installation of ~~[~~dowels~~]~~ ~~[~~and tie bars~~]~~ shall be by the bonded-in-place method, supported by means of devices fastened to the forms. Installation by removing and replacing in preformed holes will not be permitted.

3.4.7.3 Dowels Installed in Hardened Concrete

Installation shall be by bonding the dowels into holes drilled into the hardened concrete. Holes approximately 3 mm greater in diameter than the dowels shall be drilled into the hardened concrete. Dowels shall be bonded in the drilled holes using epoxy resin injected at the back of the hole

before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel shall not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic collar fitted around the dowel. The vertical alignment of the dowels shall be checked by placing the straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel. ~~[~~Where tie bars are required in longitudinal construction joints of slipform pavement, bent tie bars shall be installed at the paver, in front of the transverse screed or extrusion plate. If tie bars are required, a standard keyway shall be constructed, and the bent tie bars shall be inserted into the plastic concrete through a 0.45 to 0.55 mm thick metal keyway liner. Tie bars shall not be installed in preformed holes. The keyway liner shall be protected and shall remain in place and become part of the joint. Before placement of the adjoining paving lane, the tie bars shall be straightened, without spalling the concrete around the bar.~~]~~

3.4.7.4 Expansion Joints

Dowels in expansion joints shall be installed by the bonded-in-place method or by bonding into holes drilled in hardened concrete, using procedures specified above.

3.5 FINISHING

Clary screeds, "bridge deck" finishers, or other rotating pipe or tube type equipment shall not be permitted. The sequence of machine operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Hand finishing shall be used only infrequently and only on isolated areas of odd slab shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Equipment to be used for supplemental hand finishing shall primarily be 3 to 4 m cutting straightedges; only very sparing use of bull floats shall be allowed. At no time shall water be added to the surface of the slab in any way, except for fog (mist) sprays to prevent plastic shrinkage cracking.

3.5.1 Machine Finishing With Fixed Forms

The machine shall be designed to ride the forms. Machines that cause displacement of the forms shall be replaced, concrete placements shall be stopped immediately until the equipment is repaired or replaced. The machine shall make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

3.5.2 Machine Finishing With Slipform Pavers

If there is sufficient concrete slurry or fluid paste on the surface that it runs over the edge of the pavement, the paving operation shall be immediately stopped and the equipment, mixture, or operation modified to prevent formation of such slurry. Any slurry which does run down the vertical edges shall be immediately removed. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is

plastic or after it hardens.

3.5.3 Surface Correction

While the concrete is still plastic, irregularities and marks in the pavement surface shall be eliminated by means of cutting straightedges, 3 to 4 m in length. Depressions shall be filled with freshly mixed concrete, struck off, consolidated, and refinished. Projections above the required elevation shall also be struck off and refinished. Long-handled, flat "bull floats" shall be used sparingly and only as necessary to correct minor, scattered surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Joints and edges shall not be overfinished.

3.5.4 Hand Finishing

Hand finishing operations shall be used only for those unusual slabs as specified previously. Grate tampers (jitterbugs) shall not be used. As soon as placed and vibrated, the concrete shall be struck off and screeded. The surface shall be tamped with a strike-off and tamping screed, or vibratory screed. Immediately following the final tamping of the surface, the pavement shall be floated longitudinally. Long-handled, flat bull floats shall be used sparingly and only as necessary to correct surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Joints and edges shall not be overfinished. No water shall be added to the pavement during finishing operations.

3.5.5 Texturing

Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement shall be given a texture as described herein. Following initial texturing on the first day of placement, the Placing Foreman, Contracting Officer representative, and a representative of the Using Agency shall inspect the texturing for compliance with design requirements. After curing is complete, all textured surfaces shall be thoroughly power broomed to remove all debris. ~~[Any type of transverse texturing shall produce grooves in straight lines across each lane within a tolerance of plus or minus 13 mm of a true line.]~~ The concrete in areas of recesses for ~~tie-down anchors~~storm drain inlets, lighting fixtures, and other outlets in the pavement shall be finished to provide a surface of the same texture as the surrounding area.

3.5.5.1 Fabric-Drag Surface Finish

Surface texture shall be applied by dragging the surface of the pavement, in the direction of the concrete placement, with a moist fabric drag. The dragging shall produce a uniform finished surface having a fine sandy texture without disfiguring marks.

~~3.5.5.2 Broom Texturing~~

~~Surface texture shall be applied using a mechanical stiff bristle broom drag of a type that will uniformly score the surface transverse to the pavement center line. The broom shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the broom shall be overlapped the minimum necessary to obtain a uniformly textured surface. The scores should be uniform in appearance and approximately 1.5 mm in depth but not more than 3 mm in depth. Hand brooming will be permitted only on isolated~~

~~odd shaped slabs or slabs where hand finishing is permitted.~~

~~3.5.5.3 Wire-Comb Texturing~~

~~Surface texture transverse to the pavement center line shall be applied using a mechanical wire comb drag. The comb shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the comb shall be overlapped the minimum necessary to obtain a continuous and uniformly textured surface. The scores shall be 2 to 5 mm deep, 1.5 to 3 mm wide, and spaced 10 mm apart.~~

~~3.5.5.4 Surface Grooving~~

~~The areas indicated on the drawings shall be grooved with a spring tine drag producing individual grooves 6 mm deep and 6 mm wide at a spacing between groove centerlines of 50 mm. These grooves shall be cut perpendicular to the centerline. Before grooving begins, the concrete shall be allowed to stiffen sufficiently to prevent dislodging of aggregate. Grooves shall not be cut within 150 mm of a transverse joint or crack.~~

3.5.6 Edging

~~[~~The edges of slipformed lanes shall not be edged.~~]~~ After texturing has been completed, the edge of the slabs along the forms shall be carefully finished with an edging tool to form a smooth rounded surface of 3 mm radius. No water shall be added to the surface during edging.

3.6 CURING

Concrete shall be continuously protected against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations. Unhardened concrete shall be protected from rain and flowing water. During hot weather with low humidity and/or wind, the Contractor shall institute measures to prevent plastic shrinkage cracks from developing. ACI 305R contains means of predicting plastic shrinkage cracking and preventative measures. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry. Curing shall be accomplished by one of the following methods.

3.6.1 Membrane Curing

A uniform coating of white-pigmented membrane-forming curing compound shall be applied to the entire exposed surface of the concrete including pavement edges as soon as the free water has disappeared from the surface after finishing. If evaporation is high and no moisture is present on the surface even though bleeding has not stopped, fog sprays shall be used to keep the surface moist until setting of the cement occurs. Curing compound shall then be immediately applied. Curing compound shall be applied to the finished surfaces by means of a self-propelled automatic spraying machine, equipped with multiple spraying nozzles with wind shields, spanning the newly paved lane. The curing compound shall be applied at a maximum application rate of 5 square meters per L. The application of curing compound by hand-operated, mechanical powered pressure sprayers will be permitted only on odd widths or shapes of slabs where indicated and on concrete surfaces exposed by the removal of forms. The compound shall form a uniform, continuous, cohesive film that will not check, crack, or peel

and that will be free from pinholes and other discontinuities. Areas where the curing compound develops the above defects or is damaged by heavy rainfall, sawing or other construction operations within the curing period, shall be immediately resprayed.

3.6.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, commencing immediately after finishing. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Impervious sheet curing shall not be used.

3.7 JOINTS

No deviation from the jointing pattern shown on the drawings shall be made without written approval of the Design District Pavement or Geotechnical Engineer. All joints shall be straight, perpendicular to the finished grade of the pavement, and continuous from edge to edge or end to end of the pavement with no abrupt offset and no gradual deviation greater than 13 mm.

3.7.1 Longitudinal Construction Joints

~~[~~Dowels~~]~~ ~~[Keys]~~ ~~[~~, or Tie bars~~]~~ shall be installed in the longitudinal construction joints, or the edges shall be thickened as indicated. ~~[The dimensions of the keyway shall not vary more than plus or minus 3 mm from the dimensions indicated and shall not deviate more than plus or minus 6 mm from the mid-depth of the pavement. If any length of completed keyway of 1.5 m or more fails to meet the above tolerances, dowels shall be installed.]~~

3.7.2 Transverse Construction Joints

Transverse construction joints shall be installed at a planned transverse joint, at the end of each day's placing operations and when concrete placement is interrupted. Transverse construction joints shall be constructed either by utilizing headers and hand placement and finishing techniques, or by placing concrete beyond the transverse construction joint location and then saw cutting full depth and removing concrete back to the transverse construction joint location. For the latter case, dowels shall be installed using methods for dowels installed in hardened concrete described above. All transverse construction joints shall be dowelled.

3.7.3 Expansion Joints

Expansion joints shall be formed where indicated, and about any structures and features that project through or into the pavement, using preformed joint filler of the type, thickness, and width indicated, and shall extend the full slab depth. Edges of the concrete at the joint face shall be edged. The joint filler strips shall be installed to form a recess at the pavement surface to be filled with joint sealant. Expansion joints shall be constructed with ~~[~~dowels~~]~~ or ~~[~~thickened edges~~]~~ as shown on the drawings for load transfer.

3.7.4 Slip Joints

Slip joints shall be installed the full depth of the slab using expansion joint preformed joint filler material attached to the face of the original

concrete placement. A reservoir for joint sealant shall be constructed at the top of the joint. Edges of the joint face shall be edged.

3.7.5 Contraction Joints

Transverse and longitudinal contraction joints shall be of the weakened-plane or dummy type. Longitudinal contraction joints shall be constructed by sawing a groove in the hardened concrete with a power-driven saw. Transverse contraction joints shall be constructed in conformance with requirements for ~~[~~sawed joints~~] [~~ contraction joints~~]~~.

3.7.5.1 Sawed Joints

Sawed contraction joints shall be constructed by sawing a groove in the concrete with a 3 mm blade to the indicated depth. The time of initial sawing shall vary depending on existing and anticipated weather conditions and shall be such as to prevent uncontrolled cracking of the pavement. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. The joints shall be sawed at the required spacing consecutively in the sequence of the concrete placement. Sawing at a given joint location shall be discontinued when a crack develops ahead of the saw cut. Immediately after the joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly flushed with water until all waste from sawing is removed from the joint. The surface shall be resprayed with curing compound as soon as free water disappears. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed with cord or backer rod before the concrete in the region of the joint is resprayed with curing compound.

~~3.7.5.2 Insert-Type Joints~~

~~Insert-type joints shall not be used for slipformed pavements. Insert-type non-metallic contraction joints shall be constructed by installing a preformed insert in the plastic concrete to form a weakened plane to induce cracking. Inserts shall be installed using a machine equipped with a vibrating bar for cutting a groove in the plastic concrete for placement of the insert or for vibrating the insert into place at the prescribed joint location. The installed insert shall be perpendicular to the finished grade of the pavement, with the top of the insert not more than 3 mm below the pavement surface.~~

3.7.6 Thickened Edge Joints

Underlying material in the transition area shall meet the requirements for smoothness and compaction specified for all other areas of the underlying material.

~~3.7.7 Special Joints~~

~~Special joints (undercut joints) shall be constructed adjacent to existing pavement as indicated. The concrete shall be worked under the edge of the existing pavement to completely fill the void and shall be thoroughly consolidated by the use of hand-held vibrators.~~

3.8 REPAIR, REMOVAL, AND REPLACEMENT OF SLABS

New pavement slabs that contain full-depth cracks shall be removed and replaced, as specified herein at no cost to the Government. Removal and

replacement shall be full depth, shall be full width of the paving lane, and the limit of removal shall be from each original transverse joint . The Contracting Officer will determine whether cracks extend full depth of the pavement and may require minimum 150 mm diameter cores to be drilled on the crack to determine depth of cracking. Cores shall be drilled and the hole later filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with epoxy resin. Drilling of cores and refilling holes shall be at no expense to the Government. Cracks that do not extend full depth of slab shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1. The Contractor shall ensure that the crack is not widened during epoxy resin injection. Where a full depth crack intersects the original transverse joint, the slab(s) containing the crack shall be removed and replaced, with dowels installed, as required below. Spalls along joints shall be repaired as specified.

3.8.1 Removal and Replacement of Full Slabs

Unless there are keys or dowels present, all edges of the slab shall be sawcut full depth. If keys, dowels, or tie bars are present along any edges, these edges shall be sawed full depth 150 mm from the edge if only keys are present, or just beyond the end of dowels or tie bars if they are present. These joints shall then be carefully sawed on the joint line to within 25 mm of the depth of the dowel or key. The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. The narrow strips along keyed or doweled edges shall be carefully broken up and removed. Care shall be taken to prevent damage to the dowels, tie bars, or keys or to concrete to remain in place. Protruding portions of dowels shall be painted and lightly oiled. The joint face below keys or dowels shall be suitably trimmed so that there is no abrupt offset. If underbreak occurs at any point along any edge, the area shall be hand-filled with concrete, producing an even joint face from top to bottom, before replacing the removed slab. If underbreak over 100 mm deep occurs, the entire slab containing the underbreak shall be removed and replaced. Where there are no dowels, tie bars, or keys on an edge, or where they have been damaged, dowels of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete. Original damaged dowels or tie bars shall be cut off flush with the joint face. All four edges of the new slab shall thus contain dowels or original keys or original tie bars. Prior to placement of new concrete, the underlying material shall be graded and recompacted, and the surfaces of all four joint faces shall be cleaned of all loose material and contaminants, and coated with a double application of membrane forming curing compound as bond breaker. Placement of concrete shall be as specified for original construction. The resulting joints around the new slab shall be prepared and sealed as specified.

3.8.2 Repairing Spalls Along Joints

Spalls along joints and cracks shall be repaired by first making a vertical saw cut at least 25 mm outside the spalled area and to a depth of at least 50 mm. Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete. The cavity shall be thoroughly cleaned with high pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Prime

coat for portland cement repairs shall be a neat cement grout and for epoxy resin repairs shall be epoxy resin, Type III, Grade 1. The cavity shall be filled with low slump portland cement concrete or mortar, or with epoxy resin concrete or mortar. Portland cement concrete shall be used for larger spalls, those more than 0.009 cubic meter in size after removal operations; portland cement mortar shall be used for spalls between 0.00085 and 0.009 cubic meter; and epoxy resin mortar or Type III, Grade 3 epoxy resin for those spalls less than 0.00085 cubic meter in size after removal operations. Portland cement concretes and mortars shall be very low slump mixtures, proportioned, mixed, placed, tamped, and cured. ~~[If the materials and procedures are approved in writing, latex modified concrete mixtures may be used for repairing spalls less than 0.009 cubic meter in size.]~~ Epoxy resin mortars shall be made with Type III, Grade 1, epoxy resin, using proportions, mixing, placing, tamping and curing procedures as recommended by the manufacturer. Any repair material on the surrounding surfaces of the existing concrete shall be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints. ~~[~~In lieu of sawing, spalls not adjacent to joints, and popouts, both less than 150 mm in maximum dimension, may be prepared by drilling a core 50 mm in diameter greater than the size of the defect, centered over the defect, and 50 mm deep or 13 mm into sound concrete, whichever is greater. The core hole shall be repaired as specified above for other spalls.~~]~~

3.8.3 Areas Defective in Plan Grade or Smoothness

In areas not meeting the specified limits for surface smoothness and plan grade, high areas shall be reduced to attain the required smoothness and grade, except as depth is limited below. High areas shall be reduced by grinding the hardened concrete with a surface grinding machine after the concrete is 14 days or more old. The depth of grinding shall not exceed 6 mm. All pavement areas requiring plan grade or surface smoothness corrections in excess of the specified limits, shall be removed and replaced. In pavement areas given a wire comb or tined texture, areas exceeding 2 square meters that have been corrected by rubbing or grinding shall be retextured by grooving machine sawn grooves meeting the requirements for the wire comb or tined texture. All areas in which grinding has been performed will be subject to the thickness tolerances specified in paragraph Thickness. Any grinding performed on individual slabs with excessive deficiencies shall be performed at the Contractor's own decision without entitlement to additional compensation if eventual removal of the slab is required.

3.9 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR

Existing concrete pavement shall be removed as indicated and as specified in Section 02220 DEMOLITION modified, and expanded as specified herein. Removal, repair and replacement shall be made as indicated and as specified in paragraph REPAIR, REMOVAL, AND REPLACEMENT OR SLABS.

3.10 PAVEMENT PROTECTION

The Contractor shall protect the pavement against all damage prior to final acceptance of the work. Traffic shall be excluded from the new pavement. As a construction expedient in paving intermediate lanes between newly paved pilot lanes, operation of the hauling equipment will be permitted on the new pavement after the pavement has been cured for 7 days and the

joints have been sealed or otherwise protected. All new and existing pavement carrying construction traffic or equipment shall be continuously kept completely clean. Special cleaning and care shall be used where Contractor's traffic uses or crosses active airfield pavement.

3.11 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL (CQC)

Paragraph ACCEPTABILITY OF WORK contains additional CQC requirements. 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 submit reports as specified. When, in the opinion of the Contracting Officer, the paving operation is out of control, concrete placement shall cease.

3.11.1 Batch Plant Control

A daily report shall be prepared indicating checks made for scale accuracy with test weights, checks of batching accuracy, and corrective action taken prior to and during placement for weighing or batching, 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 masses per cubic meter, amount of water as free moisture in each size of aggregate, and the batch aggregate and water masses per cubic meter for each class of concrete batched during each day's plant operation.

3.11.2 Concrete Mixture

a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two other tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of paving. Whenever air content reaches specified limits, an immediate confirmatory test shall be made. If the second test also shows air content at or exceeding specified limits, an adjustment shall immediately be made in the amount of air-entraining admixture batched to bring air content within specified limits. If the next adjusted batch of concrete is not within specified limits, concrete placement shall be halted until concrete air content is within specified limits.

b. Slump Testing. Slump tests shall be made when test specimens are fabricated. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Whenever slump approaches the maximum limit, an adjustment shall immediately be made in the batch masses of water and fine aggregate, without exceeding the maximum w/(c+p). When a slump result exceeds the specification limit, no further concrete shall be delivered to the paving site until adjustments have been made and slump is again within the limit.

c. Temperature. The temperature of the concrete shall be measured when strength specimens are fabricated.

d. Concrete Strength Testing. Four (4) cylinders from the same batch shall be fabricated, cured and tested for compressive strength, testing two cylinders at 7-day and two cylinders at 28-day age. A minimum of one set of four (4) cylinders shall be fabricated, cured and tested for each shift of concrete placement. Control charts for strength, showing the 7-day and 28-day CQC compressive

strengths, and the 28-day required compressive strength, shall be maintained and submitted with weekly CQC Reports.

3.11.3 Inspection Before Placing

Underlying materials, joint locations and types, construction joint faces, forms, reinforcing, dowels, and embedded items shall be inspected by a Registered Engineer in sufficient time prior to each paving operation 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, and the certification signed by the Registered Engineer, prior to each days' paving.

3.11.4 Paving Operations

The placing foreman shall supervise all placing and paving operations, shall determine that the correct quality of concrete is placed in each location as shown, shall insure that the concrete is consolidated full depth and that finishing is performed as specified. The placing foreman shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume of concrete placed, and method of paving and any problems encountered.

3.11.5 Curing Inspection

a. Moist Curing Inspections. Each 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. When any inspection finds an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for the area shall be extended by 1 day.

b. Membrane Curing Inspection. At the end of each day's placement, the CQC Representative shall determine the quantity of compound used by measurement of the container; shall determine the area of concrete surface covered; shall then compute the rate of coverage in square meters per L and shall also note whether or not coverage is uniform. 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.

3.11.6 Cold-Weather Protection

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

3.11.7 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report, signed by a registered engineer, shall be prepared for the updating of control charts and test data, and all CQC inspections and actions covering the entire period from the start of the construction through the current week. 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 CQC records. A copy of weekly reports shall be faxed to the Design District Pavement or Geotechnical Engineer. At the completion of concrete

placement, a certification report shall be prepared containing mix designs, all updated control charts and concrete test data, quality control reports, smoothness reports, and other pertinent data on the concrete, with a certification by a registered engineer that the concrete placed meets all specification requirements. A copy of the certification report shall be mailed to the Design District pavement or Geotechnical Engineer in EC-GD.

-- End of Section --

SECTION 02760A

FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS
03/97

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 this text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM D 789	(1998) Determination of Relative Viscosity and Moisture Content of Polyamide (PA)
ASTM D 3405	(1997) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements
ASTM D 3569	(1995) Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant-Type for Portland Cement Concrete Pavements
ASTM D 5893	(1996) Cold Applied, Single Component Chemically Curing Silicon Joint Sealant for Portland Cement Concrete Pavement

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 525	(1989) Corps of Engineers Test Method for Evaluation of Hot-Applied Joint Sealants for Bubbling Due to Heating

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-200	(Rev E; Am 2) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

1.2 ~~UNIT PRICES~~NOT USED

~~1.2.1 Measurement~~

~~The quantity of each sealing item to be paid for shall be determined by actual measurement of the number of linear meters of in-place material that has been approved by the Contracting Officer.~~

~~1.2.2 Payment~~

~~Payment shall be made at the contract unit bid prices per linear meter for~~

~~the sealing items scheduled. The unit bid prices shall include the cost of all labor, materials, and the use of all equipment and tools required to complete the work.~~

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

Manufacturer's Recommendations; G, ~~[_____]~~RE.

Where installation procedures, or any part thereof, are required to be in accordance with the manufacturer's recommendations, printed copies of these recommendations, ~~[_____]~~30 days prior to use on the project. Installation of the material will not be allowed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

Construction Equipment List

List of proposed equipment to be used in performance of construction work including descriptive data, ~~[_____]~~30 days prior to use on the project.

SD-04 Samples

Materials; G, ~~[_____]~~RE.

Samples of the materials (sealant, primer if required, and backup material), in sufficient quantity for testing. Samples will be retained by the Government for possible future testing.~~and approval [_____]~~ Submit samples 30 days prior to the beginning of work.~~ No material will be allowed to be used until it has been approved.~~

SD-07 Certificates

Materials; G, RE.

Certified certificate(s) with test data showing compliance with the laboratory test requirements. No material will be allowed to be used until it has been approved. Submit certificates at least 30 days prior to use in the work.

1.4 SAFETY

Joint sealant shall not be placed within 8 meters of any liquid oxygen (LOX) equipment, LOX storage, or LOX piping. Joints in this area shall be thoroughly cleaned and left unsealed.

1.5 TEST REQUIREMENTS

The joint sealant and backup or separating material shall be tested for

conformance with the referenced applicable material specification. ~~[The materials will be tested by the Government. No material shall be used at the project prior to receipt of written notice that the materials meet the laboratory requirements. The cost of the first test of samples shall be borne by the Government. If the samples fail to meet specification requirements, the materials represented by the sample shall be replaced and the new materials tested at the Contractor's expense.]~~ [Testing of the materials shall be performed in an approved independent laboratory and certified copies of the test reports shall be submitted and approved ~~[_____]~~ days prior to the use of the materials at the job site. Samples will be retained by the Government for possible future testing should the materials appear defective during or after application.~~]~~ Conformance with the requirements of the laboratory tests specified will not constitute final acceptance of the materials. Final acceptance will be based on the performance of the in-place materials.

1.6 EQUIPMENT

Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

1.6.1 Joint Cleaning Equipment

1.6.1.1 Tractor-Mounted Routing Tool

The routing tool used for removing old sealant from the joints shall be of such shape and dimensions and so mounted on the tractor that it will not damage the sides of the joints. The tool shall be designed so that it can be adjusted to remove the old material to varying depths as required. The use of V-shaped tools or rotary impact routing devices will not be permitted. Hand-operated spindle routing devices may be used to clean and enlarge random cracks.

1.6.1.2 Concrete Saw

A self-propelled power saw with water-cooled diamond or abrasive saw blades will be provided for cutting joints to the depths and widths specified or for refacing joints or cleaning sawed joints where sandblasting does not provide a clean joint.

1.6.1.3 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening should not exceed 6.4 mm ~~(1/4 inch)~~. The air compressor shall be portable and shall be capable of furnishing not less than 71 liters per second ~~(150 cubic feet per minute)~~ and maintaining a line pressure of not less than 621 kPa ~~(90 psi)~~ at the nozzle while in use. Compressor capability under job conditions must be demonstrated before approval. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint approximately ~~1 inch~~25 mm above the pavement surface. The height, angle of inclination and the size of the nozzle shall be adjusted as necessary to secure satisfactory results.

1.6.1.4 ~~Waterblasting Equipment~~NOT USED

~~Waterblasting equipment shall include a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment. The water tank and auxiliary resupply equipment shall be of sufficient capacity to permit continuous operations. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint approximately 1 inch above the pavement surface. The height, angle of inclination and the size of the nozzle shall be adjustable as necessary to obtain satisfactory results. A pressure gauge mounted at the pump shall show at all times the pressure in pounds per square inch at which the equipment is operating.~~1.6.1.5 Hand Tools

Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces.

1.6.2 Sealing Equipment

1.6.2.1 Hot-Poured Sealing Equipment

The unit applicators used for heating and installing ~~[~~ASTM D 3405~~]~~ and ~~[~~ ASTM D 3569~~]~~ joint sealant materials shall be mobile and shall be equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit shall be designed so that the sealant will circulate through the delivery hose and return to the inner kettle when not in use.

1.6.2.2 Two-Component, Cold-Applied, Machine Mix Sealing Equipment

The equipment used for proportioning, mixing, and installing FS SS-S-200 Type M joint sealants shall be designed to deliver two semifluid components through hoses to a portable mixer at a preset ratio of 1 to 1 by volume using pumps with an accuracy of plus or minus 5 percent for the quantity of each component. The reservoir for each component shall be equipped with mechanical agitation devices that will maintain the components in a uniform condition without entrapping air. Provisions shall be incorporated to permit thermostatically controlled indirect heating of the components, when required. However, immediately prior to proportioning and mixing, the temperature of either component shall not exceed 32.2 degrees C ~~(90 degrees F)~~. Screens shall be provided near the top of each reservoir to remove any foreign particles or partially polymerized material that could clog fluid lines or otherwise cause misproportioning or improper mixing of the two components. The equipment shall be capable of thoroughly mixing the two components through a range of application rates of 37.8 to 189 liters ~~(10 to 60 gallons)~~ per hour and through a range of application pressures from 345 kPa to 10.3 MPa ~~(50 to 1500 psi)~~ as required by material, climatic, or operating conditions. The mixer shall be designed for the easy removal of the supply lines for cleaning and proportioning of the components. The mixing head shall accommodate nozzles of different types and sizes as may be required by various operations. The dimensions of the nozzle shall be such that the nozzle tip will extend into the joint to allow sealing from the bottom of the joint to the top. The initially approved equipment shall be maintained in good working condition, serviced in accordance with the supplier's instructions, and shall not be altered in any way without obtaining prior approval.

1.6.2.3 Two-Component, Cold-Applied, Hand-Mix Sealing Equipment

Mixing equipment for FS SS-S-200 Type H sealants shall consist of a slow-speed electric drill or air-driven mixer with a stirrer in accordance with the manufacturer's recommendations.

1.6.2.4 Cold-Applied, Single-Component Sealing Equipment

The equipment for installing ASTM D 5893 single component joint sealants shall consist of an extrusion pump, air compressor, following plate, hoses, and nozzle for transferring the sealant from the storage container into the joint opening. The dimension of the nozzle shall be such that the tip of the nozzle will extend into the joint to allow sealing from the bottom of the joint to the top. The initially approved equipment shall be maintained in good working condition, serviced in accordance with the supplier's instructions, and shall not be altered in any way without obtaining prior approval. Small hand-held air-powered equipment (i.e., caulking guns) may be used for small applications.

1.7 TRIAL JOINT SEALANT INSTALLATION

Prior to the cleaning and sealing of the joints for the entire project, a test section of at least 60 m —long shall be prepared using the specified materials and approved equipment, so as to demonstrate the proposed joint preparation and sealing of all types of joints in the project. Following the completion of the test section and before any other joint is sealed, the test section shall be inspected to determine that the materials and installation meet the requirements specified. If it is determined that the materials or installation do not meet the requirements, the materials shall be removed, and the joints shall be recleaned and resealed at no cost to the Government. When the test section meets the requirements, it may be incorporated into the permanent work and paid for at the contract unit price per linear foot for sealing items scheduled. —All other joints shall be prepared and sealed in the manner approved for sealing the test section.

1.8 DELIVERY AND STORAGE

Materials delivered to the job site shall be inspected for defects, unloaded, and stored with a minimum of handling to avoid damage. Storage facilities shall be provided by the Contractor at the job site for maintaining materials at the temperatures and conditions recommended by the manufacturer.

1.9 ENVIRONMENTAL CONDITIONS

The ambient air temperature and the pavement temperature within the joint wall shall be a minimum of 10 degrees C and rising at the time of application of the materials. Sealant shall not be applied if moisture is observed in the joint.

PART 2 PRODUCTS

2.1 SEALANTS

Joint sealant shall be a commercial formulation which has had satisfactory field performance for a period of at least 2 years in similar climate and traffic conditions. Hot applied joint sealant shall be tested in accordance with COE CRD-C 525. Joint sealants for use on roads, sidewalks, curbs and gutters, and slabs on grade, (except fuel truck traffic areas and vehicle refueling areas), shall conform to ASTM D 3405, or ASTM D 5893.

Joint sealants for use on pavements subject to traffic by fuel trucks, or used in vehicle fueling areas shall conform to ASTM D 3569 or FS SS-S-200 Type M or H.~~Materials for sealing cracks in the various paved areas indicated on the drawings shall be as follows:~~

~~Area~~	~~Sealing Material~~
~~[_____]~~	~~[ASTM D 3405 and COE CRD-C 525]~~
~~[_____]~~	~~[ASTM D 3569 and COE CRD-C 525]~~
~~[_____]~~	~~[FS SS-S-200 Type M]~~
~~[_____]~~	~~[FS SS-S-200 Type H]~~
~~[_____]~~	~~[ASTM D 5893]~~

2.2 PRIMERS

Primers, when their use is recommended by the manufacturer of the sealant, shall be as recommended by the manufacturer of the sealant.

2.3 BACKUP MATERIALS

The backup material shall be a compressible, nonshrinking, nonstaining, nonabsorbing material and shall be nonreactive with the joint sealant. The material shall have a melting point at least 3 degrees C greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D 789. The material shall have a water absorption of not more than 5 percent of the sample weight when tested in accordance with ASTM C 509. The backup material shall be 25 plus or minus 5 percent larger in diameter than the nominal width of the crack.

2.4 BOND BREAKING TAPES

The bond breaking tape or separating material shall be a flexible, nonshrinkable, nonabsorbing, nonstaining, and nonreacting adhesive-backed tape. The material shall have a melting point at least 3 degrees C greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D 789. The bond breaker tape shall be approximately 3 mm wider than the nominal width of the joint and shall not bond to the joint sealant.

PART 3 EXECUTION

3.1 PREPARATION OF JOINTS

Immediately before the installation of the sealant, the joints shall be thoroughly cleaned to remove all laitance, curing compound, filler, protrusions of hardened concrete, and old sealant from the sides and upper edges of the joint space to be sealed.

3.1.1 Existing Sealant Removal

The in-place sealant shall be cut loose from both joint faces and to the depth shown on the drawings, using the ~~[~~tractor-mounted routing equipment~~]~~ or ~~[~~concrete saw~~] [waterblaster]~~ as specified in paragraph EQUIPMENT. Depth shall be sufficient to accommodate any separating or backup material that is required to maintain the depth of new sealant to be installed. Prior to further cleaning operations, all loose old sealant remaining in

the joint opening shall be removed by blowing with compressed air. Hand tools may be required to remove sealant from random cracks. Chipping, spalling, or otherwise damaging the concrete will not be allowed.

3.1.2 Sawing

3.1.2.1 Refacing of Joints

~~[~~Facing or Refacing~~]~~ ~~[Facing]~~ of joints shall be accomplished using a concrete saw as specified in paragraph EQUIPMENT ~~[~~to loosen and remove material until the joint is clean and open to the full specified width and depth. Previously sealed joints which require sealant replacement shall be cleaned and refaced to remove all residual old sealant and a minimum of concrete from the joint face to provide exposure of newly cleaned concrete, and, if required, to enlarge the joint opening to the width and depth shown on the drawings.~~]~~ ~~[to saw through sawed and filler-type joints to loosen and remove material until the joint is clean and open to the full specified width and depth.]~~ The blade shall be stiffened with a sufficient number of suitable dummy (used) blades or washers. Immediately following the sawing operation, the joint opening shall be thoroughly cleaned using a water jet to remove all saw cuttings and debris.

3.1.2.2 Refacing of Random Cracks

Sawing of the cracks shall be accomplished using a power-driven concrete saw as specified in paragraph EQUIPMENT. The saw blade shall be 152 mm ~~(6 inch)~~ or less in diameter to enable the saw to follow the trace of the crack. The blade shall be stiffened as necessary with suitable dummy (or used) blades or washers. Immediately following the sawing operation, the crack opening shall be thoroughly cleaned using a water jet to remove all saw cuttings and debris.

3.1.3 Sandblasting

The newly exposed concrete joint faces and the pavement surfaces extending a minimum of 13 mm from the joint edges shall be ~~[~~sandblasted~~]~~ ~~[waterblasted]~~ clean. A multiple-pass technique shall be used until the surfaces are free of dust, dirt, curing compound, filler, old sealant residue, or any foreign debris that might prevent the bonding of the sealant to the concrete. After final cleaning and immediately prior to sealing, the joints shall be blown out with compressed air and left completely free of debris and water.

3.1.4 Back-Up Material

When the joint opening is of a greater depth than indicated for the sealant depth, the lower portion of the joint opening shall be plugged or sealed off using a back-up material to prevent the entrance of the sealant below the specified depth. Care shall be taken to ensure that the backup material is placed at the specified depth and is not stretched or twisted during installation.

3.1.5 Bond Breaking Tape

Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, a bond breaker separating tape will be inserted to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. The tape shall be securely bonded to the bottom of the joint opening so it will not

float up into the new sealant.

3.1.6 Rate of Progress of Joint Preparation

The stages of joint preparation which include sandblasting, air pressure cleaning and placing of the back-up material shall be limited to only that lineal footage that can be sealed during the same day.

3.2 PREPARATION OF SEALANT

3.2.1 Hot-Poured Sealants

Sealants conforming to ~~[~~ASTM D 3405~~]~~ ~~[~~ASTM D 3569~~]~~ shall not be heated in excess of the safe heating temperature recommended by the manufacturer as shown on the sealant containers. Sealant that has been overheated or subjected to application temperatures for over 4 hours or that has remained in the applicator at the end of the day's operation shall be withdrawn and wasted.

3.2.2 Type M Sealants

The FS SS-S-200 Type M sealant components and containers shall be inspected prior to use. Any materials that contain water, hard caking of any separated constituents, nonreversible jell, or materials that are otherwise unsatisfactory shall be rejected. Settlement of constituents in a soft mass that can be readily and uniformly remixed in the field with simple tools shall not be cause for rejection. Prior to transfer of the components from the shipping containers to the appropriate reservoir of the application equipment, the materials shall be thoroughly mixed to ensure homogeneity of the components and incorporation of all constituents at the time of transfer. When necessary for remixing prior to transfer to the application equipment reservoirs, the components shall be warmed to a temperature not to exceed 32 degrees C by placing the components in heated storage or by other approved methods but in no case shall the components be heated by direct flame, or in a single walled kettle, or a kettle without an oil bath.

3.2.3 Type H Sealants

The FS SS-S-200 Type H sealant components shall be mixed either in the container furnished by the manufacturer or a cylindrical metal container of volume approximately 50 percent greater than the package volume. The base material shall be thoroughly mixed in accordance with the manufacturer's instructions. The cure component shall then be slowly added during continued mixing until a uniform consistency is obtained.

3.2.4 Single-Component, Cold-Applied Sealants

The ASTM D 5893 sealant and containers shall be inspected prior to use. Any materials that contain water, hard caking of any separated constituents, nonreversible jell, or materials that are otherwise unsatisfactory shall be rejected. Settlement of constituents in a soft mass that can be readily and uniformly remixed in the field with simple tools will not be cause for rejection.

3.3 INSTALLATION OF SEALANT

3.3.1 Time of Application

Joints shall be sealed immediately following final cleaning of the joint walls and following the placement of the separating or backup material. Open joints that cannot be sealed under the conditions specified, or when rain interrupts sealing operations shall be recleaned and allowed to dry prior to installing the sealant.

3.3.2 Sealing Joints

Immediately preceding, but not more than 15 m ahead of the joint sealing operations, a final cleaning with compressed air shall be performed. The joints shall be filled from the bottom up to ~~[3] [6]~~ mm plus or minus 1.5 mm below the pavement surface. Excess or spilled sealant shall be removed from the pavement by approved methods and shall be discarded. The sealant shall be installed in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until authorized by the Contracting Officer. When a primer is recommended by the manufacturer, it shall be applied evenly to the joint faces in accordance with the manufacturer's instructions. Joints shall be checked frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

3.4 INSPECTION

3.4.1 Joint Cleaning

Joints shall be inspected during the cleaning process to correct improper equipment and cleaning techniques that damage the concrete pavement in any manner. Cleaned joints shall be approved prior to installation of the separating or back-up material and joint sealant.

3.4.2 Joint Sealant Application Equipment

The application equipment shall be inspected to ensure conformance to temperature requirements, proper proportioning and mixing (if two-component sealant) and proper installation. Evidences of bubbling, improper installation, failure to cure or set shall be cause to suspend operations until causes of the deficiencies are determined and corrected.

3.4.3 Joint Sealant

The joint sealant shall be inspected for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified herein at no additional cost to the Government.

3.5 CLEAN-UP

Upon completion of the project, all unused materials shall be removed from the site and the pavement shall be left in a clean condition.

-- End of Section --

SECTION 02770A

CONCRETE SIDEWALKS AND CURBS AND GUTTERS
03/98

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 M 182	(1991) Burlap Cloth Made from Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
~~ASTM A 615/A 615M~~	~~(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement~~
~~ASTM A 616/A 616M~~	~~(1996a) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement~~
~~ASTM A 617/A 617M~~	~~(1996a) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement~~
ASTM C 31/C 31M	(1996) Making and Curing Concrete Test Specimens in the Field
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 171	(1997) Sheet Materials for Curing Concrete
ASTM C 172	(1997) Sampling Freshly Mixed Concrete
ASTM C 173	(1996) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 309	(1997) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient

	Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 3405	(1996) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements

~~1.2 MEASUREMENT FOR PAYMENT~~

~~1.2.1 Sidewalks~~

~~The quantities of sidewalks to be paid for will be the number of square meters of each depth of sidewalk constructed as indicated.~~

~~1.2.2 Curbs and Gutters~~

~~The quantities of curbs and gutters to be paid for will be the number of linear meters of each cross section constructed as indicated, measured along the face of the curb at the gutter line.~~

~~1.3 BASIS FOR PAYMENT~~

~~1.3.1 Sidewalks~~

~~Payment of the quantities of sidewalks measured as specified will be at the contract unit price per square meter of the thickness specified.~~

~~1.3.2 Curbs and Gutters~~

~~Payment of the quantities of curbs and gutters measured as specified will be at the contract unit price per linear meter of each cross section.~~

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-03 Product Data

Concrete; ~~[~~_____~~]~~ _, ~~[~~_____~~]~~RE

Copies of certified delivery tickets for all concrete used in the construction.

SD-06 Test Reports

Field Quality Control; ~~[~~_____~~]~~G, ~~[~~_____~~]~~RE

Copies of all test reports within 24 hours of completion of the test.

1.3 WEATHER LIMITATIONS

1.3.1 Placing During Cold Weather

Concrete placement shall not take place when the air temperature reaches 5 degrees C and is falling, or is already below that point. Placement may begin when the air temperature reaches 2 degrees C and is rising, or is already above 5 degrees C . Provisions shall be made to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 2 degrees C, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. ~~[~~Mixing water and aggregates~~] [Mixing water] [Aggregates]~~ shall be heated as necessary to result in the temperature of the in-place concrete being between 10 and 30 degrees C. Methods and equipment for heating shall be subject to approv~~ed~~al. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 10 degrees C for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.3.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 30 degrees C except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 35 degrees C at any time.

1.4 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.4.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.4.2 Slip Form Equipment

Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in 1 pass.

PART 2 PRODUCTS

2.1 CONCRETE

Concrete shall conform to the applicable requirements of ~~[Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE] [Section 02753 CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY-DUTY PAVEMENTS] [~~Section 02754 CONCRETE PAVEMENTS FOR SMALL PROJECTS~~,~~ ~~]~~ except as otherwise specified. ~~Concrete shall have a minimum compressive strength of 24 MPa at 28 days. Maximum size of aggregate shall be 37.5 mm.~~

~~2.1.1 Air Content~~

~~Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.~~

~~2.1.2 Slump~~

~~The concrete slump shall be 50 mm plus or minus 25 mm where determined in accordance with ASTM C 143.~~

2.1.1 Reinforcement Steel

~~Reinforcement bars shall conform to ASTM A 615/A 615M, ASTM A 616/A 616M, or ASTM A 617/A 617M.~~ Wire mesh reinforcement shall conform to ASTM A 185. Use of rolled mesh is specifically prohibited. Wire mesh shall be supplied in flat sheets.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

2.2.3 ~~White Pigmented~~Liquid Membrane-Forming Curing Compound

~~White pigmented~~Liquid membrane-forming curing compound shall conform to ASTM C 309, Type 1-D or Type 2, Class A or B.

~~2.3 CONCRETE PROTECTION MATERIALS~~

~~Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.~~

2.3 JOINT FILLER STRIPS

2.3.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.3.2 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 10 mm thick, unless otherwise indicated. The expansion joint filler material shall be certified by the manufacturer to be compatible with the joint sealants used in the work. Do not use bituminous joint filler if joint sealer is non-bituminous.

2.4 JOINT SEALANTS

2.4.1 Joint Sealant, Cold-Applied

Joint sealant, cold-applied shall conform to ASTM C 920, Type M or S, Grade P or NS as required, Class 25, use T.

2.4.2 Joint Sealant, Hot-Poured

Joint sealant, hot-poured shall conform to ASTM D 3405.

2.5 FORM WORK

Form work shall be designed and constructed to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 50 mm nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 3 m. Radius bends may be formed with 19 mm boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 3 m with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.5.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

2.5.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 3 m or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 38 mm benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

PART 3 EXECUTION

3.1 SUBGRADE and BASE COURSE PREPARATION

The subgrade and base course shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted ~~[as directed] [~~ in conformance with Section: ~~[_____]]~~EARTHWORK. Base course shall conform with Section: GRADED-CRUSHED AGGREGATE BASE COURSE.

3.1.1 Sidewalk, Subgrade and Base Course

The subgrade and base course shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter, Subgrade and Base Course

The subgrade and base course shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade and base course shall be of materials equal in bearing quality to the subgrade and base course under the adjacent pavement.

3.1.3 Maintenance of Subgrade and Base Course

The subgrade and base course shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade and base course shall be in a moist condition when concrete is placed. The subgrade and base course shall be prepared and protected to produce a subgrade and base course free from frost when the concrete is deposited.

3.2 FORM SETTING

Forms shall be set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 1.2 meters. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Forms for sidewalks shall be set with the upper edge true to line and grade with an allowable tolerance of 3 mm in any 3 m long section. After forms are set, grade and alignment shall be checked with a 3 m straightedge. Forms shall have a transverse slope ~~[as indicated] [~~of 20 millimeters per meter ~~]~~ with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Concrete shall be placed in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After

concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 3 mm. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 8 mm from the testing edge of a 3 m straightedge. Permissible deficiency in section thickness will be up to 6 mm

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 13 mm. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 6 mm from the testing edge of a 3 m straightedge. Permissible deficiency in section thickness will be up to 6 mm.

3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 1.5 m on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 3 m or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated.

3.5.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 3 mm blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Expansion joints shall be formed with ~~[10] [13] [_____]~~ mm joint filler strips. Joint filler shall be placed with top edge 6 mm below the surface and shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 3 mm, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with joint sealant. ~~[~~Joints as indicated or directed to be sealed, shall be sealed as specified in Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.

3.5.3 Reinforcement Steel Placement

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed. Reinforcement shall be used at locations shown on the drawings.

3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 1.5 m nor greater than 4.5 m in length. Contraction joints shall be constructed by means of 3 mm thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

3.6.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least ~~[10] [13] [_____]~~ mm in width shall be provided at intervals not exceeding ~~[_____]~~35 meters. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. ~~[~~Joints shall be sealed as specified in Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.

3.7 CURING AND PROTECTION

3.7.1 General Requirements

Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 150 mm. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 300 mm when a continuous sheet is not used. The curing medium shall not be less than 450 mm wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 5 square meters per liter ~~(200 square feet per gallon)~~ for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

3.8 FIELD QUALITY CONTROL

3.8.1 General Requirements

The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing.

Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every ~~19~~50 cubic meters of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 4 MPa.

3.8.2.2 Air Content

Air content shall be determined in accordance with ASTM C 173 or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests shall be made on randomly selected batches of each class of concrete for every 25 cubic meters, or fraction thereof, of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every ~~19~~25 cubic meters, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 6 mm the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 6 mm. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

-- End of Section --

SECTION 02763

PAVEMENT MARKINGS
09/98

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 M 247	(1981) Glass Beads Used in Traffic Paint

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 792	(1991) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM E 28	(1997) Softening Point of Resins by Ring and Ball Apparatus

FEDERAL SPECIFICATIONS (FS)

FS TT-B-1325	(Rev C; Notice 1) Beads (Glass Spheres) Retro-Reflective (Metric)
FS TT-P-1952	(Rev D) Paint, Traffic and Airfield Marking, Waterborne (Metric)

AIRFORCE PUBLICATIONS (AFI)

AFT 32-1042	(STANDARDS FOR MARKING AIRFIELDS

1.2 [Enter Appropriate Subpart Title Here]

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. All submittals listed below shall be submitted at the same time. Failure to due so will cause the submittal to be rejected. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Lists; GA-RE.

Lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation.

SD-06 Instructions

Mixing, Thinning and Application; __GA-RE___.

Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use.

SD-08 Statements

Qualifications;GA-RE.

Document certifying that personnel are qualified for equipment operation and handling of chemicals.

SD-09 Reports

Material Tests; __GA-RE___.

Certified copies of the test reports, prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

SD-13 Certificates

Volatile Organic Compound (VOC) Content; _GA-RE____.

Certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located.

1.4 DELIVERY AND STORAGE

All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

1.5 EQUIPMENT

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Equipment operating on roads and runways shall display low speed traffic markings and traffic warning lights.

1.5.1 Paint Application Equipment

The equipment to apply paint to pavements shall be a self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. The

machine shall have a speed during application not less than 8 kilometers per hour (5 mph), and shall be capable of applying the stripe widths indicated, at the paint coverage rate specified in paragraph APPLICATION, and of even uniform thickness with clear-cut edges. The equipment used to apply the paint binder to airfield pavements shall be a self-propelled or mobile-drawn pneumatic spraying machine with an arrangement of atomizing nozzles capable of applying a line width at any one time in multiples of 150 mm (6 inches), from 150 mm (6 inches)to 900 mm (36 inches). The paint applicator shall have paint reservoirs or tanks of sufficient capacity and suitable gauges to apply paint in accordance with requirements specified. Tanks shall be equipped with suitable air-driven mechanical agitators. The spray mechanism shall be equipped with quick-action valves conveniently located, and shall include necessary pressure regulators and gauges in full view and reach of the operator. Paint strainers shall be installed in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Pneumatic spray guns shall be provided for hand application of paint in areas where the mobile paint applicator cannot be used.

1.5.2 Reflective Media Dispenser

The dispenser for applying the reflective media shall be attached to the paint dispenser and shall operate automatically and simultaneously with the applicator through the same control mechanism. The dispenser shall be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION, at all operating speeds of the applicator to which it is attached.

1.5.3 Surface Preparation Equipment

1.5.3.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 70.8 liters per sec (150 cfm) of air at a pressure of not less than 620 kPa (90 psi) at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1.5.3.2 Waterblast Equipment

The water pressure shall be specified at 17.9 MPa (2600 psi) at 60 degrees C (140 degrees F in order to adequately clean the surfaces to be marked.

1.5.4 Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

1.5.4.1 Shotblasting Equipment

Shotblasting equipment shall be capable of producing an adjustable depth of

removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.

1.5.4.2 Chemical Equipment

Chemical equipment shall be capable of application and removal of chemicals from the pavement surface, and shall leave only non-toxic biodegradeable residue.

1.5.5 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite 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 HAND-OPERATED, PUSH-TYPE MACHINES

All machines, tools, and equipment used in performance of the work shall be approved and maintained in satisfactory operating condition. Hand-operated push-type machines of a type commonly used for application of paint to pavement surfaces will be acceptable for marking small streets and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Sandblasting equipment shall be provided as required for cleaning surfaces to be painted. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

1.7 WEATHER LIMITATIONS FOR REMOVAL

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 5 degrees C and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

PART 2 PRODUCTS

2.1 PAINT

The paint shall be lead free, homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Paints for airfields, roads, and streets shall conform to FS TT-P-1952. Select Type 1, "Ten Minute No Pick-up Time" or Type II, "Fast Dry, High Humidity Formula." The color shall be as indicated for the parking lot and access road. Colors for the apron shall be the following color chips from FS 595: Yellow - 33538 and Black 37038. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

2.2 REFLECTIVE MEDIA

Reflective media for airfields shall conform to FS TT-B-1325, Type I, Gradation A with refraction index of 1.5.

2.3 SAMPLING AND TESTING

Materials proposed for use shall be stored on the project site in sealed and labeled containers, or segregated at source of supply, sufficiently in advance of needs to allow 60 days for testing. Upon notification by the Contractor that the material is at the site or source of supply, a sample shall be taken by random selection from sealed containers by the Contractor in the presence of a representative of the Contracting Officer. Samples shall be clearly identified by designated name, specification number, batch number, manufacturer's formulation number, project contract number, intended use, and quantity involved. Testing shall be performed in an approved independent laboratory. If materials are approved based on reports furnished by the Contractor, samples will be retained by the Government for possible future testing should the material appear defective during or after application.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Surfaces to be marked shall be thoroughly cleaned before application of the pavement marking material. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Areas of old pavement affected with oil or grease shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be recleaned, when work has been stopped due to rain.

3.1.1 Pretreatment for Early Painting

Where early painting is required on rigid pavements, a pretreatment with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride shall be applied to prepared pavement areas prior to painting.

3.1.2 Cleaning Existing Pavement Markings

In general, markings shall not be placed over existing pavement marking patterns. Existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns, shall be removed. Deteriorated or obscured markings that are not misleading or confusing or interfere with the adhesion of the new marking material do not require removal. Whenever grinding, scraping, sandblasting or other operations are performed the work must be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

3.1.3 Cleaning Concrete Curing Compounds

On new Portland cement concrete pavements, cleaning operations shall not begin until a minimum of 30 days after the placement of concrete. All new concrete pavements shall be cleaned by either sandblasting or water blasting. The extent of the blasting work shall be to clean and prepare the concrete surface as follows:

a. There is no visible evidence of curing compound on the peaks of the textured concrete surface.

b. There are no heavy puddled deposits of curing compound in the valleys of the textured concrete surface.

c. All remaining curing compound is intact; all loose and flaking material is removed.

d. The peaks of the textured pavement surface are rounded in profile and free of sharp edges and irregularities.

e. The surface to be marked is dry.

3.2 APPLICATION

All pavement markings and patterns shall be placed as shown on the plans.

3.2.1 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 5 degrees C and less than 35 degrees C. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied pneumatically with approved equipment at rate of coverage specified . The Contractor shall provide guide lines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

3.2.1.1 Rate of Application

a. Reflective Markings: Pigmented binder shall be applied evenly to the pavement area to be coated at a rate of 2.9 plus or minus 0.5 square meter per liter. Glass spheres shall be applied uniformly to the wet paint on airfield pavement at a rate of 1.0

b. Nonreflective Markings: The parking lot paint shall be applied evenly to the pavement surface to be coated at a rate of 2.9 plus or minus 0.5 square meter per liter.

3.2.1.2 Drying

The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a delay in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

3.2.2 Reflective Media

Application of reflective media shall immediately follow application of pigmented binder. Drop-on application of glass spheres shall be accomplished to insure that reflective media is evenly distributed at 3.6 to 3.9 KG per 11.24 square meters (eight to nine pounds per gallon of paint). Should there be malfunction of either paint applicator or reflective media dispenser, operations shall be discontinued immediately until deficiency is corrected.

3.3 MARKING REMOVAL

Pavement marking, shall be removed in the areas shown on the drawings. Removal of marking shall be as complete as possible without damage to the surface. Aggregate shall not be exposed by the removal process. After the markings are removed, the cleaned pavement surfaces shall exhibit adequate texture for remarking as specified in paragraph SURFACE PREPARATION. Contractor shall demonstrate removal of pavement marking in an area designated by the Contracting Officer. The demonstration area will become the standard for the remainder of the work.

3.3.1 Equipment Operation

Equipment shall be controlled and operated to remove markings from the pavement surface, prevent dilution or removal of binder from underlying pavement, and prevent emission of blue smoke from asphalt or tar surfaces.

3.3.2 Cleanup and Waste Disposal

The worksite shall be kept clean of debris and waste from the removal operations. Cleanup shall immediately follow removal operations in areas subject to air traffic. Debris shall be disposed of at approved sites.

-- End of Section --

SECTION 07416A

STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
11/01

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.

ALUMINUM ASSOCIATION (AA)

AA ADM	(2000) Aluminum Design Manual: Specification & Guidelines for Aluminum Structures

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 335	(1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG-973	(1996) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463/A 463M	(2000) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 653/A 653M	(2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 792/A 792M	(1999) Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B 209	(2000) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(2000) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C 1177/C 1177M	(1999) Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C 1289	(1998) Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

ASTM C 991	(1998) Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings
ASTM D 1308	(1987; R 1998) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2244	(1995) Calculation of Color Differences from Instrumentally Measured Color Coordinates
ASTM D 2247	(1999) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D 2794	(1993; R 1999el) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D 3359	(1997) Measuring Adhesion by Tape Test
ASTM D 4214	(1998) Evaluating Degree of Chalking of Exterior Paint Films
ASTM D 4397	(1996) Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 522	(1993a) Mandrel Bend Test of Attached Organic Coatings
ASTM D 523	(1989; R 1999) Specular Gloss
ASTM D 5894	(1996) Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
ASTM D 610	(1995) Evaluating Degree of Rusting on Painted Steel Surfaces
ASTM D 714	(1987; R 1994el) Evaluating Degree of Blistering of Paints
ASTM D 968	(1993) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM E 1592	(1998) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E 84	(2000a) Surface Burning Characteristics of Building Materials
ASTM E 96	(2000) Water Vapor Transmission of Materials

ASTM G 154	(2000ael) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(1998) Minimum Design Loads for Buildings and Other Structures

STEEL JOIST INSTITUTE (SJI)

SJI Specs & Tables	(1994) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders

1.2 GENERAL REQUIREMENTS

The Contractor shall furnish a commercially available roofing system which satisfies all requirements contained herein and has been verified by load testing and independent design analyses to meet the specified design requirements.

1.2.1 Structural Standing Seam Metal Roof (SSSMR) System

The SSSMR system covered under this specification shall include the entire roofing system; the standing seam metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system shall consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system.

1.2.2 Manufacturer

The SSSMR system shall be the product of a manufacturer who has been in the practice of manufacturing and designing SSSMR systems for a period of not less than 3 years and has been involved in at least five projects similar in size and complexity to this project.

1.2.3 Installer

The installer shall be certified by the SSSMR system manufacturer to have experience in installing at least three projects that are of comparable size, scope and complexity as this project for the particular roof system furnished. The installer may be either employed by the manufacturer or be an independent installer.

1.2.4 Manufacturer's Representative

A representative of the SSSMR manufacturer, who is familiar with the design of the roof system supplied and experienced in the erection of roof systems similar in size to the one required under this contract, shall be present at the job site during installation of the SSSMR to assure that the roof system meets specified requirements. The manufacturer's representative shall be either an employee of the manufacturer with at least two years

experience in installing the roof system or an employee of an independent installer that is certified by the SSSMR manufacturer to have two years of experience in installing similar roof systems.

1.3 DESIGN REQUIREMENTS

The design of the SSSMR system shall be provided by the Contractor as a complete system. Members and connections not indicated on the drawings shall be designed by the Contractor. Roof panels, components, transitions, accessories, and assemblies shall be supplied by the same roofing system manufacturer.

1.3.1 Design Criteria

Design criteria shall be in accordance with ASCE 7.

1.3.2 Dead Loads

The dead load shall be the weight of the SSSMR system. Collateral loads such as sprinklers, mechanical and electrical systems, and ceilings shall not be attached to the panels.

1.3.3 Live Loads

1.3.3.1 Concentrated Loads

The panels and anchor clips shall be capable of supporting a 1335 N concentrated load. The concentrated load shall be applied at the panel midspan and will be resisted by a single standing seam metal roof panel assumed to be acting as a beam. The undeformed shape of the panel shall be used to determine the section properties.

1.3.3.2 Uniform Loads

The panels and concealed anchor clips shall be capable of supporting a minimum uniform live load of [960] [_____] Pa.

1.3.4 Roof Snow Loads

The design roof snow loads shall be as shown on the contract drawings.

1.3.5 Wind Loads

The design uplift pressures for the roof system shall be as indicated on the contract drawings. The safety factor listed below shall be applied to the design force and compared against the ultimate capacity. Prying shall be considered when figuring fastener design loads.

a. Single fastener in each connection.....3.0

b. Two or more fasteners in each connection...2.25

1.3.6 Thermal Loads

Roof panels shall be free to move in response to the expansion and contraction forces resulting from a total temperature range of 220 degrees C during the life of the structure.

1.3.7 Framing Members Supporting the SSSMR System

Structural cold formed steel framing members and their connections shall be designed in accordance with AISI SG 673. Maximum deflections under applied dead and live load and/or wind load for subpurlins shall not exceed 1/180 times the span length and shall be based on constraint conditions at the supports. Subpurlins shall be designed to span from structural member to structural member. Attachment to a metal deck, if present, is permitted for lateral stability only. Subpurlins must be adequately braced for both positive and negative bending. Subpurlins are required at all clip locations in installations above a metal deck. Attaching clips through rigid insulation to structure is prohibited.

1.3.8 Roof Panels Design

Steel panels shall be designed in accordance with AISI SG-973. Aluminum panels shall be designed in accordance with AA ADM. The structural section properties used in the design of the panels shall be determined using the unloaded shape of the roof panels. The calculated panel deflection from concentrated loads shall not exceed 1/180 of the span length. The calculated panel deflection under applied live load, snow, or wind load shall not exceed 1/180 times the span length. Deflections shall be based on panels being continuous across three or more supports, fastener spacing, and the ability of the panel to rotate freely on the support. Deflection shall be calculated and measured along the major ribs of the panels.

1.3.9 Accessories and Their Fasteners

Accessories and their fasteners shall be capable of resisting the specified design wind uplift forces and shall allow for thermal movement of the roof panel system. Exposed fasteners shall not restrict free movement of the roof panel system resulting from thermal forces. There shall be a minimum of two fasteners per clip. Single fasteners with a minimum diameter of 9 mm will be allowed when the supporting structural members are prepunched or predrilled. The design uplift force for the accessory connections and the factors of safety, shall be as required in subparagraph 1.3.5 Wind Loads.

1.4 PERFORMANCE REQUIREMENTS

The SSSMR shall be tested for wind uplift resistance in accordance with ASTM E 1592; SSSMR systems previously tested and approved by the Corps of Engineers' STANDARD TEST METHOD FOR STRUCTURAL PERFORMANCE OF SSMRS BY UNIFORM STATIC AIR PRESSURE DIFFERENCE may be acceptable. Two tests shall be performed. Test 1 shall simulate the edge condition with one end having crosswise restraint and other end free of crosswise restraint. The maximum span length for the edge condition shall be 750 mm. Test 2 shall simulate the interior condition with both ends free of crosswise restraint. The maximum span length for the interior condition shall be 1.5 m . External reinforcement, such as clamps on the ribs, shall not be installed to improve uplift resistance. Bolts through seams shall not be installed.

1.4.1 Concealed Anchor Clip Connection to Building Structure

The tested capacity of fasteners used to connect the concealed anchor clips to subpurlins, structural purlins, or metal roof deck shall be determined from tests supplied by the fastener manufacturer or an independent testing laboratory. Tests shall be performed on fasteners and supporting members that are made from the same materials and are equal or less in size and thickness to the fasteners and supporting members used in the actual roof

installation. The maximum uplift loading used in the test shall be the design uplift force multiplied by the factor of safety. The design uplift force and the factors of safety shall be as required in subparagraph 1.3.5 Wind Loads.

1.4.2 Subpurlin Connection to Building Structure

The tested capacity of fasteners used to connect the subpurlins to structural purlins or through metal roof deck to building structure shall be determined from tests supplied by the fastener manufacturer or an independent testing laboratory. Tests shall be performed on fasteners and supporting members that are made from the same materials and are equal or less in size and thickness to the fasteners and supporting members used in the actual roof installation. The maximum uplift loading used in the test shall be the design uplift force multiplied by the factor of safety. The factors of safety and the design uplift force shall be as required in subparagraph 1.3.5 Wind Loads.

1.5 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

Structural Standing Seam Metal Roof System; G, RE

Metal roofing drawings and specifications and erection drawings; shop coating and finishing specifications; and other data as necessary to clearly describe design, materials, sizes, layouts, standing seam configuration, construction details, provisions for thermal movement, line of panel fixity, fastener sizes and spacings, sealants and erection procedures. Drawings shall reflect the intent of the architectural detailing using the manufacturer's proprietary products and fabricated items as required. The SSSMR system shop drawings shall be provided by the metal roofing manufacturer.

Drawings; G, RE

The shop drawings shall also include the SSSMR component details that resulted from the design calculations and the wind uplift testing required herein. The shop drawings also shall show the locations and configuration of any thermal spacer blocks or barriers. Subpurlin layouts shall be shown and the spacing must be coordinated with the metal deck configuration, lap locations, and sidelap configurations.

SD-03 Product Data

Design Analysis; G, RE.

Design analysis signed by a Registered Professional Engineer, and submitted for approval prior to beginning of manufacture. The design analysis shall include, but not be limited to the following information:

a. A list of the design loads.

b. Thermal movements that will result from the specified temperature range. The calculations shall be accompanied by details from the manufacturer that demonstrate how installed concealed anchor clips and other roof system devices will accommodate the required thermal movement.

c. Concentrated load and roof live load analysis.

d. Subpurlin catalog cuts, section property information and sketches to indicate that the subpurlin geometry has been coordinated with the metal deck configuration and that the subpurlins will nest properly in the metal deck flutes.

****
NOTE: The following submittal requirements apply to metal building systems only.
****
d. Complete calculations of the support system ,including purlins and/or subpurlins designed in accordance with subparagraph: Framing Members.

e. Wind forces on various parts of the roof. Both positive and negative pressures shall be calculated based on the criteria in subparagraph: Design Conditions and parameters in subparagraph: Wind Uplift Loads. The resultant wind uplift forces and dimensions of the edge and corner zones will be shown on an isometric view of the roof."

Qualifications; G, RE.

Qualifications of the manufacturer and installer.

SD-04 Samples

Accessories; G, RE.

One sample of each type of flashing, trim, closure, thermal spacer block, cap and similar items. Size shall be sufficient to show construction and configuration.

Roof Panels; G, RE.

One piece of each type to be used, 225 mm long, full width.

Factory Color Finish; G, RE.

Three 75 by 125 mm samples of each type and color.

Fasteners; G, RE.

Two samples of each type to be used, with statement regarding intended use. If so requested, random samples of bolts, nuts, and washers as delivered to the job site shall be taken in the presence of the Contracting Officer and provided to the Contracting Officer for testing to establish compliance with

specified requirements.

Insulation; G, RE.

One piece, 300 by 300 mm, of each type and thickness to be used, with a label indicating the rated permeance (if faced) and R-values. The flame spread, and smoke developed rating shall be shown on the label or provided in a letter of certification.

Gaskets and Insulating Compounds; G, RE.

Two samples of each type to be used and descriptive data.

Sealant; G, RE.

One sample, approximately 0.5 kg, and descriptive data.

Concealed Anchor Clips; G, RE.

Two samples of each type used.

Subpurlins; G, RE.

One piece, 225 mm long.

EPDM Rubber Boots; G, RE.

One piece of each type.

External Attachments;; G, RE

Two samples of every type of permanent external attachment either, clips or clamps, used in the tested system to increase the rated capacity of the roofing system

SD-06 Test Reports

Test Report for Uplift Resistance of the SSSMR; G, RE

The report shall include the following information:

a. Details of the SSSMR system showing the roof panel cross-section with dimensions and thickness.

b. Details of the anchor clip, dimensions, and thickness.

c. Type of fasteners, size, and the number required for each connection.

d. Purlins/subpurlins size and spacing used in the test.

e. Description of the seaming operation including equipment used.

f. Maximum allowable uplift pressures. These pressures are determined from the ultimate load divided by a factor of safety equal to 1.65.

g. Any additional information required to identify the SSSMR

system tested.

h. Signature and seal of an independent registered engineer who witnessed the test.

i. Fastener Test Report (Additional Requirement)? Manufacturer's test report or independent test laboratory report. Tests shall be performed on fasteners and supporting members that are made from the same materials and are equal or less in size and thickness to the fasteners and supporting members used in the actual roof installation.

j. Panel Finish Color (Additional Requirement)? Test results shall be submitted for all roofing panels showing the results of testing in accordance with the color finish tests specified in paragraphs 2.6.1 through 2.6.8.

SD-07 Certificates

Structural Standing Seam Metal Roof System; G, RE.

a. Certification that the actual thickness of uncoated sheets used in SSSMRS components including roofing panels, subpurlins, and concealed anchor clips complies with specified requirements.

b. Certification that materials used in the installation are mill certified.

c. Previous certification of SSSMR system tested under the Corps of Engineers' Standard Test Method in lieu of ASTM E 1592 testing.

d. Certification that the sheets to be furnished are produced under a continuing quality control program and that a representative sample consisting of not less than three pieces has been tested and has met the quality standards specified for factory color finish.

e. Certification of installer. Installer certification shall be furnished.

f. Warranty certificate. At the completion of the project the Contractor shall furnish signed copies of the 5-year Warranty for Structural Standing Seam Metal Roof (SSSMR) System, a sample copy of which is attached to this section, [and] the 20-year Manufacturer's Material Warranties, [and the manufacturer's 20-year system weathertightness warranty].

Insulation; G, RE

Certificate attesting that the polyisocyanurate insulation furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

1.6 DELIVERY AND STORAGE

Materials shall be delivered to the site in a dry and undamaged condition and stored out of contact with the ground. Materials shall be covered with

weathertight coverings and kept dry. Storage conditions shall provide good air circulation and protection from surface staining.

1.7 WARRANTIES

The SSSMR system shall be warranted as outlined below. Any emergency temporary repairs conducted by the owner shall not negate the warranties.

1.7.1 Contractor's Weathertightness Warranty

The SSSMR system shall be warranted by the Contractor on a no penal sum basis for a period of five years against material and workmanship deficiencies; system deterioration caused by exposure to the elements and/or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The SSSMR system covered under this warranty shall include the entire roofing system including, but not limited to, the standing seam metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system shall consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, and skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of these specifications that are part of the SSSMR system. All material and workmanship deficiencies, system deterioration caused by exposure to the elements and/or inadequate resistance to specified design loads, water leaks and wind uplift damage shall be repaired as approved by the Contracting Officer. See the attached Contractor's required warranty for issue resolution of warrantable defects. This warranty shall warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. The Contractor shall supplement this warranty with written warranties from the installer and system manufacturer, which shall be submitted along with Contractor's warranty; however, the Contractor shall be ultimately responsible for this warranty. The Contractor's written warranty shall be as outlined in attached WARRANTY FOR STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM, and shall start upon final acceptance of the facility. It is required that the Contractor provide a separate bond in an amount equal to the installed total roofing system cost in favor of the owner (Government) covering the Contractor's warranty responsibilities effective throughout the five year Contractor's warranty period for the entire SSSMR system as outlined above.

1.7.2 Manufacturer's Material Warranties.

The Contractor shall furnish, in writing, the following manufacturer's material warranties which cover all SSSMR system components such as roof panels, anchor clips and fasteners, flashing, accessories, and trim, fabricated from coil material:

a. A manufacturer's 20 year material warranty warranting that the aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel as specified herein will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty shall be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed coil material.

b. A manufacturer's 20 year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214 test procedures; or change color in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to refinishing with an air-drying version of the specified finish or replacing the defective coated material.

c. A roofing system manufacturer's 20 year, non-prorated, system weathertightness warranty.

1.8 COORDINATION MEETING

A coordination meeting shall be held 30 days prior to the first submittal, for mutual understanding of the Structural Standing Seam Metal Roof (SSSMR) System contract requirements. This meeting shall take place at the building site and shall include representatives from the Contractor, the roof system manufacturer, the roofing supplier, the erector, the SSSMR design engineer of record, and the Contracting Officer. All items required by paragraph SUBMITTALS shall be discussed, including applicable standard manufacturer shop drawings, and the approval process. The Contractor shall coordinate time and arrangements for the meeting.

PART 2 PRODUCTS

2.1 ROOF PANELS

Panels shall be steel and shall have a factory color finish. Length of sheets shall be sufficient to cover the entire length of any unbroken roof slope for slope lengths that do not exceed 9 m. When length of run exceeds 9 m and panel laps are provided, each sheet in the run shall extend over three or more supports. Sheets longer than 30 m may be furnished if approved by the Contracting Officer. Width of sheets shall provide not more than 600 mm of coverage in place. SSSMR system with roofing panels greater than 300 mm in width shall have standing seams rolled during installation by an electrically driven seaming machine. Height of standing seams shall be not less than 2 mm for rolled seam and 2 mm for seams that are not rolled.

2.1.1 Steel Panels

Steel panels shall be zinc-coated steel conforming to ASTM A 653/A 653M; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ [55] [50] coating; or aluminum-coated steel conforming to ASTM A 463/A 463M, Type 2, coating designation T2 65. Uncoated panels shall be 0.024-inch (0.61 mm) thick minimum, except that areas of the roof subject to design wind uplift pressures of 60 psf (2.87 kPa) or greater shall have a minimum panel thickness of 0.030-inch (0.76 mm)." Panels shall be within 95 percent of reported tested thickness as noted in wind uplift resistance testing required in paragraph PERFORMANCE REQUIREMENTS. Prior to shipment, mill finish panels shall be treated with a passivating chemical to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment and have started to oxidize shall be rejected.

2.2 CONCEALED ANCHOR CLIPS

Concealed anchor clips shall be the same as the tested roofing system.

Clip bases shall have factory punched or drilled holes for attachment. Clips shall be made from multiple pieces with the allowance for the total thermal movement required to take place within the clip. Single piece clips may be acceptable when the manufacturer can substantiate that the system can accommodate the thermal cyclic movement under sustained live or snow loads.

2.3 ACCESSORIES

Flashing, trim, metal closure strips, caps and similar metal accessories shall be the manufacturer's standard products. Exposed metal accessories shall be finished to match the panels furnished. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the panels and shall not absorb or retain water. The use of a continuous angle butted to the panel ends to form a closure will not be allowed.

2.4 FASTENERS

Fasteners for steel roof panels shall be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for aluminum roof panels shall be aluminum or corrosion resisting steel. Fasteners for structural connections shall provide both tensile and shear ultimate strengths of not less than 3340 N per fastener. Fasteners for accessories shall be the manufacturer's standard. Exposed roof fasteners shall be sealed or have sealed washers on the exterior side of the roof to waterproof the fastener penetration. Washer material shall be compatible with the roofing; have a minimum diameter of 10 mm for structural connections; and gasketed portion of fasteners or washers shall be neoprene or other equally durable elastomeric material approximately 3 mm thick. Exposed fasteners for factory color finished panels shall be factory finished to match the color of the panels.

2.4.1 Screws

Screws for attaching anchor devices shall be not less than No. 14 self-tapping type and not less than No. 12 if self-drilling and self-tapping type. Actual screw pull out test results shall be performed for the actual material gage and yield strength of the structural purlins or subpurlins to which the clip is to be anchored/attached. Other screws shall be as recommended by the manufacturer to meet the strength design requirements of the panels.

2.4.2 Bolts

Bolts shall be not less than 6 mm diameter, shouldered or plain shank as required, with locking washers and nuts.

2.4.3 Structural Blind Fasteners

Blind screw-type expandable fasteners shall be not less than 6 mm diameter. Blind (pop) rivets shall be not less than 7 mm minimum diameter.

2.5 SUBPURLINS

Cold formed subpurlins , when required by the system design, shall be formed from steel sheet as standard with the manufacturer. The uncoated

thickness may be a minimum of 0.059 inches and a minimum tensile yield strength of 50,000 psi. Hot rolled structural members shall have a minimum thickness of 6 mm and a minimum tensile yield strength of 248 MPa. Subpurlins shall be shop painted.

2.6 FACTORY COLOR FINISH

Panels shall have a factory applied polyvinylidene fluoride finish on the exposed side. The exterior finish shall consist of a baked-on topcoat with an appropriate prime coat. Color shall match the color indicated in the Statement of Work. The exterior coating shall be a nominal [0.025] [0.050] mm thickness consisting of a topcoat of not less than 0.018 mm dry film thickness and the paint manufacturer's recommended primer of not less than [0.005] [0.025] mm thickness. The interior color finish shall consist of the same coating and dry film thickness as the exterior. The exterior color finish shall meet the test requirements specified below.

2.6.1 Salt Spray Test

A sample of the sheets shall withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating shall receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, over 2.0 to 3.0 mm failure at scribe, as determined by ASTM D 1654.

2.6.2 Formability Test

When subjected to testing in accordance with ASTM D 522 Method B, 3 mm diameter mandrel, the coating film shall show no evidence of cracking to the naked eye.

2.6.3 Accelerated Weathering, Chalking Resistance and Color Change

A sample of the sheets shall be tested in accordance with ASTM G 154, test condition UVA-340 lamp, 4h UV at 60 degrees C followed by 4h CON at 50 degrees C for 2,500 total hours. The coating shall withstand the weathering test without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating with an adhesion rating less than 4B when tested in accordance with ASTM D 3359, Test Method B, shall be considered as an area indicating loss of adhesion. Following the accelerated weathering test, the coating shall have a chalk rating not less than No. 8 in accordance with ASTM D 4214 test procedures, and the color change shall not exceed 5 CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. For sheets required to have a low gloss finish, the chalk rating shall be not less than No. 6 and the color difference shall be not greater than 7 units.

2.6.4 Humidity Test

When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel shall show no signs of blistering, cracking, creepage or corrosion.

2.6.5 Impact Resistance

Factory-painted sheet shall withstand direct and reverse impact in accordance with ASTM D 2794 13 mm diameter hemispherical head indenter,

equal to 6.7 times the metal thickness in mm, expressed in Newton-meters, with no cracking.

2.6.6 Abrasion Resistance Test

When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system shall withstand a minimum of [50] [80] liters of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

2.6.7 Pollution Resistance

Coating shall show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

2.7 INSULATION

Thermal resistance of roof insulation shall be R-30. R-values shall be determined at a mean temperature of 24 degrees C in accordance with ASTM C 518. Insulation shall be a standard product with the insulation manufacturer, factory marked or identified with insulation manufacturer's name or trademark and R-value. Identification shall be on individual pieces or individual packages. Insulation , including facings, shall have a flame spread not in excess of 9 and a smoke developed rating not in excess of 50 when tested in accordance with ASTM E 84. The stated R-value of the insulation shall be certified by an independent Registered Professional Engineer if tests are conducted in the insulation manufacturer's laboratory. Contractor shall comply with EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

2.7.1 Polyisocyanurate Rigid Board Insulation for Use Above a Roof Deck

Polyisocyanurate insulation shall conform to ASTM C 1289, Type II, (having a minimum recovered material content of 9 percent by weight of core material in the polyisocyanurate portion). For impermeable faced polyisocyanurate, the maximum design R-value per 25 mm of insulation used shall be 6.0. Facings shall be non-asphaltic, glass fiber reinforced.

2.7.2 Blanket Insulation

Blanket insulation shall conform to ASTM C 991.

2.8 INSULATION RETAINERS

Insulation retainers shall be type, size, and design necessary to adequately hold the insulation and to provide a neat appearance. Metallic retaining members shall be nonferrous or have a nonferrous coating. Nonmetallic retaining members, including adhesives used in conjunction with mechanical retainers or at insulation seams, shall have a fire resistance classification not less than that permitted for the insulation.

2.9 SEALANT

Sealants shall be elastomeric type containing no oil or asphalt. Exposed sealant shall be clear and shall cure to a rubberlike consistency. Sealant placed in the roof panel standing seam ribs shall be provided in accordance with the manufacturer's recommendations.

2.10 GASKETS AND INSULATING COMPOUNDS

Gaskets and insulating compounds shall be nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds shall be nonrunning after drying.

2.11 EPDM RUBBER BOOTS

Flashing devices around pipe penetrations shall be flexible, one-piece devices molded from weather-resistant EPDM rubber. Rubber boot material shall be as recommended by the manufacturer. The boots shall have base rings made of aluminum or corrosion resisting steel that conform to the contours of the roof panel to form a weather-tight seal.

2.12 PREFABRICATED CURBS AND EQUIPMENT SUPPORTS

Prefabricated curbs and equipment supports shall be of structural quality, hot-dipped galvanized or galvanized sheet steel, factory primed and prepared for painting with mitered and welded joints. Integral base plates and water diverter crickets shall be provided. Minimum height of curb shall be 200 mm above finish roof. Curbs shall be constructed to match roof slope and to provide a level top surface for mounting of equipment. Curb flange shall be constructed to match configuration of roof panels. Curb size shall be coordinated, prior to curb fabrication, with the mechanical equipment to be supported. Strength requirements for equipment supports shall be coordinated to include all anticipated loads. Flashings shall not be rigidly attached to underline structure.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be in accordance with the manufacturer's erection instructions and drawings. Dissimilar materials which are not compatible when contacting each other shall be insulated by means of gaskets or insulating compounds. Molded closure strips shall be installed wherever roofing sheets terminate in open-end configurations, exclusive of flashings. The closure strip installation shall be weather-tight and sealed. Screws shall be installed with a clutching screw gun, to assure screws are not stripped. Field test shall be conducted on each gun prior to starting installation and periodically thereafter to assure it is adjusted properly to install particular type and size of screw as recommended by manufacturer's literature. Improper or mislocated drill holes shall be plugged with an oversize screw fastener and gasketed washer; however, sheets with an excess of such holes or with such holes in critical locations shall not be used. Exposed surfaces and edges shall be kept clean and free from sealant, metal cuttings, hazardous burrs, and other foreign material. Stained, discolored, or damaged sheets shall be removed from the site.

3.1.1 Field Forming of Panels for Unique Area

When roofing panels are formed from factory-color-finished steel coils at the project site, the same care and quality control measures that are taken in shop forming of roofing panels shall be observed. Rollformer shall be operated by the metal roofing manufacturer's representative. In cold weather conditions, preheating of the steel coils to be field formed shall be performed as necessary just prior to the rolling operations.

3.1.2 Subpurlins

Unless otherwise shown, subpurlins shall be anchored to the purlins or other structural framing members with bolts or screws. Attachment to the substrate (when provided) or to the panels is not permitted. The subpurlin spacing shall not exceed 750 mm on centers at the corner, edge and ridge zones, and 1500 mm maximum on centers for the remainder of the roof. Corner, edge, and ridge zones are as defined in ASCE 7. Closer spacing may be required by the roofing manufacturer to meet the roof uplift loads calculated and submitted with the shop drawings.

3.1.3 Roof Panel Installation

Roof panels shall be installed with the standing seams in the direction of the roof slope. The side seam connections for installed panels shall be completed at the end of each day's work. Method of applying joint sealant shall conform to the manufacturer's recommendation to achieve a complete weather-tight installation. End laps of panels shall be provided in accordance with the manufacturer's instructions. Closures, flashings, EPDM rubber boots, roof curbs, and related accessories shall be installed according to the manufacturer's drawings. Fasteners shall not puncture roofing sheets except as provided for in the manufacturer's instructions for erection and installation. Expansion joints for the standing seam roof system shall be installed at locations indicated on the contract drawings and other locations indicated on the manufacturer's drawings.

3.1.4 Concealed Anchor Clips

Roof panels shall be fastened to framing members with concealed fastening clips or other concealed devices. Clips shall be attached directly to the building structural system or to the subpurlins with bolts or screws. Attachment to the substrate (when provided) or to the metal deck is not permitted. The maximum distance, parallel to the seams, between clips shall be 750 mm on center at the corner, edge, and ridge zones, and 1500 mm maximum on centers for the remainder of the roof. Closer spacing may be required by the roofing manufacturer to meet the roof uplift pressures calculated and submitted with the shop drawings. Attachment of clips through rigid insulation to structure is prohibited

3.2 INSULATION INSTALLATION

Insulation shall be continuous over entire roof surface. Where expansion joints, terminations, and other connections are made, the cavity shall be filled with batt insulation with vapor retarder providing equivalent R-value and perm rating as remaining insulation. Insulation shall be installed as indicated and in accordance with manufacturer's instructions.

3.2.1 Board Insulation with Blanket Insulation

Rigid or semirigid board insulation shall be laid in close contact. Board shall be attached to the metal roof deck with bearing plates and fasteners, as recommended by the insulation manufacturer, so that the insulation joints are held tight against each other, and shall have a minimum of 1 fastener per 0.37 square meters. Layout and joint pattern of insulation and fasteners shall be indicated on the shop drawings. If more than one layer of insulation is required, joints in the second layer shall be offset from joints in the first layer. A layer of blanket insulation shall be placed over the rigid or semirigid board insulation to be compressed

against the underside of the metal roofing to reduce thermal bridging, dampen noise, and prevent roofing flutter. This layer of blanket insulation shall be compressed a minimum of 50 percent. Thermal blocks shall not be placed in between the concealed anchor clips and the subpurlins or supporting structure.

3.2.2 Blanket Insulation

Blanket insulation shall be installed between and parallel to the purlins with tabs of a facer lapping on the top face of the purlins. Thermal blocks shall be provided over purlins, between clips. A second layer of unfaced insulation shall be added between purlins to provide full R-value. Blanket insulation shall be supported by an integral facing or other commercially available support system.

3.3 PROTECTION OF VAPOR RETARDER FROM ROOF DECK

A cloth industrial duct tape shall be applied over the seams of metal roof decks, at penetration edges, and at surface areas exhibiting sharp burrs or similar protrusions. For other types of roof decks, cloth industrial duct tape shall be applied over irregularities which could potentially puncture polyethylene membrane.

3.4 VAPOR RETARDER INSTALLATION

3.4.1 Integral Facing on Blanket Insulation

Integral facing on blanket insulation shall have the facing lapped and sealed with a compatible tape to provide a vapor tight membrane.

3.4.2 Polyethylene Vapor Retarder

The polyethylene vapor retarder membrane shall be installed over the entire surface. A fully compatible polyethylene tape shall be used to seal the edges of the sheets to provide a vapor tight membrane. Sheet edges shall be lapped not less than 150 mm. Sufficient material shall be provided to avoid inducing stresses in the sheets due to stretching or binding. All tears or punctures that are visible in the finished surface at any time during the construction process shall be sealed with polyethylene tape.

3.5 SLIP SHEET INSTALLATION

A slip sheet shall be laid over the blanket insulation facing to prevent the vinyl facing from adhering to the metal roofing.

3.6 CLEANING AND TOUCH-UP

Exposed SSSMR systems shall be cleaned at completion of installation. Debris that could cause discoloration and harm to the panels, flashings, closures and other accessories shall be removed. Grease and oil films, excess sealants, and handling marks shall be removed and the work shall be scrubbed clean. Exposed metal surfaces shall be free of dents, creases, waves, scratch marks, and solder or weld marks. Immediately upon detection, abraded or corroded spots on shop-painted surfaces shall be wire brushed and touched up with the same material used for the shop coat. Factory color finished surfaces shall be touched up with the manufacturer's recommended touch up paint.

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM

FACILITY DESCRIPTION_____

BUILDING NUMBER:_____

CORPS OF ENGINEERS CONTRACT NUMBER:_____

CONTRACTOR

CONTRACTOR:_____

ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

OWNER

OWNER:_____

ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

CONSTRUCTION AGENT

CONSTRUCTION AGENT:_____

ADDRESS:_____

POINT OF CONTACT:_____

TELEPHONE NUMBER:_____

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
(continued)

THE SSSMR SYSTEM INSTALLED ON THE ABOVE NAMED BUILDING IS WARRANTED BY _____ FOR A PERIOD OF FIVE (5) YEARS AGAINST WORKMANSHIP AND MATERIAL DEFICIENCES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE. THE SSSMR SYSTEM COVERED UNDER THIS WARRANTY SHALL INCLUDE, BUT SHALL NOT BE LIMITED TO, THE FOLLOWING: THE ENTIRE ROOFING SYSTEM, MANUFACTURER SUPPLIED FRAMING AND STRUCTURAL MEMBERS, METAL ROOF PANELS, FASTENERS, CONNECTORS, ROOF SECUREMENT COMPONENTS, AND ASSEMBLIES TESTED AND APPROVED IN ACCORDANCE WITH ASTM E 1592. IN ADDITION, THE SYSTEM PANEL FINISHES, SLIP SHEET, INSULATION, VAPOR RETARDER, ALL ACCESSORIES, COMPONENTS, AND TRIM AND ALL CONNECTIONS ARE INCLUDED. THIS INCLUDES ROOF PENETRATION ITEMS SUCH AS VENTS, CURBS, SKYLIGHTS; INTERIOR OR EXTERIOR GUTTERS AND DOWNSPOUTS; EAVES, RIDGE, HIP, VALLEY, RAKE, GABLE, WALL, OR OTHER ROOF SYSTEM FLASHINGS INSTALLED AND ANY OTHER COMPONENTS SPECIFIED WITHIN THIS CONTRACT TO PROVIDE A WEATHERTIGHT ROOF SYSTEM; AND ITEMS SPECIFIED IN OTHER SECTIONS OF THE SPECIFICATIONS THAT ARE PART OF THE SSSMR SYSTEM.

ALL MATERIAL DEFICIENCIES, WIND DAMAGE, STRUCTURAL FAILURE, AND LEAKAGE ASSOCIATED WITH THE SSSMR SYSTEM COVERED UNDER THIS WARRANTY SHALL BE REPAIRED AS APPROVED BY THE CONTRACTING OFFICER. THIS WARRANTY SHALL COVER THE ENTIRE COST OF REPAIR OR REPLACEMENT, INCLUDING ALL MATERIAL, LABOR, AND RELATED MARKUPS. THE ABOVE REFERENCED WARRANTY COMMENCED ON THE DATE OF FINAL ACCEPTANCE ON _____ AND WILL REMAIN IN EFFECT FOR STATED DURATION FROM THIS DATE.

SIGNED, DATED, AND NOTARIZED (BY COMPANY PRESIDENT)

_____

(Company President) (Date)

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
(continued)

THE CONTRACTOR SHALL SUPPLEMENT THIS WARRANTY WITH WRITTEN WARRANTIES FROM THE MANUFACTURER AND/OR INSTALLER OF THE SSSMR SYSTEM, WHICH SHALL BE SUBMITTED ALONG WITH THE CONTRACTOR'S WARRANTY. HOWEVER, THE CONTRACTOR WILL BE ULTIMATELY RESPONSIBLE FOR THIS WARRANTY AS OUTLINED IN THE SPECIFICATIONS AND AS INDICATED IN THIS WARRANTY EXAMPLE.

EXCLUSIONS FROM COVERAGE

1. NATURAL DISASTERS, ACTS OF GOD (LIGHTNING, FIRE, EXPLOSIONS, SUSTAINED WIND FORCES IN EXCESS OF THE DESIGN CRITERIA, EARTHQUAKES, AND HAIL).

2. ACTS OF NEGLIGENCE OR ABUSE OR MISUSE BY GOVERNMENT OR OTHER PERSONNEL, INCLUDING ACCIDENTS, VANDALISM, CIVIL DISOBEDIENCE, WAR, OR DAMAGE CAUSED BY FALLING OBJECTS.

3. DAMAGE BY STRUCTURAL FAILURE, SETTLEMENT, MOVEMENT, DISTORTION, WARPAGE, OR DISPLACEMENT OF THE BUILDING STRUCTURE OR ALTERATIONS MADE TO THE BUILDING.

4. CORROSION CAUSED BY EXPOSURE TO CORROSIVE CHEMICALS, ASH OR FUMES GENERATED OR RELEASED INSIDE OR OUTSIDE THE BUILDING FROM CHEMICAL PLANTS, FOUNDRIES, PLATING WORKS, KILNS, FERTILIZER FACTORIES, PAPER PLANTS, AND THE LIKE.

5. FAILURE OF ANY PART OF THE SSSMR SYSTEM DUE TO ACTIONS BY THE OWNER TO INHIBIT FREE DRAINAGE OF WATER FROM THE ROOF AND GUTTERS AND DOWNSPOUTS OR ALLOW PONDING WATER TO COLLECT ON THE ROOF SURFACE. CONTRACTOR'S DESIGN SHALL INSURE FREE DRAINAGE FROM THE ROOF AND NOT ALLOW PONDING WATER.

6. THIS WARRANTY APPLIES TO THE SSSMR SYSTEM. IT DOES NOT INCLUDE ANY CONSEQUENTIAL DAMAGE TO THE BUILDING INTERIOR OR CONTENTS WHICH IS COVERED BY THE WARRANTY OF CONSTRUCTION CLAUSE INCLUDED IN THIS CONTRACT.

7. THIS WARRANTY CANNOT BE TRANSFERRED TO ANOTHER OWNER WITHOUT WRITTEN CONSENT OF THE CONTRACTOR; AND THIS WARRANTY AND THE CONTRACT PROVISIONS WILL TAKE PRECEDENCE OVER ANY CONFLICTS WITH STATE STATUTES.

**

CONTRACTOR'S FIVE (5) YEAR NO PENAL SUM WARRANTY
FOR
STRUCTURAL STANDING SEAM METAL ROOF (SSSMR) SYSTEM
(continued)

**REPORTS OF LEAKS AND SSSMR SYSTEM DEFICIENCIES SHALL BE RESPONDED TO WITHIN 48 HOURS OF RECEIPT OF NOTICE, BY TELEPHONE OR IN WRITING, FROM EITHER THE OWNER OR CONTRACTING OFFICER. EMERGENCY REPAIRS TO PREVENT FURTHER ROOF LEAKS SHALL BE INITIATED IMMEDIATELY; A WRITTEN PLAN SHALL BE SUBMITTED FOR APPROVAL TO REPAIR OR REPLACE THIS SSSMR SYSTEM WITHIN SEVEN (7) CALENDAR DAYS. ACTUAL WORK FOR PERMANENT REPAIRS OR REPLACEMENT SHALL BE STARTED WITHIN 30 DAYS AFTER RECEIPT OF NOTICE, AND COMPLETED WITHIN A REASONABLE TIME FRAME. IF THE CONTRACTOR FAILS TO ADEQUATELY RESPOND TO THE WARRANTY PROVISIONS, AS STATED IN THE CONTRACT AND AS CONTAINED HEREIN, THE CONTRACTING OFFICER MAY HAVE THE SSSMR SYSTEM REPAIRED OR REPLACED BY OTHERS AND CHARGE THE COST TO THE CONTRACTOR.

IN THE EVENT THE CONTRACTOR DISPUTES THE EXISTENCE OF A WARRANTABLE DEFECT, THE CONTRACTOR MAY CHALLENGE THE OWNER'S DEMAND FOR REPAIRS AND/OR REPLACEMENT DIRECTED BY THE OWNER OR CONTRACTING OFFICER EITHER BY REQUESTING A CONTRACTING OFFICER'S DECISION UNDER THE CONTRACT DISPUTES ACT, OR BY REQUESTING THAT AN ARBITRATOR RESOLVE THE ISSUE. THE REQUEST FOR AN ARBITRATOR MUST BE MADE WITHIN 48 HOURS OF BEING NOTIFIED OF THE DISPUTED DEFECTS. UPON BEING INVOKED, THE PARTIES SHALL, WITHIN TEN (10) DAYS, JOINTLY REQUEST A LIST OF FIVE (5) ARBITRATORS FROM THE FEDERAL MEDIATION AND CONCILIATION SERVICE. THE PARTIES SHALL CONFER WITHIN TEN (10) DAYS AFTER RECEIPT OF THE LIST TO SEEK AGREEMENT ON AN ARBITRATOR. IF THE PARTIES CANNOT AGREE ON AN ARBITRATOR, THE CONTRACTING OFFICER AND THE PRESIDENT OF THE CONTRACTOR'S COMPANY WILL STRIKE ONE (1) NAME FROM THE LIST ALTERNATIVELY UNTIL ONE (1) NAME REMAINS. THE REMAINING PERSON SHALL BE THE DULY SELECTED ARBITRATOR. THE COSTS OF THE ARBITRATION, INCLUDING THE ARBITRATOR'S FEE AND EXPENSES, COURT REPORTER, COURTROOM OR SITE SELECTED, ETC., SHALL BE BORNE EQUALLY BETWEEN THE PARTIES. EITHER PARTY DESIRING A COPY OF THE TRANSCRIPT SHALL PAY FOR THE TRANSCRIPT. A HEARING WILL BE HELD AS SOON AS THE PARTIES CAN MUTUALLY AGREE. A WRITTEN ARBITRATOR'S DECISION WILL BE REQUESTED NOT LATER THAN 30 DAYS FOLLOWING THE HEARING. THE DECISION OF THE ARBITRATOR WILL NOT BE BINDING; HOWEVER, IT WILL BE ADMISSIBLE IN ANY SUBSEQUENT APPEAL UNDER THE CONTRACT DISPUTES ACT.

A FRAMED COPY OF THIS WARRANTY SHALL BE POSTED IN THE MECHANICAL ROOM OR OTHER APPROVED LOCATION DURING THE ENTIRE WARRANTY PERIOD.

-- End of Section --

SECTION 16000

DIVISION 16: ELECTRICAL - OUTLINE SPECIFICATIONS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

1.1.1 Guide Specifications

The contractor shall edit and provide the following UFGS guide specifications for Division 16, Electrical. All Part 3 requirements shall be included and uneditied for all equipment included in this contract.

Section 16070A, SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT

Section 16375A, ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

Section 16415A, ELECTRICAL WORK, INTERIOR

Section 16528A, EXTERIOR LIGHTING

Section 16665A, STATIC ELECTRICITY PROTECTION SYSTEM

Section 16710A, PREMISE DISTRIBUTION SYSTEM

Section 16711A, TELEPHONE SYSTEM OUTSIDE PLANT

Section 16713N, FIBER OPTIC CABLE OUTSIDE PLANT

Section 16721A, INTERCOMMUNICATION SYSTEM

Section 16751A, CLOSED CIRCUIT TELEVISION SYSTEMS

Section 16770, RADIO AND PUBLIC ADDRESS SYSTEMS

1.2 SECTION 16070, SEISMIC BRACING FOR ELECTRICAL EQUIPMENT

1.2.1 Material Criteria

This section should be editted to conform to the seismic requirements for this area.

1.3 SECTION 16375, ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

1.3.1 General Requirements

A. Pad mounted transformer shall be delta/wye, dead front, loop feed, surge arresters, with oil immersed current limiting fuses with load break switch.

B. Primary cable shall be shielded, 15KV with 133% insulation. Cable

insulation shall be EPR with minimum conductor size #2. Neutral cable shall be 600 volts.

C. All primary connections shall be load break type.

D. Ducts shall be 2-103mm concrete encased type EB ducts.

E. All cabinets shall be provided with padlock hasp.

1.4 SECTION 16415, ELECTRICAL WORK, INTERIOR

1.4.1 General Requirements

A. All conductors shall be copper.

B. Conduits shall be EMT in concealed areas. Surface mounted IMC & cast boxes shall be used for conduit rough-in in trainer buildings.

C. All interior branch circuit wiring shall be THHN/THWN.

D. Light Fixtures shall meet requirements of COE light fixture details identified in Section 01017.

E. All bus in panelboards shall be copper.

F. Transient voltage surge suppression be incorporated into the main panel and shall meet the requirements of IEEE C62.41 and be UL listed in accordance with the testing requirements of UL1449.

G. All step down transformers shall be compliant with NEMA TP-1.

H. Hazardous Areas electrical requirements for areas shown in space data sheets and in section 01017 Electrical Requirements.

1.5 SECTION 16528, EXTERIOR LIGHTING

1.5.1 General Requirements

A. All exterior lighting shall meet the requirements of COE light fixture details identified in Section 01017.

1.6 SECTION 16665A STATIC ELECTRICITY PROTECTION SYSTEM

1.6.1 General Requirements

In the POL laboratory ground the conductive flooring and all metals that can pose the static electricity hazard.

1.7 SECTION 16710, PREMISE DISTRIBUTION SYSTEM

1.7.1 General Requirements

A. Cable tray shall be basket type.

B. Cables shall be plenum rated where required.

C. Contractor shall have a minimum of 3 years experience in the application, installation and testing of the specified systems and equipment.

D. All supervisors and installers assigned to the installation of this system or any of its components shall have factory certification from each equipment manufacturer that they are qualified to install and test the provided products.

E. All installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components.

F. Electrical boxes for telecommunication outlets shall be 117 mm square by 53 mm deep with minimum 9 mm deep single or two gang plaster ring as shown. Provide a minimum 27 mm conduit. Surface mounted IMC & cast boxes shall be used for conduit rough-in in trainer buildings.

1.8 SECTION 16711, TELEPHONE SYSTEM, OUTSIDE PLANT

1.8.1 General Requirements

A. Cable shall be sized as indicated in Section 01017.

B. Coil 4.5 meters of cable in each handhole for future splicing.

C. Outside plant copper cables shall be terminted on 110 block.

1.9 SECTION 16713, FIBER OPTIC SYSTEM OUTSIDE PLANT

1.9.1 General Requirements

A. Fiber optic cable shall be provided as indicated in section 01017.

B. Coil 15 meters of cable in each handhole for future splicing.

C. Single mode fiber shall be loose tube fiber with 6 fibers per tube.

1.10 SECTION 16721A, INTERCOMMUNICATION SYSTEM

1.10.1 General Requirements

A. No special requirements other than those indicated in Section 01017.

1.11 SECTION 16751A CLOSED CIRCUIT TELEVISION SYSTEMS

1.11.1 General Requirements

A. No special requirements other than those indicated in Section 01017.

1.12 SECTION 16770, RADIO & PUBLIC ADDRESS SYSTEMS

No special requirements. Location of devices shall be determined during the design of the project.

PART 2 NOT APPLICABLE

PART 3 NOT APPLICABLE

-- End of Section --