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SPECIFICATIONS**

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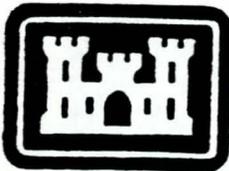
**ARIZONA CANAL DIVERSION CHANNEL
(CAVE CREEK TO 29TH AVENUE)**

Maricopa County, Arizona

Prelim

Authority: Public Law 89-298, Flood Control Act of 1965

Appropriation: Construction, General
Contributed Funds, Required



**US Army Corps
of Engineers**
Los Angeles District

A118.516

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REMARKS	

SECTION 3H

PRECAST PRESTRESSED CONCRETE

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

1.1 American Association of State Highway and Transportation Officials (AASHTO).

AASHTO 1983

Standard Specifications for Highway
Bridges (13th Edition)

1.2 American Concrete Institute (ACI) Standards.

ACI 214 - 77
(R 1983)

Recommended Practice for Evaluation
of Strength Test Results of Concrete

ACI 318 - 83

Building Code Requirements for
Reinforced Concrete

1.3 American Society for Testing and Materials (ASTM) with Corresponding U.S. Army Corps of Engineers Handbook for Cement and Concrete CRD Standard Indicated Where Available.

C 31 - 85 (CRD-C 11)

Making and Curing Concrete Test
Specimens in the Field

C 33 - 86 (CRD-C 133)

Concrete Aggregates

C 39 - 86 (CRD-C 14)

Compressive Strength of Cylindrical
Concrete Specimens

C 150 - 86 (CRD-C 201)

Portland Cement

C 172 - 82 (CRD-C 4)

Sampling Freshly Mixed Concrete

C 231 - 82 (CRD-C 41)

Air Content of Freshly Mixed
Concrete By The Pressure Method

C 260 - 86 (CRD-C 13)

Air Entraining Admixtures for Concrete

C 494 - 86 (CRD-C 87)	Chemical Admixtures for Concrete
C 595 - 86 (CRD-C 203)	Blended Hydraulic Cements
C 617 - 85b (CRD-C 29)	Capping Cylindrical Concrete Specimens
C 618 - 85 (CRD-C-255)	Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture In Portland Cement Concrete

1.4 Prestressed Concrete Institute (PCI) Publications

MNL 116 - 77	Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products
MNL 120 - 78	PCI Design Handbook Precast Prestressed Concrete

2. DESIGN.

2.1 Design of Precast Prestressed Members and Connections. Design of members and connections shall be in accordance with AASHTO and PCI Design Handbook, Precast Prestressed Concrete.

2.2 Loads. Loadings for members and connections shall include all dead load, live load, handling, erection and other applicable loads.

2.3 Calculations. Calculations for design of members and connections not shown on the contract drawings shall be made by a registered professional engineer experienced in the design of precast prestressed concrete.

3. QUALITY CONTROL.

3.1 Construction Testing by the Contractor. The Contractor shall perform testing to insure the materials and method he uses meet the requirements of these specifications and will produce precast prestressed concrete members which are suitable for their intended use. In addition, the Contractor shall perform all other testing he feels is necessary to insure the quality of the precast prestressed concrete members.

3.1.1 High Strength Steel Tendons. Testing shall be as specified in SECTION: STRESSING TENDONS AND ACCESSORIES FOR PRESTRESSED CONCRETE.

3.1.2 Concrete. Concrete shall be sampled and cylinders made in strict accordance with ASTM C 172 and ASTM C 31.

3.1.2.1 Concrete Test Cylinders. At least four test cylinders per casting bed shall be made each day the bed is used. A minimum of two test cylinders per bed shall be made to verify the strength of concrete at the time of stress transfer and a minimum of two test cylinders per day or 50 cubic yards of concrete or fraction thereof, whichever results in the most cylinders, shall be made for each

mix design to verify the attainment of the specified strength. Cylinders to be used for judging stress transfer strength shall be made from concrete placed during the latter half of a casting.

3.1.2.2 Cylinder Making. Cylinders shall be made as near as possible to the location where they will be cured and shall not be disturbed in any way from one half hour after casting until they are either 20 plus or minus 4 hours old or ready to be tested. Concrete in cylinders may be consolidated by rodding or by vibration as specified in ASTM C 31. If vibrators are used, techniques shall be used which will preclude segregation.

3.1.2.3 Cylinder Curing.

3.1.2.3.1 Test cylinders shall be cured with and by the same methods as the members they represent. In lieu of actual curing with the members, cylinders may be cured in curing chambers correlated in temperature and humidity with the beds. In such a case, the correlation shall be constantly verified by use of recording thermometers in the curing chambers and comparison with the temperature records of beds, and by use of the same methods of moisture retention for curing chambers and casting beds.

3.1.2.3.2 For beds cured by steam or radiant heat, cylinders shall be placed at random points along the bed. If there is any indication of variable heat, cylinders shall be placed in the coolest area.

3.1.2.3.3 Test cylinders to indicate compliance with specified 28-day or earlier strength shall remain in the bed with the member until the member is removed. At that time the cylinders shall be removed from their molds and placed in storage in a moist condition at 73.4 degrees plus or minus 3 degrees F.

3.1.2.4 Capping of Cylinders.

3.1.2.4.1 Unless cylinder ends are cast or ground to within 0.002 inch of a plane surface, they shall be capped prior to testing. Capping procedures shall be as specified in ASTM C 31 and C 617 except with fast setting sulphur compounds, especially manufactured for capping, compression testing can be performed one half hour or less after the caps have been in place.

3.1.2.5 Testing of Cylinders.

3.1.2.5.1 Testing of cylinders to determine compressive strength shall be performed in accordance with ASTM C 39. The strength of concrete at any given age shall be determined as the average of two cylinders, except a single cylinder test can be used to determine stress transfer strength.

3.1.2.5.2 Testing machines shall be calibrated so the maximum error is not more than plus or minus one percent. Calibration shall be performed whenever there is a reason to doubt the accuracy of indicated loads, or at least once every six months. Calibration curves shall be available at all times and used by testing personnel.

3.1.3 Air Content. The air content tests shall be conducted in accordance with ASTM C 231. At least one air content test will be conducted on the concrete from which each member is cast.

4. EVALUATION AND ACCEPTANCE.

4.1 Concrete. A test result shall be the average of the strengths of the two test cylinders made in accordance with paragraph 3.1.2.1. The strength level of the concrete will be considered satisfactory if the average of all sets of three consecutive strength tests equal or exceed the specified strength f'_c and no individual test falls below the specified value by more than 500 psi. Members manufactured with concrete which does not meet the strength requirements shall be rejected.

4.1.1 Air Content. All members cast with concrete having a measured air content less than 5 percent shall be rejected. Any member cast with concrete having an air content greater than 7 percent may be incorporated into the work if the strength requirements are met.

4.2 Tolerances. The precast prestressed members shall be manufactured within the following tolerances. Members which fail to meet the dimensional tolerances shall be rejected.

4.2.1 Length of Member. The length of the member shall not deviate from the length shown on the contract drawings by more than plus or minus $3/4$ inch or plus or minus $1/8$ inch per 10 feet of length, whichever is greater.

4.2.2 Cross Sectional Dimensions. The cross sectional dimensions of a member, if less than 36 inches shall not vary by more than plus or minus $1/4$ inch and if over 36 inches, they shall not vary by more than plus or minus $3/8$ inch.

4.2.3 Horizontal Alignment (Sweep). The horizontal alignment of the members shall not deviate from a straight line parallel to the theoretical centerline by more than $1/2$ inch or $1/8$ inch per 10 feet of length, whichever is greater. The maximum gap between two adjacent members due to sweep shall not exceed one inch.

4.2.4 Camber. The actual camber of beams shall not deviate from the computed camber by more than plus or minus $1/8$ inch per 10 feet but not more than plus or minus $1/2$ inch maximum total deviation.

4.2.5 Camber Differential. The differential in camber at midspan between adjacent members shall not exceed $1/4$ inch per 10 feet of length or $3/4$ inch maximum.

4.2.6 Position of Tendons. The position of the tendons shall not deviate from the design position by more than plus or minus $1/4$ inch.

4.2.7 Handling Devices. The actual position of handling devices shall not deviate from the designed position by more than plus or minus 6 inches.

4.2.8 Anchors and Inserts. The actual position of anchors and inserts shall not vary by more than plus or minus one inch from positions shown on the contract drawings.

4.2.9 Flange Thickness. The thickness of a flange or slab shall not vary from the dimensions on the drawings by more than plus or minus $1/4$ inch or $-1/8$ inch.

4.2.10 Depth of Member at Support. At the supports the depth of a member shall not deviate from the dimensions shown on the contract drawings by more than plus or minus 1/4 inch.

4.2.11 Squareness of Ends. The ends of members shall not deviate from being square by more than plus or minus 1/4 inch. Squareness shall be checked in both the vertical and horizontal planes.

4.3 Defects.

4.3.1 Minor Defects. Minor defects are those which involve less than 36 square inches of concrete, and do not expose stressing tendons or reinforcing steel. These defects will be repaired as specified hereinafter. Cracks which are visible but are 0.01 inch wide or less will be accepted.

4.3.2 Major Defects. Major defects are those which involve more than 36 square inches of concrete or expose stressing tendons or reinforcing steel. If one or more major defects appear in a member it shall be rejected. Cracks of a width of more than 0.01 inch shall be cause for rejection of the member.

5. SUBMITTALS.

5.1 Design Calculations. Design calculations shall be submitted to the Contracting Officer prior to the initiation of manufacture of members to be used under this contract.

5.2 Test Reports. Certified test reports of required material tests shall be submitted to the Contracting Officer (ATTN: _____ by the Contractor prior to the use of the materials in the work. Reports shall be furnished for each shipment and shall be identified with specific lots).

5.3 Test Results. The results of construction testing by the contractor shall be submitted to the contracting officer not more than 5 days after the tests are completed.

5.4 Manufacturers' Certificate.

5.4.1 Cement. Cement shall be certified for compliance with all specifications requirements.

5.4.2 Pozzolan. Pozzolan shall be certified for compliance with all specification requirements.

5.4.3 Water-reducing admixture shall be certified for compliance with all specifications requirements.

5.4.4 Aggregates shall be certified for compliance with all specifications requirements.

5.4.5 Certified Air Content. Each precast member delivered to the job site shall be accompanied by a certificate certifying that the air content in the concrete in that member is in compliance with the specifications. The certification must be based on an air content test conducted in conformance with ASTM C 231 on at least one of the batches concrete from which the member was cast.

5.5 Concrete Mixture Proportions. Concrete mixture proportions shall be submitted to the Contracting Officer for approval.

5.6 Shop Drawings. The Contractor shall prepare and submit to the Contracting Officer for approval, complete shop drawings which show the precast unit manufacturer's recommended details and materials for the work required by paragraph: HANDLING AND ERECTION and the following:

- a. Design Computations.
- b. Marking of the units for the placing drawings.
- c. Anchorages for work of other trades.
- d. Anchorages to support construction.
- e. Size and location of steel tendons.
- f. Methods of stressing.
- g. Location and sizes of all openings 12 inches wide or larger to be cast into members.
- h. Formwork.
- i. Joints between units and other construction.
- j. Reinforcing steel details.
- k. Method of curing.
- l. Pickup points and lifting devices.

6. MATERIAL.

6.1 Cement.

6.1.1 Portland Cement shall conform to ASTM C 150 Type II or III. The C_3A content of the Type III cement shall not exceed 8 percent.

6.1.2 Blended Hydraulic Cement shall conform to the requirements of the SECTION: CONCRETE.

6.2 Pozzolan. Pozzolan shall conform to the requirements of the SECTION: CONCRETE.

6.3 Other Materials.

6.3.1 Aggregates shall meet the requirements of SECTION: CONCRETE.

6.3.2 Admixtures. In no event shall admixtures containing chlorides or nitrates be used in the concrete.

6.3.2.1 Water-Reducing Admixture shall be certified to comply with SECTION: CONCRETE.

6.3.2.2 Accelerating Admixture shall be certified to comply with SECTION: CONCRETE.

6.4 Steel Reinforcement shall be in accordance with SECTION: CONCRETE REINFORCEMENT.

6.5 Steel Tendons shall be in accordance with SECTION: STRESSING TENDONS AND ACCESSORIES FOR PRESTRESSED CONCRETE.

7. COMPOSITION AND QUALITY.

7.1 Concrete shall be composed of cementitious material, water, fine and coarse aggregate and admixtures. The cementitious material shall be portland cement, blended hydraulic cement, or portland cement or blended hydraulic cement and pozzolan. The admixtures may include a water reducing admixture when its formulation and use are approved.

7.2 Quality. The concrete proportions shall be selected by the Contractor to meet the following requirements:

Specified Strength = 5000 p.s.i. at 28 days

f'_c = 5000 psi at 28 days

f_{ci} = 4000 psi, prior to detensioning

Entrained Air Content = 5 to 7 percent as determined in accordance with ASTM C 231. Proportions shall be selected so as to produce an average strength exceeding the design strength f'_c by the amount indicated below. Where the production facility has a standard deviation record determined in accordance with ACI 214, based on 30 consecutive strength tests of similar mixture proportions to that proposed, obtained within one year of the time when concrete placing is expected, it shall be used in selecting average strength. The average strength used as the basis for selecting proportions shall exceed the specified strength f'_c by at least.

400 psi if standard deviation is less than 300 psi

550 psi if standard deviation is 300 to 400 psi

700 psi if standard deviation is 400 to 500 psi

900 psi if standard deviation is 500 to 600 psi

If the standard deviation exceeds 600 psi or if a standard deviation record is not available, proportions shall be selected to produce an average strength at least 1200 psi greater than the specified strength. The Contractor shall have the mixture proportions determined by persons knowledgeable in the formulation of concrete mixtures. The trial mixtures shall be formulated using the same

materials as those to be used in the units supplied under this specification and the selected proportions shall be submitted for approval with the results of cylinder strengths at 28 days.

8. FABRICATION. Fabrication of precast-prestressed members shall follow the applicable provisions of the PCI Manual for Quality Control, MNL 116- except as specified herein.

9. BEDS AND FORMS.

9.1 All casting beds shall have concrete support on unyielding foundations.

9.2 Forms, both fixed and movable, shall be of steel of adequate thickness, braced, stiffened, anchored and aligned adequately to produce members within the limits of dimensional tolerances, specified hereafter.

9.3 Bulkheads, spacers, templates and similar equipment having influence on the accuracy of dimensions and alignment shall be regularly inspected and maintained as necessary.

9.4 Accurate alignment of forms shall be maintained during the casting operation. Form alignment and grade shall be checked for each setting. Form joints shall be smooth and tight enough to prevent leakage of paste. Joints between soffits, side forms and bulkheads may require gaskets of rubber or other suitable material to prevent leakage of paste. Such material may be used to provide corner chamfers. Plugging of holes and slots in the forms shall be done neatly so the finished member will have a workman like appearance.

9.5 For exposed members, form ties, if used, shall be of the threaded or snap-off type so no metal parts will be left at the surface of the finished concrete.

9.6 Provision shall be made in form anchorage for any anticipated differential movements of beds and forms during the casting and curing operations.

9.7 Beds and form shall be thoroughly cleaned after each use. Coatings used for release of members shall not be allowed to build up.

10. TENDONS. The tendons shall be placed, stressed and destressed in accordance with SECTION: STRESSING TENDONS AND ACCESSORIES FOR PRESTRESSED CONCRETE.

11. ANCHORAGES FOR POST-TENSIONING. Anchorages for post-tensioning tendons will not interfere with the placement of the member.

12. STEEL REINFORCEMENT. Steel bars and welded wire fabric shall be placed in accordance with SECTION: CONCRETE REINFORCEMENT.

13. CONCRETE PLACEMENT. Concrete placement shall be in accordance with SECTION: CONCRETE, except that once placement is started in a member it shall be carried on in a continuous operation until the member is completed. Members shall be cast in a horizontal position and casting in tiers will not be permitted.

Adequate vibration shall be provided with internal and form vibrators so the cast members shall be free of rock pockets or surface blemishes resulting from inadequate vibration. Cold joints shall not be permitted in prestressed concrete members. If delays occur which result in hardening of the concrete so it will not receive a vibrator and again become plastic, partially filled forms shall be washed out or partially cast members rejected.

14. CURING AND PROTECTION. Concrete for the manufacturing of the precast prestressed concrete members shall be cured and protected in accordance with SECTION: CONCRETE or by other methods further specified herewithin.

14.1 Curing with Steam at Atmospheric Pressure. Steam curing shall be under a suitable enclosure to retain the live steam to minimize moisture and heat losses. The enclosure shall allow free circulation of the steam around the sides and top of the beams. Steam jets shall be so positioned so they do not discharge directly on the concrete, forms, or test cylinders. The cycle of steam application shall conform to the following:

14.1.1 After placing and vibrating, the concrete shall be allowed to attain its initial set before the steam is applied. During the period between placement of the concrete and application of steam, provisions shall be made to prevent surface drying by means of a coating of membrane curing compound, moist covers or equally effective methods. Application of the steam shall be delayed not less than 2 hours and not more than 10 hours after the time of concrete placement. If the ambient temperature is below 50 degrees F enough heat shall be applied to maintain the concrete at its placing temperature.

14.1.2 The ambient temperature within the casting enclosure shall be increased at a rate not to exceed 40 degrees F per hour. Temperature increase shall be as uniform as possible.

14.1.3 The temperature shall be increased until the ambient temperature in the casting enclosure is between 140 degrees F and 160 degrees F. Once this temperature range is reached, it shall be maintained until the concrete has reached the compressive strength necessary for stressing or destressing the tendons.

14.1.4 In discontinuing the steam curing the ambient air temperature shall decrease at a rate not to exceed 40 degrees F per hour. Temperature decrease shall be as uniform as possible.

14.1.5 Recording thermometers showing the time-temperature relationship through the curing period from placing concrete to transfer of prestress shall be provided. At least one recording thermometer per casting enclosure shall be used. The desired curing time-temperature relationship shall be placed on the recording chart of the recording thermometer, to aid the personnel that control the temperature during curing. Recording charts shall be made available upon request and shall be clearly visible during the curing process.

14.2 Curing with Radiant Heat and Moisture.

14.2.1 Radiant heat may be applied to beds by means of pipe circulating steam, hot oil or hot water or by electric blankets or heating elements on forms. Pipes, blankets or elements shall not be in contact with concrete, form surface or test cylinders.

14.2.2 During the cycle of radiant heat curing, effective means shall be provided to prevent rapid loss of moisture in any part of the member. Moisture may be applied by a covering of moist burlap or cotton matting. Moisture may be retained by covering the member with a plastic sheet in combination with an insulating cover, or by applying a liquid seal coat or membrane curing compound.

14.2.3 Temperature limits and use of recording thermometer shall be as specified for curing with steam at atmospheric pressure.

14.2.4 Termination of curing shall be as specified in SECTION: CAST-IN-PLACE STRUCTURAL CONCRETE unless the concrete has been cured by one of the two methods stated above. Termination of curing for concrete cured by either the steam at atmospheric pressure method or the radiant heat with moisture shall be determined based on the compressive strength of the concrete necessary for stressing or destressing the tendons. The strength shall be determined from concrete cylinders as specified in paragraph entitled QUALITY ASSURANCE.

15. REPAIRS. All honeycombed areas, chipped corners, air pockets over 1/4 inch in diameter, and other minor defects shall be repaired. Form offsets of fins over 1/8 inch shall be ground smooth. All unsound concrete shall be removed from defective areas prior to repairing. All surfaces permanently exposed to view shall be repaired by a blend of portland cement and white cement properly proportioned so that the final color when cured will be the same as adjacent concrete.

16. FINISHING.

16.1 Unformed surfaces shall receive a rough finish.

17. HANDLING AND ERECTION.

17.1 General. The location of pickup points for handling of the members and details of the pickup devices shall be shown on shop drawings. Members shall be handled only by means of approved devices at designated location.

17.2 Position of Members. In the handling of members, it is imperative they be maintained in an upright position at all times and picked up and supported as shown on approved shop drawings.

17.3 Storage.

17.3.1 Storage areas for prestressed members shall be stabilized, and suitable foundations shall be provided, so differential settlement or twisting of members will not occur.

17.3.2 Stacked members shall be separated and supported by battens placed across the full width of each bearing point. Battens shall be arranged in vertical planes at a distance not greater than the depth of the member from designated pickup points. Battens shall not be continuous over more than one stack of precast units. Stacking of members shall be such that lifting devices will be accessible and undamaged. The upper members of a stacked tier shall not be used as storage areas for shorter members or equipment.

17.4 Transportation.

17.4.1 In transporting members by truck, railroad car or barge, provision shall be made for supporting the members as described above, except battens can be continuous over more than one stack of units, with adequate bracing to insure their maintaining the vertical position and damping of dangerous vibrations. Trucks with double bolsters are generally satisfactory provided the members are fully seated on the outer bolsters at not more than 3 ft. or the depth of the member from the end and the inner bolster is not more than 8 ft. from the end of the member or the designated pickup point. Adequate padding material shall be provided between tie chains or cables to preclude chipping of concrete.

17.4.2 Any noticeable indication of lateral deflection or vibration during transportation shall be corrected by rigid bracing between members or by means of lateral trussing.

17.5 Erection.

17.5.1 All provision for storage and handling given in the foregoing paragraph shall be observed at the erection site.

17.5.2 The precast prestressed concrete members shall be set into place in a manner which assures full bearing. If the bearing called for on the contract drawing is not obtained then the members shall be removed and the situation corrected.

17.5.3 Welding during erection shall be done in accordance with SECTION: MISCELLANEOUS METALS. When welding or burning with a welding electrode, the ground shall be attached directly to the base metal. Under no circumstances shall the member be used as a conductor for the ground.

17.5.4 The contractor shall prepare a detailed erection plan which will be submitted to the Contracting Officer at least 15 days prior to the date that erection of members is to begin. This plan shall be in sufficient detail so that adequacy of equipment, techniques and accessories can be determined and comments offered. Acceptance of the contractor's erection plan shall not relieve the contractor of his responsibility for erecting precast prestressed members into position as required by the plans and specifications.

18. QUALITY CONTROL.

18.1 General. The Contractor shall establish and maintain quality control to assure compliance with Contract requirements and shall maintain records of his quality control for all construction operations required under this section.

18.2 Records. Complete records shall be kept of the manufacturing, handling and erection of the precast prestressed concrete members. Records shall be kept for but not limited to the following items:

18.2.1 Specifications of material used in the manufacture of the members.

18.2.2 Time-temperature history of the concrete members from casting to the transfer of the prestress force.

18.2.3 Records of the tendon stressing operation including initial prestress force, measured elongation, how it was measured and how the tendons were stressed and destressed.

18.2.4 Records of inspection of the members before and after the prestress force is transferred to the members.

18.2.5 Records of the inspection of the members each time they are moved.

18.2.6 Records of any defects in the member and any corrective measures taken.

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SECTION 1D

ENVIRONMENTAL PROTECTION

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10. Post Construction Clean Up

1. **SCOPE.** This section covers prevention of environmental pollution and damage as the result of construction operations under this contract and for those measures set forth in other Technical Provisions of these specifications. For the purpose of this specification, environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, radiant energy and radioactive materials, as well as other pollutants.

2. **QUALITY CONTROL.** The Contractor shall establish and maintain quality control for environmental protection of all items set forth herein. The Contractor shall record on daily reports any problems in complying with laws, regulations and ordinances and corrective action taken.

3. **SUBMITTALS.** The Contractor shall submit an environmental protection plan in accordance with provisions as herein specified.

3.1 Environmental Protection Plan shall include but not be limited to the following:

(1) A list of Federal, State and local laws, regulations, and permits concerning environmental protection, pollution control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations and permits.

(2) Methods for protection of features to be preserved within authorized work areas. The Contractor shall prepare a listing of methods to protect resources needing protection, i.e., trees, cacti, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, archeological and cultural resources.

(3) Procedures to be implemented to provide the required environmental protection and to comply with the applicable laws and regulations. The Contractor shall set out the procedures to be followed to correct pollution of the environment due to accident, natural causes or failure to follow the procedures set out in accordance with the environmental protection plan.

(4) Permit or license and the location of the solid waste disposal area.

(5) Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials.

(6) Environmental monitoring plans for the job site, including land, water, air, and noise monitoring.

(7) Traffic control plan.

(8) Methods of protecting surface and ground water during construction activities.

(9) Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas.

3.2 Implementation. After receipt of Notice to proceed, the Contractor shall submit in writing the above Environmental Protection Plan within 14 days. If the Contractor fails to submit an acceptable Environmental Protection Plan within the time herein prescribed, the Contracting Officer may refuse to allow construction to start or may withhold funds from progress payments in accordance with the CONTRACT CLAUSE entitled PAYMENTS UNDER FIXED-PRICE CONSTRUCTION CONTRACTS until such time as the Contractor submits an acceptable final plan. Approval of the Contractor's plan will not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and other environmental protection measures.

4. SUBCONTRACTORS. Assurance of compliance with this section by subcontractors will be the responsibility of the Contractor.

5. NOTIFICATION. The Contracting Officer will notify the Contractor in writing of any observed noncompliance with the aforementioned Federal, State or local laws or regulations, permits and other elements of the Contractor's environmental protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of proposed corrective action and take such action as may be approved. If the Contractor fails to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or costs or damages allowed to the Contractor for any such suspension.

6. PROTECTION OF ENVIRONMENTAL RESOURCES. The environmental resources within the project boundaries and those affected outside the limits of permanent work under this contract shall be protected during the entire period of this contract. The Contractor shall confine his activities to areas defined by the drawings and specifications. Environmental protection shall be as stated in the following subparagraphs.

6.1 Protection of Land Resources. Prior to the beginning of any construction, the Contractor shall identify all land resources to be preserved within the Contractor's work area. The Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, cacti, shrubs, vines, grasses, top soil, and land forms without special permission from the Contracting Officer. No ropes,

cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such special emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs.

6.1.1 Work Area Limits. Prior to any construction the Contractor shall mark the areas within the construction work limits that are not required to accomplish all work to be performed under this contract. Isolated areas within the general work area which are to be saved and protected shall also be fenced or flagged. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, the markers shall be visible. The Contractor shall convey to his personnel the purpose of marking and/or protection of all necessary objects.

6.1.2 Protection of Landscape. Trees, cacti, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved shall be clearly identified by fencing, flagging, or any other approved techniques.

6.1.3 Reduction of Exposure of Unprotected Erodible Soils. Earthwork brought to final grade shall be finished as indicated and specified. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils.

6.1.4 Temporary Protection of Disturbed Areas. Such methods as necessary shall be utilized to effectively prevent erosion and control sedimentation, including but not limited to the following:

(1) Retardation and control of Runoff. Runoff from the construction site shall be controlled by construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses, and any measures required by area-wide plans approved under paragraph 208 of the Clean Water Act.

6.1.5 Erosion and Sedimentation Control Devices. The Contractor shall construct or install all temporary and permanent erosion and sedimentation control features as necessary. Temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing and mulching shall be maintained until permanent drainage and erosion control facilities are completed and operative.

6.1.6 Location of Field Offices, Storage and Other Contractor Facilities. The Contractors' field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated by the Contracting Officer. Due to the sensitive nature of riparian habitat in the basin, strict adherence to the designated areas is necessary. Temporary movement or relocation of Contractor facilities shall be made only on approval by the Contracting Officer.

6.1.7 Spoil Areas shall be managed and controlled to limit spoil to areas designated and prevent erosion of soil or sediment from entering nearby water courses or lakes.

6.1.8 Temporary Excavations and Embankments for plant and/or work areas shall be controlled to protect adjacent areas from spoils.

6.1.9 Disposal of Solid Wastes. Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. All handling and disposal shall be conducted to prevent contamination and shall conform to the requirements of applicable local, State and Federal laws and regulations.

6.1.10 Disposal of Chemical Waste. Chemical waste shall be stored in corrosion resistant containers, removed from the work area and disposed of in accordance with Federal, State and local regulations. Crankcase oil and other waste chemicals shall be captured and not drained onto the ground.

6.1.11 Disposal of Discarded Materials. Discarded material other than those which can be included in the solid waste category will be handled as directed by the Contracting Officer.

6.2 Protection of Historical, Archeological and Cultural resources shall conform to the requirements of SECTION: GENERAL REQUIREMENTS.

6.3 Protection of Water Resources. The Contractor shall keep construction activities under surveillance, management and control to avoid pollution of surface and ground waters. Special management techniques as set out below shall be implemented to control water pollution by the construction activities which are included in this contract.

6.3.1 Washing and Curing Water. Waste waters directly derived from construction activities shall not be allowed to enter water areas. These waste waters shall be collected and placed in retention ponds where suspended material can be settled out or the water evaporates so that pollutants are separated from the water.

6.3.2 Monitoring of Water Areas Affected by Construction Activities shall be the responsibility of the Contractor. All water areas affected by construction activities shall be monitored by the Contractor.

6.4 Protection of Wildlife Resources. The Contractor shall keep construction activities under surveillance, management and control to minimize interference with, disturbance to and damage of wildlife. Species that require specific attention along with measures for their protection will be listed by the Contractor prior to beginning of construction operations.

6.5 Protection of Air Resources. The Contractor shall keep construction activities under surveillance, management and control to minimize pollution of air resources. All activities, equipment, processes, and work operated or performed by the Contractor in accomplishing the specified construction shall be in strict accordance with the State of Arizona and all Federal emission and performance laws and standards. Ambient Air Quality Standards set by the Environmental Protection Agency shall be maintained for those construction operations and activities specified in this section. Special management techniques as set out below shall be implemented to control air pollution by the construction activities which are included in the contract.

6.5.1 Particulates. Dust particles, aerosols, and gaseous by-products from all construction activities, processing and preparation of materials, such as from asphaltic batch plants, shall be controlled at all times, including weekends,

holidays and hours when work is not in progress. A permit will be required by Maricopa County Bureau of Air Pollution Control that will require particulate suppression control.

6.5.1.1 **Particulates Control.** The Contractor shall maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards mentioned in paragraph hereinabove to be exceeded or which would cause a hazard or a nuisance. Sprinkling, treatment with an approved non-toxic dust palliative, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated at such intervals as to keep the disturbed area damp at all times. The Contractor must have sufficient competent equipment available to accomplish this task. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.

6.5.2 **Hydrocarbons and Carbon Monoxide.** Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal and State allowable limits at all times.

6.5.3 **Odors.** Odors shall be controlled at all times for all construction activities, processing and preparation of materials.

6.5.4 **Monitoring of air Quality** shall be the responsibility of the Contractor. All air areas affected by the construction activities shall be monitored by the Contractor.

6.6 **Protection of Sound Intrusions.** The Contractor shall keep construction activities under surveillance, and control to minimize damage to the environment by noise. Construction will not be allowed between the hours of 6:00 PM and 7:00 AM without the prior written approval of the Contracting Officer.

7. **RESTORATION OF LANDSCAPE DAMAGE.** The Contractor shall restore all landscape features damaged or destroyed during construction operations outside the limits of the approved work areas. Such restoration shall be in accordance with the plan submitted for approval by the Contracting Officer. This work will be accomplished at the Contractor's expense.

8. **MAINTENANCE OF POLLUTION CONTROL FACILITIES.** The Contractor shall maintain all constructed facilities and portable pollution control devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

9. **TRAINING OF CONTRACTOR PERSONNEL IN POLLUTION CONTROL.** The Contractor shall train his personnel in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual familiarization with cultural resource identification, and installation and care of facilities to ensure adequate and continuous environmental pollution control.

10. POST CONSTRUCTION CLEAN UP. The Contractor shall clean up all areas used for construction ~~(including haul routes, disposal area)~~ in conformance with CONTRACT CLAUSE: CLEANING UP.

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SECTION 2A

CLEARING SITE AND REMOVING OBSTRUCTIONS

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1. Protection
2. Burning
3. Requirements
4. Disposal of Cleared, Grubbed and Removed Material

1. PROTECTION.

1.1 Environmental Protection. All work and Contractor operations shall comply with the requirements of SECTIONS: ENVIRONMENTAL PROTECTION and EXCAVATION.

2. BURNING. The use of burning at the project site for the disposal of refuse and debris will not be permitted.

3. REQUIREMENTS.

3.1 General. Except as otherwise specified, and/or indicated, areas to be cleared will be limited to actual excavation areas, areas to be landscaped, and areas on which fills and/or structures are to be placed. The removal of trees, shrubs, turf, and other vegetation outside of these areas shall be held to a minimum and care shall be exercised not to damage any trees, shrubs, turf, or vegetation which can be left in place.

3.2 Existing Structures and Obstructions. The Contractor shall clear and grub the site, fill, borrow, and excavation areas, and remove and dispose of all existing structures and obstructions for project construction, except as those structures which are identified to be protected in place as shown on the drawings. Obstructions which are designed or specified to be removed but which are not designated or specified to be removed by others shall be removed by the Contractor. Except as otherwise specified, obstructions designated to be removed by others will be removed in sufficient time to preclude interference with the Contractor's operations. Utility relocations are not considered to be obstructions.

3.2.1 Clearing. Trees smaller than 1-1/2 inches in diameter and other vegetation, except as specified, shall be cut off 6 inches below the indicated channel subgrade or ground level whichever is lower. Other vegetation shall be cut off flush or slightly below the original ground surface. Clearing operations shall be conducted so as to prevent damage to trees, structures, and installations under construction, or to remain in place, and to provide for the safety of employees and others. All rubbish, waste dumps, and debris areas shall be cleared.

3.2.2 Grubbing shall consist of removing all trees, stumps, roots, logs, and other objectionable vegetable matter in the required fills, foundation areas, and all excavation areas. In grubbing out stumps and roots, all roots or other timber more than 1-1/2 inches in diameter shall be removed to 3 feet below the depth of the required excavation or existing ground level, whichever is lower. Trees and stumps shall be pulled, not cut off.

3.3 Utilities. Prior to removing an obstruction, all applicable utility relocations shall have been coordinated. Pipes designated by owners as "abandoned" shall be removed within the limits of the project as necessary for clearing. All abandoned pipes shall be plugged at the cut ends as shown on the drawings or as directed by the Contracting Officer.

4. DISPOSAL OF CLEARED, GRUBBED, AND REMOVED MATERIAL. All material removed, except material specified and/or indicated to be salvaged, is designated as scrap, shall become the property of the Contractor, and shall be removed from the site. Stone, broken concrete, pavement, and similar materials may be wasted in the miscellaneous fill areas in accordance with the requirements of the SECTION: EXCAVATION. Unsuitable materials from clearing operations may be temporarily used for diversion and control of water. Disposal shall be in accordance with the requirements of SECTION: ENVIRONMENTAL PROTECTION.

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SECTION 2B

EXCAVATION

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| 1. Applicable Publications | 6. Excavation for Roads |
| 2. General | 7. Excavation for Side Drains |
| 3. Blasting | 8. Removal of Unsatisfactory Soils |
| 4. Preservation of Property | 9. Disposal of Excavated Materials |
| 5. Excavation for Structures | 10. Overcut |

1. **APPLICABLE PUBLICATIONS.** The American Society for Testing and Materials (ASTM) Standards listed below forms a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

D 2487-83

Classification of Soils for Engineering Purposes

2. **GENERAL.** Excavation shall consist of the removal of every type of material encountered (except materials covered by the provisions of the SECTION: CLEARING SITE AND REMOVING OBSTRUCTIONS) in the designated areas or from areas directed. The material to be removed may include but is not limited to earth, hardpan, silt, clay, gravel, cemented sand and gravel, rock, adobe, detached pieces of stone and concrete, rock fills, existing fills of miscellaneous debris and rubbish, and other unsuitable materials. Slope lines indicated on the drawings for temporary cuts do not necessarily represent the actual slope to which the excavation must be made to safely perform the work. Excavation for permanent cuts shall be made to the slope lines indicated. Excavation shall be performed in a manner which will not impair the subgrade. Except as otherwise specified, the finish surface of subgrades shall be smooth and shall not vary more than 1/2 inch from indicated grade.

3. **BLASTING.** Blasting will not be permitted.

4. **PRESERVATION OF PROPERTY.** All excavation operations shall be conducted in such a manner that street pavements, sidewalks, curbs, utilities, or other facilities and improvements which are to remain in place permanently will not be subjected to settlement or horizontal movement. The Contractor shall furnish and install sheet piling, cribbing, bulkheads, shores or whatever means may be necessary to adequately support material carrying such improvements themselves and shall maintain such means in position until they are no longer needed. Temporary sheet piling, cribbing, bulkheads, shores or other protective means shall remain the property of the Contractor and when no longer needed shall be removed from the site. The Contractor shall submit for approval shop drawings showing proposed method of bracing which he intends to use. All shoring and bracing shall be designed so that it is effective to the bottom of the excavation, and shall be based upon calculation of pressure exerted by and the condition and nature of the materials to be retained, including surcharge imparted to the side of the trench by equipment and stored materials. Removal of shoring shall be performed in such a manner as not to disturb or damage the finished concrete.

4.1 Shoring is indicated between stations 468+00 and 472+00 and station 491+00 and 497+00.

4.2 The following soil parameters can be used for the design of the temporary sheet piling, cribbing, bulkheads, shores or other protective means.

Wet unit weight = 130 lbs/ft³
Angle of internal friction = 30 degrees
Coefficient of cohesion = 0 lbs/ft²

5. **EXCAVATION FOR STRUCTURES.** Excavation within the vicinity of existing structures, utilities, and drainage pipes to remain in place shall be performed in a manner to prevent damage to the structure. Earth banks and facilities to remain in place shall be supported as necessary during excavation. In general, unless otherwise shown or specified, the actual side slopes will be at the Contractor's option.

6. **EXCAVATION FOR ROADS** will include excavation for curbs and access roads, including materials unsuitable for road subgrade. Unsuitable materials included but not limited to those materials containing roots and material classified is ASTM D 2487 as ML, CL, MH, CH, PT, OH and OL.

7. **EXCAVATION FOR SIDE DRAINS.** Excavation for culverts shall conform to the requirements of SECTION: SIDE DRAINS AND WATER LINES.

8. **REMOVAL OF UNSATISFACTORY SOILS.** The removal of soils which are unsatisfactory for foundations of the channel, structures, streets, and drains, will be required in certain areas. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris and materials classified in ASTM D 2487 as ML, CL, MH, CH, PT, OH and OL. The Contractor will be required to excavate any such areas to the depth directed and backfill the areas with compacted fill conforming to the requirements of the SECTION: FILLS AND SUBGRADE PREPARATION.

9. **DISPOSAL OF EXCAVATED MATERIALS.** Excavated materials suitable for required fills shall be placed in temporary stock piles or used directly in the work. All excess materials suitable for fills may be placed in the indicated optional disposal area. Excavated material not suitable for fills and unsatisfactory materials shall become the property of the Contractor and shall be removed from the site. Prior to placing material, the miscellaneous fill disposal and stockpile area(s) shall be cleared of trash and vegetation. Vegetation shall be cut off at the existing ground line. Clearing shall conform to the applicable requirements of the SECTION: CLEARING SITE AND REMOVING OBSTRUCTIONS. The stockpiles and disposal fills shall be placed in manner to preclude ponding of water. The Contractor shall furnish notice of his intentions in connection with the use of indicated disposal areas in accordance with the requirements of the paragraph: PUBLIC UTILITIES, NOTICES, AND RESTRICTIONS of the GENERAL REQUIREMENTS.

9.1 All required fills shall be completed prior to disposal of any material in any optional disposal areas or other disposal areas selected by the Contractor unless approved by the Contracting Officer.

9.2 If the Contractor elects to use the optional disposal area(s), the optional disposal site A (as indicated on the drawings) shall be completely filled prior to disposal in area B. The Contractor shall complete and fill in area A prior to ~~January 31, 1988~~.

9.3 Compaction of the fill in the Required Fill Area, as indicated on the drawings, shall conform to the applicable requirements of paragraph: COMPACTED FILL, REQUIRED FILL AREA of SECTION: FILLS AND SUBGRADE PREPARATION.

9.4 Additional requirements for disposal of excess material can be found in the SPECIAL CLAUSES and SECTIONS: GENERAL REQUIREMENTS; ENVIRONMENTAL PROTECTION; and CLEARING SITE AND REMOVING OBSTRUCTIONS.

10. OVERCUT. Except as otherwise specified or as may be ordered in writing, any overcut or excavation made outside the lines indicated on the drawings or directed shall be backfilled with compacted fill or concrete, and all excavating, backfilling, compacting of backfill, and concreting occasioned thereby shall be by the Contractor at no additional cost to the Government. Any overcut under bridge footings shall be backfilled with concrete.

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SECTION 2C

FILLS AND SUBGRADE PREPARATION

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| 2. Compaction Equipment | 7. Subgrade Preparation |
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Fills and Compacted Backfills | 8. Compacted Fill,
Required Fill Area |
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and Water Lines | |

1. **APPLICABLE PUBLICATIONS.** The American Society for Testing and Materials (ASTM) Standards listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

- | | |
|-----------|--|
| D 1556-82 | Density of Soil In-Place by the Sand-Cone Method |
| D 1557-78 | Moisture-Density Relations of Soils Using a 10-Lb. Rammer and an 18-In. Drop |
| D 2216-80 | Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil-Aggregate Mixtures |
| D 2922-81 | Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth) |
| D 3877-80 | One-Dimensional Expansion, Shrinkage and Uplift Pressure of Soil-Lime Mixture |

2. **COMPACTION EQUIPMENT.**

2.1 **General.** Compaction shall be accomplished by tamping rollers, steel drum rollers or vibratory compactors.

3. **GENERAL REQUIREMENTS FOR COMPACTED FILLS AND COMPACTED BACKFILLS.**

3.1 **Control.** Moisture-density relations shall be established by the Contractor. Field density tests shall be performed by the Contractor in sufficient number and in such locations to insure that the specified density is being obtained. Moisture-density relations and field densities shall be reported on approved forms. One copy of density data less dry weight determinations shall be provided on the day each test is taken. The completed test reports shall be provided with the Contractor Quality Control Report on the work day following the test.

3.1.1 Laboratory Control. One moisture-density relation shall be made for each classification, blend or change in classification of soil material encountered. Approval of moisture-density relations shall be obtained prior to the compacting of any material in the work. The moisture-density relations shall be determined in a laboratory in accordance with ASTM D 1557 ~~or D-698~~ (modified as specified hereinafter).

3.1.1.1 A separate batch of materials will be used for each compaction test specimen. No materials will be re-used.

3.1.1.2 The desired amount of mixing water will be added for each compaction test specimen, mixed well, and the mixture will be placed in a container with an airtight cover and allowed to cure for 24 hours. A shorter curing time may be allowed where tests show that shortening the curing time will not affect the results.

3.1.2 Field Control. Field in-place density shall be determined in accordance with ASTM D 1556 and Field Moisture Content shall be determined in accordance with ASTM D 2216. The density tests shall be well distributed and shall average not less than one test for each 2000 cubic yards of material. At least one test shall be made in each 2 feet of compacted material processed as a unit and at least one test shall be made in each area.

3.1.3 Moisture-Density Curves for Cohesionless and Cohesive Material. Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.2 Settling of Fills or Backfills with Water will not be permitted, except as specified hereinafter for sand fill, filling voids behind walls, and channel R.C.P. bedding.

3.3 Material shall be obtained from the required excavations, shall be free from sod, roots, brush, debris, trash or other objectionable material, and shall contain not stone whose greatest dimension is more than 3/4 of the layer thickness.

3.4 Placement. Fill material shall not be placed against concrete which has not been in place at least 14 days or until the concrete has attained a strength of 2,500 p.s.i. when tested in accordance with the SECTION: CONCRETE. Heavy equipment shall not be operated over pipes and buried structures until at least 2 feet of fill material has been placed and compacted over them in conformance with the requirements of SECTION: SIDE DRAINS AND WATER LINES. Compacted fill and backfill shall be placed with suitable equipment in horizontal layers which after compaction, shall not exceed 12 inches in depth for rubber-tired or vibratory rollers, 6 inches in depth for tamping rollers, and 4 inches in depth when mechanical tampers are used. The Contractor may vary the layer thickness within these limits for most efficient operations. Material containing stones shall be placed in a manner to prevent the stones from striking the concrete structures and to prevent the formation of voids.

3.5 Moisture Content. Material shall have a uniform moisture content while being placed and compacted. Water shall be added at the source, if required, or by sprinkling each layer of material during placement. Uniform distribution of moisture shall be obtained by disking, harrowing, or otherwise manipulating the soil during and after the time water is added. Material containing an excess of moisture shall be manipulated with suitable implements to facilitate maximum aeration and shall be permitted to dry to the proper consistency before being compacted. Fill shall have a maximum moisture content of not more than 3 percent above optimum and a minimum moisture content of not less than 3 percent below optimum.

3.6 Compaction. No layer of fill shall be compacted before the practicable uniform moisture content has been obtained. If the Contractor elects to use rubber-tired or steel drum, compaction equipment and the compacted surface of any layer of material is determined by the Contracting Officer to be too smooth to bond properly with succeeding layers, it shall be scarified by a method approved by the Contracting Officer. Scarified areas shall be compacted as specified for the fill placed thereon. Rollers will not be permitted to operate within one foot of channel or structure walls or over buried structures until the compacted fill over the top of the structures has reached a depth of 2 feet. Compaction equipment shall be so operated that structures are not damaged nor overstressed during compaction operations. Mechanical tampers shall be used for compaction of fill material adjacent to structures where rolling equipment is impracticable for use in compaction.

4. COMPACTED FILL, CHANNEL.

4.1 Invert.

4.1.1 Material for compacted fill channel shall be obtained from the required excavations as approved by the Contracting Officer. In general, the best material available will be designated as compacted fill, channel. Compacted fill, channel may consist of sand, gravelly sand, silty sands, and clayey sands. Organic material, silt, sandy silt, clay, sandy clay, broken concrete or pavement, stone when the greatest dimension is greater than 3 inches, and other objectionable materials shall not be used.

4.1.2 Preparation for Placing. Before placing material for compacted fill, the foundation surface shall be cleared of all existing obstructions, vegetation, and debris proofrolled by 4 passes of the compaction equipment. Unsuitable material not meeting the requirements for fill material, as defined in the above paragraph, shall be removed where directed, and the existing surfaces scarified to a depth of 6 inches before placing the fill. Sloped ground surfaces steeper than one vertical to 4 horizontal, on which fill or compacted backfill is to be placed, shall be stepped in such a manner that the compaction equipment will bear on the full depth of the fill layer.

4.1.3 Compaction. Each layer of the materials shall be compacted to not less than 90 percent of maximum density.

4.2 Behind Channel Walls.

4.2.1 Placing. Fill material as defined in the above paragraph shall not be placed against concrete which has not been in place at least 14 days or until the

defined hereinabove shall not be placed

against any section of concrete

concrete has attained a strength of 2500 psi when tested in accordance with SECTION: CONCRETE. *In addition to the foregoing, the concrete invert shall have been in place not less than 7 days, prior to placing backfill at that location.*

4.2.2 Limitations on Equipment. The gross weight of any piece of equipment, or the combined weight of any combinations of equipment coupled together, used to place, moisten and/or compact fill behind channel walls shall not exceed 35,000 pounds, including dynamic forces produced by vibratory equipment. Equipment used to compact the fill behind the channel walls shall be of such size as to be capable of operating in the area between the cut slope and the channel wall. Compaction equipment will not be required to operate at elevations lower than 2 feet above the top of the heel of the channel invert. This equipment shall be of such size as to be capable of operating in the area between the cut slope and the channel wall at any point 2 feet above the top of the heel of channel invert.

4.2.3 Construction Balance. Fills behind walls on one side of the channel shall not exceed by more than 5 feet the height of the fill behind the opposite channel wall at any time during construction.

4.2.4 Compaction. Each layer of fill behind channel walls shall be compacted to not less than 90 percent of maximum density.

5. COMPACTED FILL, SIDE DRAINS AND WATER LINES. Bedding and backfill for side drains and storm drains shall conform to the requirements of SECTION: SIDE DRAINS AND WATER LINES.

6. BACKFILLS.

6.1 Backfill and Fill About Structures.

6.1.1 Location. Backfill and fill shall consist of all fill against and/or around structures, except backfill for side drains trenches, 35th Avenue Bridge and compacted fill channel.

6.1.2 Material. Backfill and fill material for compacted fill channel shall be obtained from the required excavation as approved by the Contracting Officer. In general, the best material available will be designated as backfill and fill about structures. Backfill may consist of sand, gravelly sand, silty sands, and clayey sands. Organic material, silt, sandy silts, clay, sandy clays, broken concrete or pavement, stone when the greatest dimension is greater than 3 inches and other objectionable material shall not be used.

6.1.3 Placing. Fill material shall not be placed against concrete which has not been in place at least 14 days or until the concrete has attained a strength of 2,500 p.s.i. when tested in accordance with SECTION: CONCRETE.

6.1.4 Compaction shall be not less than 90 percent of maximum density.

6.2 Backfill, Side Drain Trenches. Backfill for side drains and storm drains shall conform to the requirements of SECTION: SIDE DRAINS AND WATER LINES.

7. SUBGRADE PREPARATION.

7.1 Subgrade for Channel Invert Slab. After the channel has been excavated to rough grade in accordance with SECTION: EXCAVATION, the entire subgrade for the channel invert slab shall be proofrolled by 4 passes of the compaction equipment

and trimmed to a uniform grade and smoothed with a steel-wheeled roller to make the subgrade ready to receive concrete. If the subgrade is disturbed by the Contractor's operations or is overexcavated, the subgrade shall be restored to grade and compacted to a density of 90 percent of maximum density. The finished surface of the subgrade shall not be more than 1/2 inch from the indicated grade at any point when tested with a 10-foot straightedge.

7.2 Subgrade Preparation for Spillway, Road Pavement, Curbs, and Driveways. The subgrade shall be alternately watered and scarified until the material is uniformly moistened throughout for a depth of not less than 6 inches. All stones larger than 4 inches in diameter, and hard ribs of earth shall be removed. The amount of water to be applied shall be that which is required to provide optimum results in compaction under rolling. Following the above operations, the roadbed shall be shaped to a true cross section sufficiently higher than the specified grade to allow for subsequent compaction and then be thoroughly compacted to not less than 95 percent of maximum density as determined by ASTM D 1557. After the subgrade has been prepared and completed, the surface shall be firm, hard, and unyielding, with a true, even, and uniform surface conforming to the grade and cross section indicated on the drawings. All points of the finished subgrade shall be not more than 1/4 inch below or above true subgrade.

8. COMPACTED FILL, REQUIRED FILL AREAS.

8.1 General. The required fill areas shall be filled in accordance with the following requirements.

8.2 Subgrade Preparation. Area to be filled shall be cleared in conformance with SECTION: CLEARING SITE AND REMOVING OBSTRUCTIONS. Unsuitable material not meeting the requirements for fill material shall be removed as directed; the subgrade scarified to a depth of 12 inches; the moisture content of the subgrade material shall be adjusted to between 3 percentage points above optimum and 3 percentage points below optimum; and the material compacted to not less than 90 percent of maximum density. Sloped ground surfaces deeper than 1 vertical to 4 horizontal on which fill is to be placed shall be stepped in such a manner that the compaction equipment will bear on the full depth of the fill layer.

8.3 Material. Fill material shall be obtained from the required excavation. The upper 3 feet of the fill area shall consist of granular soils. Granular soils include clayey sands, silty sands, sand, gravelly sands, clayey gravels, silty gravels, sandy gravels, and gravels. The fill material between the subgrade and the upper 3 feet of fill shall contain no trash, debris, vegetation, or stones greater than 3/4 of the lift thickness.

8.4 Certification. The fill shall be placed, compacted, and tested for relative compaction and expansion potential in the upper 3 feet of each fill area under the direct supervision of a qualified engineer registered in the State of Arizona. The field tests (ASTM D 1556) shall be well-distributed and shall average one test per 8000 square feet in the subgrade and one test for each 2000 cubic yards of compacted fill. One expansion potential test (ASTM D 3877) per 24,000 square feet shall be performed on samples of material obtained in the upper 3 feet of each fill. The locations from which the samples are obtained for testing shall be well distributed. The expansion potential tests shall be performed in accordance with ASTM D 3877. The sample shall be compacted to 90 percent of maximum density at the moisture content 2 percent below optimum. The sample shall be confined under

a surcharge of 100 pounds per square foot and exposed to inundation. The maximum acceptable expansion potential shall be 1.5 percent. Testing shall be done by a soils testing company with the following qualifications.

8.4.1 The firm shall be an established Arizona firm that has been involved in other mass grading/fill placement projects in the State of Arizona.

8.4.2 The field technicians which conduct the daily testing and observations should demonstrate previous experience with this type of project and should have a minimum 2 years experience in this type of work.

8.5 Certification Report. A report certifying that the materials in the optional disposal area has been compacted to 90 percent of ASTM D 1557 (or higher), and that the upper 3 feet of each fill meets the expansion potential requirements of these specifications shall be submitted by the Contractor. The report shall be signed by the registered engineer responsible for supervision of sampling and testing. The report will include the field density test results, expansion potential test results, and a plan and profile which shows the locations of the field density tests and the locations at which the expansion potential test samples were obtained. The field density test results shall include the in-place dry density, in-place moisture content, maximum density, optimum moisture content, and percent compaction. Five bound copies of the report shall be provided to the Contracting Officer.

9. MISCELLANEOUS FILL. Miscellaneous fill shall consist of material from the required excavation, placed in the area indicated and shall be placed with suitable equipment in layers which shall not exceed 24 inches in depth before consolidation. No depressions in which water might pond shall be left in miscellaneous fill areas. The finished areas shall be sloped to drain compaction other than that obtained by the controlled movement of the construction equipment will not be required. Broken concrete, rock, bituminous paving and other objectionable material shall not be used.

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SECTION 2D

PRIME COAT AND WEED KILLER

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| 4. Quantity To Be Applied | 9. Application of Bituminous Material |
| 5. Weather Limitations | 10. Waybills and Delivery Tickets |

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

1.1 American Society for Testing and Materials (ASTM) Standards.

D 140-70
(R 1981)

Sampling Bituminous Materials

D 2027-76
(R 1981)

Liquid Asphalt (Medium-Curing Type)

2. **BITUMINOUS MATERIAL.** The bituminous material for the prime coat shall be liquid asphalt, conforming to ASTM D 2027, designation MC-70.

3. **SAMPLING AND TESTING.**

3.1 **Sampling.** Samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140.

3.2 **Testing** shall be the responsibility of the Contractor. Testing shall be performed by an acceptable commercial testing laboratory or by the Contractor on approval of the Contracting Officer. Materials shall be tested to establish compliance with the specified requirements.

3.3 **Certified Laboratory Test Reports.** Before delivery of bituminous materials, certified copies, in triplicate, of the tests specified herein and in referenced publications shall be submitted to and approved by the Contracting Officer. The testing shall have performed by an independent laboratory approved by the Contracting Officer.

4. **QUANTITY TO BE APPLIED.** Bituminous material for the prime coat shall be applied in quantities of not less than 0.10 gallon nor more than 0.35 gallon per squared yard of the surface to be primed. Application of prime coat shall be divided, if necessary, into 2 applications to avoid flowing off the surface. The exact quantities which may be varied to meet field conditions shall be determined by the Contractor and approved.

5. WEATHER LIMITATIONS. The prime coat shall be applied only when the prepared surface is dry or contains moisture not exceeding quantity to permit uniform distribution and desired penetrations. Prime coat shall be applied only when the ambient temperature is 50 degrees F. or above and the temperature has not been below 35 degrees F. for 12 hours immediately prior to application.

6. EQUIPMENT.

6.1 General. All equipment, tools, and machines, used in the performance of the work required by this section shall be subject to the approval and shall be maintained in satisfactory working condition.

6.2 Bituminous Distributor shall have pneumatic tires of such width and number than the load produced on the base surface shall not exceed 650 pounds per inch of tire width. The distributor shall be designed and equipped to distribute the bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard with a pressure range of 25 to 75 pounds per square inch and with an allowable variation not to exceed 5 percent from any specified rate. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gages, volume-measuring devices, adequate heaters for heating the materials to the proper application temperature, a thermometer to show the temperature of the tank contents, and a hose attachment suitable for applying bituminous material to spots avoidably missed by the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

6.3 Heating Equipment for Storage Tanks. Equipment for heating bituminous material shall consist of steam coils and equipment for producing steam, so designed that steam cannot get into the material. An armored thermometer with a range from 40 to 200 degrees F. shall be fixed to the tank so that the temperature of the bituminous material may be read at all times.

6.4 Brooms and Blowers shall be of the power type and shall be suitable for cleaning prepared surfaces.

7. PREPARATION OF SURFACE. Immediately before applying the weed killer and prime coat, all loose material, dirt, clay or other objectionable substance shall be removed from the surface by means of a power broom or blower supplemented with hand brooms. After the cleaning operation and prior to the application of the material, an inspection of the area to be treated shall be made by the Contractor to determine the fitness of the area to receive the material. The Contracting Officer shall be notified 24 hours in advance of application of the material. To assure a uniform spread of the material, the areas prepared for treatment, if excessively dry, shall be lightly sprinkled with water immediately before the application as directed.

8. WEED KILLER. A chemical weed killer shall be applied to all areas to receive prime coat prior to application of the prime coat. The weed killer shall be EPA-approved pre-emergent herbicide specifically formulated for the intended purpose and suitable for eradicating weed species found in the area. The weed killer shall have demonstrated satisfactory performance for a period of at least 3 years. Application methods and rates shall be as recommended by the manufacturer.

9. APPLICATION OF BITUMINOUS MATERIAL. Immediately following the preparation of the surface, the bituminous materials shall be applied by means of a bituminous distributor. The bituminous material shall be applied at a pressure within the range of 25 to 75 pounds per square inch and in the amounts as directed. The bituminous material shall be so applied that uniform distribution is obtained at all points of the surface to be treated. Unless the distributor is equipped to obtain satisfactory results at the junction of the previous and subsequent application, building paper shall be spread on the surface of applied material for a sufficient distance back from the ends of each application so that flow from the sprays may be started and stopped on the paper, and all sprayers operate at full force on the surface to be treated. Immediately after the application, building paper shall be removed and destroyed. Spots unavoidably missed by the distributor shall be properly treated with bituminous material. Following the application of bituminous material, the surface shall be allowed to dry without being disturbed for a period of not less than 48 hours, or longer as necessary to attain penetration into the foundation course and evaporation of the volatiles from prime material. The Contractor shall furnish and spread enough approved sand to blot up effectively and cure any excess bituminous material. The Contractor shall maintain the primed surface until the succeeding layer of pavement is placed by protecting the surface against damage and by repairing and repriming deficient areas at no additional cost to the Government. No smoking, fires, or flames other than heaters that are a part of the equipment shall be permitted in the vicinity of heating, distributing, or transferring operations of bituminous material.

9.1 Application Temperature shall be as directed and shall provide an application viscosity between 40 and 120 centistrokes, kinematic, or 20 and 60 seconds, Saybolt-Furol. Application temperatures shall be between 120-190 degrees F., except that appropriate changes should be made when the ranges of viscosity are raised or lowered. The temperature-viscosity relationship shall be furnished to the Contracting Officer.

10. WAYBILLS AND DELIVERY TICKETS. Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and/or certified delivery tickets for all bituminous material actually used in the construction of pavement covered by this section of the specification.

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SECTION ~~2E~~

ASPHALT CONCRETE
(CENTRAL-PLANT HOT MIX)

(SOUTH PACIFIC DIVISION
LAD REVISION 8/1/74

- 5. Sampling and Testing
 - 1. Applicable Publications
 - 2. Description
 - 3. Aggregates
 - 4. Bituminous Material
 - 6. Aggregate Gradation
 - 7. Composition of Mixture
 - 8. Mixing Plant
 - 9. Other Equipment
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- Index
 - 15 TACK COAT
 - 11 10. Transportation of Bituminous Material
 - 12 11. Placing
 - 13 12. Compaction of Mixture
 - 14 13. Joints
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 - 17 15. Surface Requirements
 - 18 16. Sampling

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

1.1 American Association of State Highway Transportation Officials (AASHTO) Standard.

M 226-73I Viscosity Graded Asphalt Cement

1.2 American Society for Testing and Materials (ASTM) Publications.

C 117-84 Materials Finer Than No. 200 (75 um) Sieve in Mineral Aggregates by Washing

C 127-84 Specific Gravity and Absorption of Coarse Aggregate

C 128-84 Specific Gravity and Absorption of Fine Aggregate

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C 136-7184a

Sieve or Screen Analysis of Fine and Coarse Aggregates

D 242-70
(R-1980)

Mineral Filler for Bituminous Paving Mixtures

D 1559-71
82

Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

1.3 Military Standard (Mil. Std.).

MIL-STD-620A

Test Methods for Bituminous Paving Materials

& Notice 1

2. DESCRIPTION. Asphalt concrete indicated as "A.C." ~~as "P.A.C."~~ shall consist of fine and coarse aggregates and mineral filler, if required, uniformly mixed with hot bituminous material, and placed and compacted on a prepared base course subgrade.

3. AGGREGATES shall consist of crushed stone, crushed slag, crushed or uncrushed gravel, screenings, sand, and mineral filler. Aggregates shall have a satisfactory service record in bituminous pavement construction. The source selected shall be approved by the Contracting Officer. Material passing the No. 200 sieve shall be known as mineral filler. Mineral filler shall conform to ASTM D 242. The combined aggregates and mineral filler shall meet the requirements of subsequent paragraphs entitled AGGREGATE GRADATION and

COMPOSITION OF MIXTURE.

4. BITUMINOUS MATERIAL:

4.1 Bituminous material to be mixed with the mineral aggregates shall be asphalt cement conforming to AASHTO M 226-80, viscosity grade AR-40 or AR-80, Table 3.

4.2 Bituminous material used for the tack coat shall be asphalt emulsion conforming to the requirements of ASTM D 977, Type SS-1. The Contractor shall furnish a certified statement from the emulsion manufacturer giving an analysis of the base asphalt used in the manufacturer of the emulsion and attesting to conformity to the applicable requirements above.

5. SAMPLING AND TESTING.

5.1 Sampling. Samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140.

5.2 Testing shall be the responsibility of the Contractor. Testing shall be performed by an acceptable commercial testing laboratory or by the Contractor on approval of the Contracting Officer. Materials shall be tested to establish compliance with the specified requirements. Certificates of compliance shall be furnished.

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495 See Reverse

4. BITUMINOUS MATERIAL to be mixed with the mineral aggregates shall be asphalt cement conforming to AASHTO M226, viscosity grade (AR-40) (AR-80)

Table 2

5. See Reverse

6. AGGREGATE GRADATION. The aggregate gradation as determined by ASTM C-117 and C 136 and as selected by the Contracting Officer shall conform to ~~the following~~ the following:

Sieve Openings	Percentage by Weight, Passing		
a	b		
1 inch	100	-	-
3/4 inch	97-100	100	-
1/2 inch	85-100	80-100	100
3/8 inch	70-95	80-95	80-95
No. 4	50-75	55-72	55-73
No. 8	35-55	40-55	45-60
No. 30	20-40	24-27	17-30
No. 200	2-8	4-8	4-9

7. COMPOSITION OF MIXTURE.

7.1 Job-Mix Formula shall be submitted by the Contractor, and no bituminous mixture shall be manufactured until it has been approved. The formula will indicate the percentage of each sieve fraction of aggregate, percentage of asphalt, and temperature of the mixture as discharged from the mixer. The percentage of asphalt in the job-mix formula will be between ~~5.0~~ 5.5 percent and ~~6.5~~ 6.5 percent. Samples of the aggregates and asphalt shall be submitted for approval with the job-mix formula.

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7.2 Test Properties of Bituminous Mixtures. The apparent specific gravity, as determined by ASTM C 127 and C 128. shall be used in computing the voids total mix and voids filled with bitumen, and the mixture shall meet the following requirements as determined by ASTM D 1559.

Test Property	50-Blow Compaction
Stability, minimum, pounds	500
Flow, maximum, 1/100-inch	20
Voids total mix, percent	3-5
Voids filled with bitumen, percent	75-85

8. Stripping of Aggregates. If the index of retained stability of the job-mix formula is less than 75 tested in accordance with Method 104 of MIL-STD-620, the aggregates shall be rejected or treated by one of the following procedures:

- (1) Addition of heat-stable additives to bitumen.
- (2) Addition of hydrated lime, or other cementitious material containing free lime, as a portion of the mineral filler.

9. MIXING PLANT shall be a weigh-batch or continuous-mixing type approved by the Contracting Officer and operated so as to produce a mixture within the job-mix formula.

10. OTHER EQUIPMENT.

10.1 Bituminous-Material Spreaders shall be self-propelled, capable of producing a finished surface conforming to the smoothness requirements

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specified hereinafter. The use of a spreader that leaves indentations or other objectionable irregularities in the freshly-laid mix will not be permitted.

10.2 Blowers and Brooms shall be of the power type suitable for cleaning the surface to be paved.

10.3 Saw shall be of the power type, capable of rapidly cutting pavement and trimming joints and edges of pavement.

10.4 Small Tools available on the work shall consist of the following: rakes, lutes, shovels, tampers, smoothing irons, pavement cutters, portable heater for heating small tools, wood sandals and stilt sandals of standard type, and other small tools as may be required.

10.5 Steel-Wheel Rollers shall be self-propelled, 3-wheel (tricycle) and/or tandem type, weighing not less than 20,000 pounds each. The rollers shall have adjustable wheel scrapers, water tanks, and sprinkling apparatus to keep the wheels sufficiently wet to prevent the bituminous mixture from sticking to the wheels. Rollers shall be capable of reversing without backlash and shall be free from worn parts. Roller wheels shall not have flat or pitted areas or projections that will leave marks in the pavement.

10.6 Pneumatic-Tired Rollers shall be self-propelled and shall consist of two axles on which are mounted multiple pneumatic-tired wheels in such manner that the rear group of wheels will not follow in the tracks of the forward group but spaced to give essentially uniform coverage with each pass. Axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. Tires shall be smooth and capable of being inflated to

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at least 90 psi. Construction of roller shall be such that each wheel can be loaded to a minimum of 4,500 pounds.

11. TREATMENT OF UNDERLYING SURFACE. Prior to laying a bituminous course, the underlying surface shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, and hand brooms, as directed. The surface to be paved shall receive a (prime coat) (tack coat) conforming to the requirements of the section.

12. TRANSPORTATION OF BITUMINOUS MIXTURE. The bituminous mixture shall be transported from the mixing plant to the site in trucks having tight, clean, smooth bodies with a minimum coating of concentrated solution of hydrated lime and water to prevent adhesion of the mixture. Each load of mixture shall be covered with canvas or other suitable material to protect the mixture from the weather and to prevent loss of heat. Mixtures having temperatures greater than 350 degrees, mixtures having temperatures less than 235 degrees. or mixtures which form or show indications of moisture will be rejected. Hauling over freshly laid material will not be permitted.

13. PLACING. Contact surfaces of previously constructed pavement, curbs, manholes, and other structures shall be sprayed with a thin coat of asphalt conforming to the requirements of the paragraph: TACK COAT. The mechanical spreader shall be adjusted and its speed regulated so that the surface of the course being placed will be smooth and continuous without tears and pulling. The course will be of such depth that after compaction, the cross section, grade, and contour will be as indicated. In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Unless otherwise directed, placing shall begin on the high side of areas with a one-way slope or along the centerline of areas with a crowned

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section and shall be in the direction of the main traffic flow. Placing of the mixture shall be as continuous as possible, and the speed of placing shall be adjusted, as directed, to permit proper rolling.

14

14. COMPACTION OF MIXTURE shall be accomplished by steel-wheel and pneumatic tired rollers. Rolling shall begin as soon after placing as the mixture will support the roller without undue displacement. Rolling of the course shall be continued until all roller marks are eliminated and at least 95 percent of the density of a laboratory specimen of the same mixture has been obtained. The speed of the rollers at all times shall be slow enough to avoid displacement of the hot mixture. The wheels of the roller shall be moistened to prevent adhesion of the mixture. In areas not accessible to the roller, the mixture shall be compacted with hot hand tampers.

15. See Attached (ZE-9, 10)

15. JOINTS. The joints between old and new pavements or between lanes of new work shall be constructed so as to insure uniform bond, texture, density, and smoothness as in other sections of the course. Edges of existing pavement shall be cut to straight, vertical surfaces. All contact surfaces of existing pavement shall be painted with a thin, uniform coat of asphalt.

16. PROTECTION OF PAVEMENT. After final rolling, no vehicular traffic shall be permitted on the pavement for at least 6 hours after rolling.

17. SURFACE REQUIREMENTS. The finished surface shall not vary more than 1/4 inch from a 10-foot straightedge. The straightedge shall be furnished by the Contractor. Defective areas shall be corrected by the Contractor at no additional cost to the Government.

15. TACK COAT.

15.1 Quantities to be Applied. Bituminous material for the tack coat shall be applied in quantities of not less than 0.05 gallon nor more than 0.15 gallon per square yard. The exact quantities within the range specified may be varied to suit field conditions, shall be determined by the Contractor and approved.

15.2 Equipment. All equipment, tools, and machines used in performance of work required by this section shall be subject to approval and shall be maintained in satisfactory working condition.

15.3
WEATHER LIMITATIONS.

Tack coat shall be applied only when the surface to be treated is dry and the temperature shall not have been lower than 35 degrees F. for 12 hours immediately prior to application. It shall not be applied when the atmospheric temperature in the shade is lower than 50 degrees F.

15.4
PREPARATION OF SURFACE.

Immediately before applying the tack coat, if surface is sufficiently bonded, all loose material, dirt, clay, or other objectionable material, shall be removed from the surface to be treated with a power broom or blower supplemented with hand brooms. After the cleaning operation, and prior to application of the tack coat, an inspection of the area to be treated will be made by the Contracting Officer to determine fitness of the area to receive the bituminous coating. That portion of surface prepared for immediate treatment shall be dry and in a satisfactory condition.

15.5
APPLICATION OF BITUMINOUS MATERIAL.

Immediately following preparation of surface, the bituminous material shall be applied by a bituminous distributor at a temperature determined by the Contracting Officer, within the range of 75 to 130 degrees F. Under no circumstances shall emulsion be heated to a temperature greater than 140 degrees F. or exposed to a temperature of less than

40 degrees F. The bituminous material shall be applied so uniform distribution is obtained over all points of the surface to be treated. Unless the distributor is equipped to obtain satisfactory results 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 so that flow through the sprays may be started and stopped on the paper, and all sprays operate at full force on the surface to be treated. Immediately after application, the building paper shall be removed and destroyed. Lightly coated areas and spots missed by the distributor shall be properly treated with bituminous material. Following application of bituminous material, the surface shall be allowed to dry to a proper condition of tackiness to receive surfacing. The period of time shall be as determined by the Contracting Officer. The Contractor shall furnish and spread a sufficient quantity of clean, dry sand on all areas that show an excess of bituminous material, to effectively blot up and cure the excess when directed by the Contracting Officer. The treated surface shall be maintained by the Contractor until the succeeding layer of pavement has been placed. During this interval the Contractor shall protect the treated surface against damage and shall repair all damaged spots at no additional cost to the Government.

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16. SAMPLING. Sampling for the determination of thickness and density of the completed pavements will be performed by the Contracting Officer. All tests necessary to determine conformance with the specified requirements will be performed by the Contracting Officer without cost to the Contractor. The Contractor shall replace the pavement where samples are removed at his expense. No payment will be made for areas of pavement deficient in composition, density, or thickness until they are removed and replaced by the Contractor as directed by the Contracting Officer.

SECTION 2F

AGGREGATE BASE

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- | | |
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| 1. Applicable Publications | 9. Mixing and Placing Materials |
| 2. Materials | 10. Layer Thickness |
| 3. Sampling and Testing | 11. Compaction |
| 4. Equipment | 12. Edges of Base Course |
| 5. Operation of Pits or Quarries | 13. Smoothness Test |
| 6. Weather Limitations | 14. Thickness Control |
| 7. Preparation of Underlying Surface | 15. Maintenance |
| 8. Grade Control | 16. Waybills and Delivery Tickets |

1. **APPLICABLE PUBLICATIONS.** The American Society for Testing and Materials (ASTM) Standards listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

C 117-84	Materials Finer than No. 200 (75-M) Sieve in Mineral Aggregates by Washing
C 127-84	Specific Gravity and Absorption of Coarse Aggregate
C 128-84	Specific Gravity and Absorption of Fine Aggregate
C 131-81	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
C 136-84	Sieve or Screen Analysis of Fine and Coarse Aggregates
D 75-82	Sampling Aggregates
D 422-63 (R 1972)	Particle-Size Analysis of Soils
D 1556-82	Density of Soil In Place by the Sand-Cone Method
D 1557-78	Moisture-Density Relations of Soils, Using 10-lb. (4.5-kg) Rammer and 18-in. (457-mm) Drop
D 4318-84	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
E 11-81	Sieves for Testing Purposes

2. **MATERIALS.** Aggregates shall consist of crushed stone, crushed gravel, angular sand, soil, 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. It shall be the responsibility of the Contractor to obtain materials that will meet the requirements specified herein and that can be constructed to meet the grade and smoothness requirements specified herein after all compaction requirements have been completed. The material retained on a No. 4 sieve shall be known as coarse aggregate, and the material passing the No. 4 sieve shall be known as binder material.

2.1 Coarse Aggregate conforming to the requirements specified above shall have a percentage of wear not to exceed 50 percent after 500 revolutions. Slag shall be an air-cooled blast-furnace product having a dry weight of not less than 65 pounds per cubic foot. Coarse aggregate shall consist of angular fragments reasonably uniform in density and quality. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3, and an elongated particle is one having a ratio of length to width greater than 3.

2.1.1 Coarse aggregate retained on each sieve specified shall contain at least 50 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 adjacent, the angle between the planes of the fractures must be at least 30 degrees to count as two fractured faces.

2.2 Binder Material shall consist of screenings, angular sand, soil, or other finely divided mineral matter processed or naturally combined with the coarse aggregate. Liquid-limit and plasticity-index requirements stated herein shall apply to any component that is blended to meet the required gradation and shall also apply to the completed course. The portion of any component or of the completed course passing the No. 40 sieve shall be either nonplastic or shall have a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.3 Gradation requirements specified herein shall apply to the completed base course, and it shall be the responsibility of the Contractor to obtain materials that will meet the gradation requirements after mixing, placing, compacting, and other operations. The aggregates shall have a maximum size of one inch and shall be continuously graded within the limits specified below:

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieve
1-1/8 inch	100
No. 4	38-65
No. 8	25-60
No. 30	10-40
No. 200	3-12

The values are based on aggregates of uniform specific gravity, and the percentages passing the various sieves are subject to appropriate correction by the Contracting Officer when aggregates of varying specific gravities are used.

3. SAMPLING AND TESTING shall be by and at the expense of the Contractor.

3.1 Samples shall be the size required and shall be taken by the Contractor. Copies of test results shall be submitted for approval 7 days prior to starting the work, and thereafter at regular intervals during production as specified hereinafter. These samples shall be obtained at the source, from test pits, borings, trucks, stockpiles, or from other designated locations. Samples for material gradation, liquid-limit determination, and plasticity-index tests shall be taken in conformance with ASTM D 75. After the material has been placed and compacted, samples for density tests shall be taken as specified in ASTM D 1556, and additional samples for gradation, liquid-limit, and plasticity-index tests shall be taken by an appropriate method. Where deemed necessary, the sampling will be supervised by the Contracting Officer. The Contractor shall arrange his work so that sampling and testing may be performed without interruption.

3.2 Tests.

3.2.1 Aggregate Gradation. Aggregate gradation shall be determined in accordance with ASTM C 117, C 127, C 128, C 136, and D 422. Sieves shall conform to ASTM E 11.

3.2.2 Liquid Limit shall be determined in accordance with ASTM D 4318.

3.2.3 Plasticity Index shall be determined in accordance with ASTM D 4318.

3.2.4 Wear Test shall be made in conformance with ASTM C 131.

3.2.5 Field-In Place Density shall be determined in accordance with ASTM D 1556. Moisture-density relations shall be established in the laboratory in accordance with ASTM D 1557, method D, or AASHTO T 190, Method D, Correction for oversize material shall be applied in accordance with AASHTO T-224.

3.3 Testing Frequency. Results of tests to determine particle shape, presence of objectionable and foreign matter, percentage of wear, fracture count, gradation, liquid-limit, plasticity-index, specific gravity, and other specification requirements for determination of the acceptability of the source shall be submitted for approval at least 7 days prior to starting of manufacture of the base course material. Production testing for material gradation, liquid limit, and plasticity index shall be performed at regular intervals with at least one test being made for each 500 cubic yards or fraction thereof, of material produced and results shall be submitted on a daily basis. Deviations from specification requirements shall be corrected immediately upon discovery. After the material has been placed and compacted, one field density test for each 1,000 square yards or fraction thereof of finished base course and one additional gradation, liquid-limit, and plasticity index test for each 3,000 square yards of base course or fraction thereof shall be performed. Maximum-density moisture relations shall be established for each 5,000 square yards of base course material. The location of the after-placement tests shall be as directed. One copy of density data (less dry weight determinations) shall be provided on the day each test is taken. The completed test report shall be provided with the Contractor Quality Control Report on the following work day. Results of all tests made shall be submitted for approval on a daily basis and subsequent paving operations shall not commence until final approval has been obtained. Failure of any test shall be reported verbally, by the most expeditious means and followed promptly by written report.

Contractor field operations shall immediately reflect corrective measures. For every failing test, retesting after completion of corrective measures have been taken will be required.

3.4 Approval of Materials. The source of the material shall be selected 7 days in advance of the time materials will be required in the work. Tentative approval of the preliminary reports submitted by the Contractor and the source will be based on an inspection by the Contracting Officer. Tentative approval of the materials will be based on test samples as specified herein. Final approval of both the source and the materials will be based on specified tests performed on samples taken from the completed and compacted base course.

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

5. OPERATION OF PITS OR QUARRIES. All work involved in clearing, stripping, and excavating in opening or operation of pits or quarries shall be performed by the Contractor. Pits or quarries shall be opened to expose vertical faces of deposit to depths suitable for working. Materials excavated from pits shall be obtained in successive vertical cuts extending through all exposed strata. All pockets or strata of unsuitable materials overlying or occurring within the deposit shall be wasted as directed. The methods of operating pits or quarries and the processing and blending of the material may be changed or modified by the Contracting Office when necessary to obtain material conforming to the specified requirements. Quarries shall be conditioned in agreement with the local laws or authorities.

6. WEATHER LIMITATIONS. Aggregate base courses shall be constructed when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F., the contractor shall protect all areas of the completed aggregate base course, by approved methods, against any detrimental effects of freezing. Areas of completed aggregate base course damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

7. PREPARATION OF UNDERLYING SURFACE. Prior to constructing the aggregate base course, the previously constructed subgrade shall be cleaned of all foreign substances. The surface of the subgrade shall be inspected by the Contractor for adequate compaction and surface tolerances. The subgrade shall conform to SECTION: FILLS AND SUBGRADE PREPARATION. Ruts or soft, yielding spots that may appear in the subgrade areas having inadequate compaction, and deviations of the surface from the requirements set forth therein shall be corrected to line and grade and to all specification requirements. The finished subgrade shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the base course is placed.

8. GRADE CONTROL. During construction, the lines and grades, including crown and cross slope indicated for the aggregate base course, shall be maintained by means of line and grade stakes placed by the Contractor at the worksite in accordance with paragraph: LAYOUT OF WORK of the SPECIAL CLAUSES.

9. MIXING AND PLACING MATERIALS. The materials shall be mixed by the stationary-plant, traveling-plant or road-mix method and placed in such a manner as to obtain uniformity of the aggregate base course material and at a uniform optimum moisture content for compaction. 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 to accelerate loss or increase of water, and to insure a satisfactory aggregate base course meeting all the requirements of this specification.

10. LAYER THICKNESS. The compacted thickness of the aggregate base course shall be as indicated on the drawings and shall be placed in a single layer.

11. COMPACTION. Each layer of the aggregate base course (including shoulders) shall be compacted with approved compaction equipment. Water content shall be maintained at optimum plus or minus 2 percent. In places not accessible to the rollers, the mixture shall be compacted with mechanical tampers. Compaction shall continue until each layer through the full depth is compacted to at least 100 percent of maximum density. The Contractor shall make such adjustments in rolling or finishing procedures as may be required to obtain true grades, to minimize segregation and degradation, to reduce or accelerate loss or gain of water, and to insure a satisfactory aggregate base course. Unsatisfactory placed materials shall be reworked until they are a satisfactory material. When materials become damaged during placing they shall be removed from the work and disposed of as directed by the Contracting Officer.

12. EDGES OF BASE COURSE. Where the course is not placed between curbs or similar construction, approved material shall be placed along the edges of the aggregate base course in such quantities as will compact to the thickness of the course being considered, or when the course is being constructed in two layers, to the thickness of each layer of the course. Allow in each operation at least a 1-foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the base course, as directed.

13. SMOOTHNESS TEST. The surface of each layer shall not show any deviations in excess of 3/8 inch when tested with either a 10- or 12-foot straightedge applied both parallel with and at right angles to the centerline of the paved area. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed.

14. THICKNESS CONTROL. The completed thickness of the base course shall be within 1/2 inch, plus or minus, of the thickness indicated. Thickness test shall be made and recorded by the Contractor. The thickness of the base course shall be measured at intervals in such manner that there will be a thickness measurement for at least each 500 square yards of base course. The thickness measurement shall be made by test holes at least 3 inches in diameter through the base course. Where the measured thickness of the base course is more than 1/2 inch deficient in thickness, the Contractor, at no additional expense to the Government, shall correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompacting, as directed. Where the measured thickness of the base course is more than 1/2 inch thicker than that indicated, it shall be considered as conforming with the specified thickness requirements plus 1/2 inch. The average job thickness shall be the average of the job measurements determined as specified above, but shall be within 1/4 inch of the thickness indicated.

15. MAINTENANCE. The Contractor shall maintain the aggregate base course in a satisfactory condition until the completed work is accepted.

16. WAYBILLS AND DELIVERY TICKETS. Copies of waybills or delivery tickets shall be attached to the Daily Contractor Quality Control Report for the day of delivery. Before the final statement is allowed, the Contractor shall file with the Contracting Officer waybills and/or certified delivery tickets for all aggregates actually used in the construction covered by the contract.

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SECTION ~~21~~

MISCELLANEOUS AGGREGATES

1. APPLICABLE PUBLICATIONS. The American Society for Testing and Materials (ASTM) Standards listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

C 33-82	Concrete Aggregates
C 131-81	Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 144-81	Aggregate for Masonry Mortar

2. GRAVEL PLACEMENT AND MATERIAL. Gravel shall be placed as shown on the drawings in accordance with the following requirements: Gravel shall be clean, hard, sound, durable, uniform in quality, and free of any detrimental quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

2.1 Abrasion. The loss of abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C 131, Grading A, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

2.2 Gravel Composition. Gravel shall be composed entirely of particles that are either fully or partially rounded and water-worn. Crushed rock may be combined provided it is uniformly distributed throughout and blended with the gravel. The quality and gradation requirements shall be as follows: ASTM C 33, 1/2-inch maximum size as indicated in Grading Table for coarse aggregates.

3. DESERT GRAVEL. Desert gravel shall be placed on the area as shown on the drawings ~~in accordance with the following requirements.~~ TO MATCH DESERT GRAVEL PREVIOUSLY PLACED IN CERTAIN REACH AREA FROM 29TH AVE. TO 47TH DRIVE IF MATCHING DESERT GRAVEL IS UNOBTAINABLE, THE DESERT GRAVEL SHALL BE PLACED IN ACCORDANCE WITH FOLLOWING REQUIREMENTS

3.1 Desert gravel (D.G.) shall be any granitoid igneous rock which has been weathered in place and which has as principal constituents granular fragments of quartz and feldspar. It may also contain fragments of granite rock not yet broken down into the component minerals. The material shall remain stable when saturated with water.

3.2 Material shall be free from all foreign objects, lumps, irregularities and shall be consistent in color.

3.3 Desert gravel shall have a maximum size of not more than 1/2 inch, have not more than 30 percent of the material passing the No. 200 sieve, and shall have a plasticity index of less than 10 for the materials passing the No. 40 sieve.

3.4 Subgrade shall be thoroughly compacted prior to application. Weed barrier fabric shall be laid on the subgrade under all desert gravel.

3.5 Coloration shall conform to the "Munsell" soil chart (1975 edition; published by the Knoll Morgen Corp., 2441 North Calvert Street, Baltimore, Maryland 21218), as follows: HUE 7.5YR, VALUE/CHROMA 6/4.

~~Areas designated "Desert Rose", hue 10R, value/chroma 5/3.~~

~~Areas designated "Coral", hue 10R, value/chroma 6/6.~~

~~Areas designated "Amber" and all other D.G. areas not color designated, hue 7.5YR, value/chroma 6/4.~~

3.6 Material shall be obtained from commercial sources.

3.7 Contractor shall submit color samples (minimum of 3) and gradations and abrasion test results of D.G. to the Contracting Officer or his representative for approval prior to installation.

3.8 D.G. shall be spread to a depth of 2 inches thick, raked, dampened, and rolled with a 90# roller.

o.k. 4. WEED BARRIER FABRIC shall be a permeable polypropylene fabric with a minimum thickness of 2 mil and shall be a produce commercially manufactured as weed barrier fabric.

o.k. 5. LANDSCAPE MOUNDING. Fill material for use in landscape mounding shall be representative of existing site soil and be free of all foreign material, caliche, and all organic material and stones larger than 2 inches in diameter. The source of landscape fill shall be from excavation areas as directed by the Contracting Officer.

6. PEA GRAVEL. Aggregate for "pea gravel" material shall be of clean sand, gravel or crushed rock and shall be free from lumps or balls of clay and shall not contain calcareous or clay coatings, caliche, synthetic materials, organic matter of foreign substances. The gradation shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method No. 201.

Sieve Size	Percent Passing
3/8 inch	100
No. 4	0-25
No. 8	0-5
No. 200	0-2.0

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J.K.
SECTION 24

TREES, SHRUBS, AND GROUND COVERS

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| 4. Delivery, Storage, and Handling | 9. Plant Establishment Period |
| 5. Environmental Protection | |

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

1.1 Federal Specification (Fed. Specs.).

O-F-241D

Fertilizers, Mixed Commercial

1.2 American National Standards Institute (ANSI) Publication.

Z60. 1-1986

American Standard for Nursery Stock

1.3 American Joint Committee on Horticultural Nomenclature (AJCHN) Publication.

Standardized Plant Names
(Second Edition-1942)

1.4 American Society for Testing and Materials (ASTM) Standard.

C 136-81

Sieve Analysis of Fine and Course
Aggregates

2. **SOURCE INSPECTIONS.**

2.1 **Plant Materials.** Plant materials will be inspected by the Contracting Officer at the growing site and tagged or otherwise approved for delivery. Such inspection does not preclude right of rejection at the project site.

2.2 **Topsoil.** The source of topsoil will be inspected by the Contracting Officer to determine the acceptability of the topsoil and the depth to which it is to be stripped.

3. **SUBMITTALS.**

3.1 **Samples.** The following samples shall be submitted for approval before work is started.

a. **Topsoil**--representative samples shall be taken from several locations on the area under consideration.

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24-1

3.2 Certificates of Conformance or Compliance. Before delivery, notarized certificates attesting that the following materials meet the requirements specified, shall be submitted in triplicate for approval.

a. Plant Materials.

3.3 Maintenance Instruction. Prior to the end of the contract maintenance period, 3 copies of written instructions for year round maintenance and care of installed plants shall be furnished to the Contracting Officer.

4. DELIVERY, STORAGE, AND HANDLING.

4.1 Delivery.

4.1.1 The Contractor shall notify the Contracting Officer of the delivery schedule in advance so the plant material may be inspected upon arrival at the jobsite by the Contracting Officer. Unacceptable plant material shall be removed from the jobsite immediately.

4.1.2 Plants shall be protected during delivery to prevent damage to the root balls or desiccation of leaves. Trees shall be protected during transportation by tying in the branches and covering all exposed branches.

4.1.3 Fertilizer shall be delivered to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis, name, trade name or trademark, and in conformance to state and Federal law. In lieu of containers, fertilizer may be furnished in bulk and a certificate indicating the above information shall accompany each delivery.

4.1.4 All pesticide material, including soil fumigants, shall be delivered to the site in the original unopened containers. Containers that do not have a legible label that identifies the Environmental Protection Agency registration number and the manufacturer's registered uses will be rejected.

4.2 Storage.

4.2.1 Plant Storage. Plants not installed on the day of arrival at the site shall be stored and protected. Outside storage locations shall be continually shaded and protected from the wind. Plants stored on the project shall be protected from any drying at all times. Plants in containers, shall be kept in a moist condition until planted by routine watering.

4.2.2 Storage of Other Materials. Pesticide material shall be kept in dry storage and shall not contaminate adjacent material, and shall be handled and stored following manufacturer's directions. Storage of materials shall be in areas designated or as approved by the Contracting Officer.

4.3 Handling. Care shall be taken to avoid damaging plants being moved from the nursery or storage area to the planting site. Plants shall be protected from freezing or drying out by covering with burlap, tarpaulin or mulching material during transportation to planting site. Plants shall not be handled by the trunk or stems. Damaged plants will be rejected and shall be removed from the site.

5. ENVIRONMENTAL PROTECTION. All work and Contractor operations shall comply with the requirements of SECTION: ENVIRONMENTAL PROTECTION.

6. MATERIALS.

6.1 Plants.

6.1.1 Plants shall conform to the varieties specified in the plant list and be true to botanical names as listed in AJCHN Standardized Plant Names. Plants shall be in accordance with ANSI Z60.1 except as otherwise stated in the specifications or shown on the plans. Where the drawings or specifications are in conflict with ANSI Z60.1, the drawings and specifications shall prevail.

6.1.2 Planting stock shall be well-branched and well-formed, sound, vigorous, healthy, and free from disease, sun-scald, windburn, abrasion, and harmful insects or insects eggs and shall have healthy, normal and unbroken root systems. Deciduous trees and shrubs shall be symmetrically developed, of uniform habit of growth, and free from objectionable disfigurements. Plants shall have been grown under climatic conditions similar to those in the locality of the project.

6.1.3 The minimum acceptable sizes of all plants, measured before pruning and with branches in normal position, shall conform to the measurements indicated. Plants larger in size than specified may be used with the approval of the Contracting Officer with no change in the contract price. If larger plants are used, the ball of earth or spread of roots shall be increased in accordance with ANSI Z60.1.

6.1.4 The Contractor shall facilitate inspection and identifications by labeling trees and bundles or containers of the same shrub, with a durable waterproof label and weather-resistant ink. Labels shall state the correct plant name and size as specified in the list of required plants. Labels shall be securely attached to plants, bundles, and containers of plants and shall be legible for 60 days after delivery to the planting site.

6.1.5 Plant material shall be nursery grown unless otherwise indicated and shall conform to the requirements and recommendations of ANSI Z60.1. Plants shall be dug and prepared for shipment in a manner that will not cause damage to branches, shape, and future development after planting.

6.1.5.1 Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers but shall not be root bound.

6.1.6 Substitutions shall be made only when a plant (or its alternates as specified) is not obtainable and the Contracting Officer authorizes a change order providing for use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of the contract price.

6.2 Topsoil.

6.2.1 Topsoil shall be the existing surface soil stripped and stockpiled on the site.

6.2.2 If additional topsoil is required, it shall be furnished by the Contractor from borrow areas approved by Contracting Officer.

6.3 Soil Conditioners and Amendments.

6.3.1 Rotted sawdust shall have 7.5 pounds of nitrogen added uniformly to each cubic yard and shall be free of chips, stones, sticks, soil, and toxic substances.

6.3.2 Planting Soil Mixture. The planting soil mixture shall be composed of two parts topsoil, and one part rotted sawdust.

6.3.3 Fertilizer. Fertilizer shall be commercial grade and uniform in composition.

6.3.4 Granular fertilizer shall conform to Fed. Spec. O-F-241, Type I, Level B, and shall bear the manufacturer's guaranteed statement of analysis. Granular fertilizer shall contain a minimum percentage by weight of: 14 nitrogen, 14 available phosphoric acid, and 14 potash.

6.3.5 After establishment of finished grade around plants, all pit areas shall be topped with fertilizer at the rate of one pound per 100 square feet of area. Fertilizer adhering to plants shall be flushed off.

6.4 Staking Material.

6.4.1 Stakes for support if required shall be lodge pole pine, free from knots, rot, cross grain, or other defects that would impair the strength. Standard stakes shall be a minimum of 2-1/2 inches in diameter, and pointed at one end, and of length indicated on the drawings.

6.5 Water. Water shall not contain elements toxic to plant life.

7. INSTALLATION.

7.1 Planting Seasons and Conditions. Planting shall be done when the ground is not frozen, water logged or in an otherwise unsuitable condition for planting. Planting shall be done within the following dates:

a. Deciduous material from 1 February to 1 May for spring planting and from 1 October to 15 November for fall planting.

b. Evergreen material from 1 February to 1 May for spring planting and from 1 October to 15 November for fall planting.

7.2 Setting Plants. Container-grown plants shall be handled and moved only by the container. Plants shall be set plumb and held in position until sufficient soil has been firmly placed around roots or ball. Plants shall be set in relation to surrounding grade so that they are even with the depth at which they were grown in the nursery container.

7.2.1 Planting shall be done with the approval of the Contracting Officer only when the ground is in suitable condition for planting. If special conditions exist that may warrant a variance in the above planting conditions, a written request shall be submitted to the Contracting Officer stating the special conditions and proposed variance.

7.2.2 Layout. Plant material locations and bed outlines shall be staked on the project site by the Contractor and approved by the Contracting Officer before any plant pits or beds are dug. The Contracting Officer may adjust plant material locations to meet field conditions.

7.3 Excavation for Planting.

7.3.1 Prior to excavating for plant pits the area shall conform to the lines and grades shown on the plans and the locations of any underground utilities shall be verified by the Contractor and the Contracting Officer. Damage to utility lines shall be repaired at the Contractor's expense. Existing trees, shrubbery, and beds that are to be preserved shall be barricaded in a manner that will effectively protect them during planting operations.

7.3.2 Rocks and other underground obstructions shall be removed to a depth necessary to permit proper planting according to plans and specifications. If underground utilities, construction, or solid rock ledges are encountered, other locations may be selected by the Contracting Officer.

7.3.3 Plant pits may be dug by any method approved by the Contracting Officer provided that the pits have vertical sides and flat bottoms. When pits are dug with an auger and the sides of the pits become glazed, the glazed surface shall be scarified. The size of plant pits shall be as shown on the plans.

7.4 Container grown stock shall be removed from containers in such a way so as to prevent damage to plant or root system. Planting shall be completed as specified above.

7.4.1 Container stock shall be backfilled with topsoil to approximately half the depth of the ball and then tamped and watered. The remainder of backfill of topsoil shall be tamped and watered. Earth saucers or water basins shall then be formed around isolated plants. Water holding basins shall be ample enough in size and height to hold at least 2-1/2 gallons for shrubs or 5 gallons for trees.

7.5 Watering. Depressed water basins shall be used around all plants. All watering shall be done in a manner which will provide deep penetration, but which will not cause erosion or damage to the finished surface. Sufficient water shall be applied to penetrate the planting bed to a depth of 24 inches. Frequent watering may be necessary during periods of hot weather.

7.6 Inspection. The trunks of the trees shall be inspected for physical damage or insect infestation and required treatment or rejection shall be determined.

7.7 Rotted sawdust shall have 7.5 pounds of nitrogen added uniformly to each cubic yard and shall be free of chips, stones, sticks, soil, and toxic substances.

7.8⁷ Planting Soil Mixture. The planting soil mixture shall be composed of two parts topsoil, and one part rotted sawdust.

7.9 Fertilizer. Fertilizer shall be commercial grade and uniform in composition.

7.9.1 Granular fertilizer shall conform to Fed. Spec. O-F-241, Type I, Level B, and shall bear the manufacturer's guaranteed statement of analysis. Granular fertilizer shall contain a minimum percentage by weight of: 14 nitrogen, 14 available phosphoric acid, and 14 potash.

7.9.2 After establishment of finished grade around plants, all pit areas shall be topdressed with fertilizer at the rate of one pound per 100 square feet of area. Fertilizer adhering to plants shall be flushed off.

8. PRUNING.

8.1 New plant material shall be pruned in the following manner. Dead and broken branches shall be removed. Trees and shrubs shall be pruned to reduce total amount of anticipated foliage by one fourth. Typical growth habit of individual plants shall be retained with as much height and spread as is practicable. Cuts shall be made with sharp instruments, and shall be flush with trunk or adjacent branch to insure elimination of stubs. "Headback" cuts at right angles to line of growth shall not be permitted. Trees shall not be poled or the leader removed. Trimmings shall be removed from the site. Cuts 1/2 inch in diameter and larger shall be painted with the specified tree wound dressing.

8.2 Restoration and Clean-Up. Excess and waste material shall be removed daily. When planting in an area has been completed, they shall be cleared of all debris, spoil piles, and containers.

8.3 Maintenance During Installation. Maintenance operations shall begin immediately after each plant is planted and shall continue as required until final acceptance. Plants shall be kept in a healthy, growing condition by watering, pruning, spraying, weeding, and any other necessary operations of maintenance. Plant saucers and beds shall be kept free of weeds, grass, and other undesired vegetation. Plants shall be inspected at least once per week by the Contractor during the installation period and needed maintenance performed promptly.

9. PLANT ESTABLISHMENT PERIOD. Final acceptance of all work and materials under this section shall be at the end of a period of establishment to be determined as follows.

9.1 Beginning of the Plant Establishment Period. The period of establishment shall begin on the date that an inspection by the Contracting Officer shows that all plants are in place and have been installed in accordance with the specifications and plans. Replacement of plants that were not supplied by the Contractor but were relocated under this contract and that die for any reason other than improper handling during transplanting and/or lack of proper care will not be required. Loss through Contractor negligence, however, shall require replacement in kind and size per specification and shall be at the Contractor's expense.

9.2 During the Plant Establishment Period.

9.2.1 During the plant establishment period, the Contractor shall water all plants as necessary to maintain an adequate supply of moisture within the root zone. Water shall not be applied so quickly that it cannot be absorbed by the plants.

9.2.2 Plants shall be pruned as required.

9.2.3 Stakes and eroded plant saucers shall be replaced as required.

9.2.4 Other work, such as spraying with approved insecticides and fungicides to control pests, shall be done (each day if necessary) to ensure plant survival in a healthy growing condition.

9.2.5 Dead plants shall be removed immediately at the Contractor's expense and replaced within seven (7) days. The Contractor will not be responsible for theft or damage to plants by vehicles or vandalism following completion and approval of the installation portion of the planting contract.

9.3 Termination of the Plant Establishment Period.

9.3.1 A preliminary inspection by the Contractor and the Contracting Officer will be held 120 days from the date of the beginning of the plant establishment period to determine plant acceptability and the number of replacements. Alternate or substituted varieties of plants shall be used only if approved by the Contracting Officer.

9.3.2 A final inspection of all plants will be held after the replacement planting has been completed. No additional plant establishment period will be required for replacement plants. The establishment period will end on the date of this inspection and said inspection will be considered final acceptance provided the Contractor has complied with the following requirements.

a. Dead, missing, and defective plant material shall have been replaced as directed by the Contracting Officer otherwise, final acceptance will be delayed until such replacements have been satisfactorily accomplished.

b. Plant saucers shall be free of weeds.

c. Stakes and guys shall be in good condition.

d. Remedial measures directed by the Contracting Officer to ensure plant survival shall have been carried out.

e. Plant material shall have been fertilized as required prior to acceptance.

9.4 Replacement. At the end of the guarantee period the Contracting Officer will make another inspection to determine the condition of plants. Plants not in healthy growing condition, as determined by the Contracting Officer will be noted and as soon as seasonal conditions permit shall be removed from the site and replaced with plants of the same species and sizes as originally specified. Such replacements shall be made in the same manner as specified for the original plantings, and at no cost to the Government. The guarantee on plants will be limited to one replacement.

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SECTION ^{2I} ~~21~~ ^{0,1C}

IRRIGATION SYSTEM

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

1.1 Federal Specification (Fed. Spec.).

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|-------------------------|---|
| WW-U-531E | Unions, Pipe, Steel or Malleable Iron,
Threaded Connection, 150 lbs and 250 lbs |
| WW-V-51F | Valve, Angle, Check, and Globe, Bronze,
(125, 150 and 200 Pound, Threaded
End, Flanged Ends, Solder Ends, and
Brazed Ends, for Land Use) |
| WW-V-54D
& Int. Am-3 | Valve, Gate, Bronze (125, 150 and 200
Pound, Threaded Ends, Flange Ends, Solder
End and Brazed Ends, for Land Use) |

1.2 Military Standard (Mil. Std.).

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| MIL-STD-621A
Notices 1, 2 | Test Method for Pavement Subgrade, Sub-
base, and Base-Course Materials |
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1.3 American National Standards Institute, Inc. (ANSI).

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|------------|---|
| B16.3-1977 | Malleable Iron Threaded Fittings Class 150
and 300 |
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1.4 American Society for Testing and Materials (ASTM) Standards.

- | | |
|-----------|--|
| A 120-79 | Pipe, Steel, Black and Hot-Dipped Zinc-
Coated (Galvanized) Welded and Seamless,
for Ordinary Uses |
| D 1785-82 | Poly (Vinyl Chloride) (PVC) Plastic Pipe,
Schedules 40, 80, and 120 |
| D 2241-82 | Poly (Vinyl Chloride) (PVC) Plastic Pipe
(DDR-PR) |

- D 2464-76 Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- D 2466-78 Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
- D 2564-80 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

1.5 American Water Works Association (AWWA) Standards.

C 601-81 Disinfecting Water Mains

1.6 SEE BELOW

2. GENERAL. This section covers irrigation piping including connection to source of water supply, complete.

2.1 Above ground piping shall be galvanized steel.

2.2 Below Ground Piping. Pipe smaller than 2-inch shall be plastic. Pipe for sleeving shall be plastic. The minimum cover for laterals and branches shall be 12 inches and 8 inches for polyethylene, unless otherwise indicated on drawings. The minimum cover for pressure lines shall be 2.5 feet except under roadways, parking and paved areas where the minimum cover shall be 3 feet.

2.3 Electrical Work shall conform to the applicable requirements of SECTION: ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

3. EXCAVATION.

3.1 General. All excavation of every description and of whatever substances encountered shall be performed to the depths indicated or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed and wasted as indicated or as directed. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Sheet piling and shoring shall be done as may be necessary for the protection of the work and for the safety of personnel. Earth excavation shall comprise all materials not classified as rock excavation. ~~Rock excavation shall comprise the following: boulders measuring 1/3 cubic yard or more in volume; rock material in ledges, bedded deposits, unstratified masses, and conglomerate deposits so firmly cemented as to possess the characteristics of solid rock that cannot be removed without systematic drilling and blasting; and concrete or masonry structures except sidewalks and paving.~~

3.2 Trench Excavation. Trenches shall be of the necessary width for proper laying of pipe. The banks of pipe trenches shall be as nearly vertical as practicable. Care shall be taken not to overexcavate. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints, and as hereinafter specified. Stones shall

1.6 Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS) Standards.

SP-58

Pipe Hangers and Supports-Materials, Design and Manufacture (1975)

SP-69

Pipe Hangers and Supports-Selection and Application (1976)

be removed as necessary to avoid point bearing. ~~Where rock excavation, as defined hereinbefore, is required in trenches for pipe, the rock shall be excavated to a minimum overdepth of 6 inches below the trench depths indicated, specified or as defined hereinbefore.~~ Except as hereinafter specified for wet or otherwise unstable material, overdepth excavation shall be backfilled as and with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe is encountered in the bottom of the trench, and overdepth is not indicated on the drawings, such material shall be overexcavated to a depth to allow for construction of a stable pipe bedding. The trench shall be backfilled to the proper grade with approved materials.

4. **BACKFILLING.** The trenches shall not be backfilled until all required pressure tests are performed and until the irrigation systems as installed conform to the requirements specified. Except as otherwise specified for special conditions, trenches shall be backfilled to the ground surface with selected material that is suitable for the specified compaction and as hereinafter specified. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified, or the condition shall be otherwise corrected as approved. ~~The meaning of "density of the adjacent soil" when the adjacent formation is rock shall be interpreted as maximum density in accordance with MIL-STD-621, Method 100, GE-55.~~ The surface shall be restored to its original condition as near as practicable and as hereinafter specified.

5. **MATERIALS** shall conform to the respective specifications and other requirements specified below.

5.1 Pipe.

5.1.1 Galvanized Steel Pipe shall conform to ASTM A 120, standard weight.

5.1.2 Plastic Pipe shall conform to ASTM D 1785, schedule 40 for pipe with solvent welded joints and schedule 80 for pipe with threaded joints, or to ASTM D 2241, Type 1, grade 1, 315 psi for pressure lines and 200 psi for other lines for pipe with solvent welded joints. Pipe and fittings shall bear the seal of approval (nsf mark) of the National Sanitation Foundation's standard for plastic pipe and fittings for potable water service.

5.1.3 Polyethylene pipe shall be 100 percent polyethylene as follows:

1/2" I.D. .574" to .600" Wall Thickness .050" to .062"

Melting point- .065 grams per 10 minutes

Plastic Recovery- 30%

Tensile strength at break- 1665 pounds per square inch

Elongation- 65%

Brittleness at 76°C- zero failures from 10 samples

Stress crack in 100% Igepol solution- zero failures from 10 samples

5.1.4 Polyethylene pipe (dripline) shall have a maximum length of 500 feet if the line returns to the PVC lateral, or a maximum length of 300 feet if the line dead ends. Maximum flow (gpm) shall not exceed the manufacturer's recommendations for pipe size indicated.

5.2 Joints.

5.2.1 Plastic Pipe Joints shall be solvent welded or threaded. Solvent for welded joints shall conform to ASTM D 2564. Use of pipe dope or solvents on threaded joints will not be permitted. Polyethylene shall have compression joints.

5.3 Fittings and Specials.

5.3.1 For Galvanized Steel Pipe. Steel fittings shall be galvanized. Threaded fittings shall conform to ANSI B 16.3.

5.3.2 For Plastic Pipe. Fittings shall conform to ASTM D 2464 or D 2466.

5.4 Gate Valves shall be designed for a working pressure of not less than 150 psi. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of the opening. Valves smaller than 3 inches shall be all bronze and shall conform to Fed. Spec. WW-V-54, type I.

5.5 Backflow Prevention Units.

5.5.1 General. Backflow prevention units of the types indicated shall be installed at the locations shown on the drawings. Where union connections are not provided as part of the unit, the Contractor shall provide and install a union or sleeve type coupling between the control valve and the inlet side of the unit. Pipe and fittings for backflow prevention units shall be galvanized steel.

5.5.2 Reduced Pressure Backflow Prevention Unit. The reduced pressure backflow prevention unit shall be a factory assembled unit consisting of two independently acting spring-loaded check valves with a differential pressure relief valve controlled-reduced-pressure zone in between and shall be complete with test cocks and drain. The first check valve shall reduce the supply pressure a predetermined amount so that during normal flow and the cessation of normal flow the pressure between the checks is less than the supply pressure. The pressure differential relief valve shall automatically discharge to atmosphere to maintain the pressure in the reduced pressure zone below the supply pressure. All parts shall be removeable or replaceable without removal of the unit from the line. The unit shall be suitable for a working pressure of 125 pounds per square inch and shall be the product of a manufacturer regularly engaged in the production of backflow prevention units of the reduced pressure type.

5.6 Emitters. Emitters shall be independent pressure compensating plastic in-line emitters, capable of providing ~~a constant discharge rate of 1 gallon per~~

CONSTANT DISCHARGE RATES OF 0.48 (0.50) ONE (1) AND TWO (2) GALLONS PER HOUR (GPH), AS REQUIRED. THE EMITTER SHALL BE CONSTRUCTED OF FLAT, RESISTANT PLASTIC AND HAVE AN OPERATING RANGE OF 3 TO 60 POUNDS PER SQUARE INCH (PSI). EMITTERS SHALL BE SPACED 12 INCHES ON CENTER FOR GROUND COVER AND SHRUBS, AND A MAXIMUM OF 24 INCHES, SPACED EQUALLY, FOR TREES.

5.7 Remote Control Valves and Valve Accessories.

5.7.1 The remote control valves shall be an electrically actuated single-chamber hydraulic valve, ~~where the diaphragm is an integral part of the flow path.~~ The valve shall have no moving parts except the diaphragm and the spring. The valve shall have a removable chamber cover for easy inline maintenance. *THE VALVE BODY SHALL BE PLASTIC*

Materials: ~~body~~ - ~~Cast bronze ASTM 115-5A~~
~~diaphragm~~ - Natural and synthetic rubber to withstand all chemicals in common landscape and agricultural use.
~~spring~~ - Stainless steel SE 302.

The valve pressure rating shall be no less than 150 PSI.

The solenoid actuator shall be 24 volt A.C. 50/60 Hz, 3-way type with manual override and 150 PSI pressure rating. ~~Orifice size shall be no less than 0.063". Inrush and holding current shall be no more than 650 mA and 275 mA respectively. The solenoid actuator shall be a universal type, capable of functioning as normally open (N.O.) or normally closed (N.C.).~~

5.7.2 Quick Coupling Valves shall be two piece, spring-loaded, compression type, normally closed, opening against line pressure, and actuated by downward thrust against the valve. Body shall be of cast red bronze. Machined parts shall be fabricated from red brass. Valve washers and sealers for key stems shall be of a semi-rigid, non-metallic, material and shall be easily replaceable. Inlets shall be tapped for National Standard pipe thread of the pipe riser size or sizes shown on the drawings. Valves shall be suitable for a maximum operating pressure of 150 psi and shall be the standard product of a reputable manufacturer of quick coupling valves for lawn sprinkling systems. The Contractor shall furnish coupler keys for operating the valves with hose swivels. Rubber sleeves shall be the standard product of the manufacturer of quick coupling valves and when required they shall replace hinged cover as regularly furnished. Each sleeve shall have a cover.

5.8 Unions shall conform to the requirements of Fed. Spec. WW-U-531, Type B.

5.9 Automatic Controllers. Controllers shall be the product of a manufacturer regularly engaged in the production of turf sprinkler systems and shall be specifically designed for use on a drip system. Controllers shall be suitable for operation on the available electrical supply and shall be capable of complete automatic and manual operation. Control circuit voltage shall be less than 30 volts. Each controller shall have a master switch to disconnect controller from supply lines.

5.9.1 Housing. Where more than one controller is installed in an irrigation system a single key shall open all cabinets. Two keys for each system shall be furnished.

5.9.2 The irrigation system automatic controllers (field satellite) shall be Motorola MIR 5000F, minimum station capacity as indicated on the project plans, mounted in metal enclosures as specified, detailed and located on the project plans.

5.9.3 Charts. A chart, encased in plastic, showing clearly the areas serviced by each remote control valve shall be provided at each controller.

5.9.4 Electrical Work shall conform to the requirements of SECTION: ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Electrical wiring from controller to control valves shall be solid, single conductor, copper wire, type UF, size recommended by the controller manufacturer except that minimum wire size shall be No. 14. Common wire shall be different color from all others and be minimum wire size of No. 12. Regardless of the number of location of valves connected to a single controller station, separate control wires shall be run from the controller station to each valve. Wiring from controllers to panel shall be installed in rigid conduit.

5.10 Gravel shall be crushed or natural materials washed and uniformly graded between 3/8 and one-inch size.

5.11 Pipe Bedding and Backfill Materials. Sand bedding material not less than 2 inches thick shall be placed under pipe where trench excavation is in rock. Where sand bedding is not required, the bottom of trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on undisturbed soil at every point along its entire length. Backfill material shall be suitable for the required compaction and free from stones larger than one-inch in any dimension.

MAINLINE PRESSURE REGULATORS

5.12 ~~The pressure regulator~~ shall be multiple spring-loaded piston type, and shall maintain constant downstream pressure regardless of upstream fluctuations. Output pressure shall be determined by the type of springs that are being utilized. The different springs, for different output pressures, shall be color coded and field interchangeable. The pressure regulator shall be installed above ground and shall have a built-in indicator to show proper functioning, and removable caps for easy inline maintenance.

Materials Housing - Brass.
Caps - Chemical resistant plastic.
Pistons - Chemical resistant plastic.
Guides - Chemical resistant plastic.
Seals - Teflon.
Springs - Stainless steel.

The pressure regulator's pressure rating shall be no less than 150 PSI.

The pressure regulator shall have a device enabling the user to neutralize the regulator (for flushing purposes) without disassembling the unit.

5.13 Plastic Disk Filter shall be designed to permit cleaning without removal from the water supply line. The filter head is made of plastic or metal, while the parts subjected to high pressures are made of reinforced plastic. The filtering element is made of grooved plastic rings which are aligned to form a cylindrical body. The recommended working pressure shall be up to 10 atmospheres.

5.14 Enclosure box shall be a NEMA 4, 12 gauge steel, all welded enclosure 36"(W) x 18"(D) x 48"(H) in height, having a full-gasketed hinged door, 3-point dead bolt latch mechanism, padlockable handle, and integral mounting racks compatible with specified controller, power supply and ancillary equipment. The preferred box is manufactured by Cross Brothers, Inc. and is known as a La Max Enclosure, specifically the "Arizona Box" which has additional louvers.

5.15 The fertilizer injector shall be venturi-type injector with no moving parts, to be used inline or in parallel to a pressure differential source. The injector shall come with a 3/4 inch MIPT inlet and outlet, and shall have a built-in union joint for portability and easy maintenance. The injector shall be equipped with an inline strainer to protect the converging nozzle and a built-in vacuum indicator. The suction port of the injector shall consist of a suction flow control valve, a non return valve and a suction hose with a strainer at the fertilizer intake.

Materials	body	-	Fiberglass reinforced plastic.
	nozzle	-	Chemical resistant plastic.
	nozzle strainer	-	Chemical resistant plastic.
	nozzle seal	-	Viton
	flow control valve	-	Polypropylene body with Viton seal.
	non-return valve	-	Chemical resistant plastic with Viton seals and stainless steel spring.
	fert. intake strainer	-	Stainless steel.

5.16 To 5.18 SEE PAGE. ZI-9

6. INSTALLATION.

6.1 General. Unless otherwise specified, installation of emitters, backflow prevention units, control valves, meters and boxes shall conform to the standard details shown on drawing.

6.2 Handling. Pipe and accessories shall be handled so as to insure delivery to the trench in sound, undamaged condition. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material at no additional cost to the Government.

6.3 Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutters shall be used when practicable.

6.3.1 Plastic Pipe shall be cut square and all burrs, particles and curls shall be removed.

6.4 Placing and Laying. Pipe and accessories shall be carefully lowered in to the trench. Under no circumstances shall any of the materials be dropped or dumped into the trench. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until jointing is completed. When work is not in progress, open ends of pipe, fitting, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings.

6.4.1 Plastic Pipe shall be installed in accordance with the procedures recommended in ASTM D 2774 and as herein specified.

6.4.2 Tracer wire or tracer tape shall follow the main line pipe lines and terminate in the yard box with the gate valve that controls these main irrigation lines. Provide enough length of wire or tape to make a loop and attach a plastic label with the designation "Tracer Wire."

6.5 Jointing.

6.5.1 Galvanized Steel Pipe. Threaded joints shall be made tight with a stiff mixture of graphite and oil, inert filler and oil, or with an approved graphite compound, applied with a brush to the male threads only. Compounds shall not contain lead.

6.5.2 Insulation Joints shall be installed in accordance with recommendations of the manufacturer.

6.5.3 Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

6.6 Pipe Sleeves shall be installed with a minimum of off-set at the joints to permit easy installation and removal of the irrigation lines. All plastic lines shall be installed in sleeves under paved areas. Sleeves shall extend at least 12 inches beyond the edges of the pavement. Sizes of sleeves shall be as follows:

Pipe Size (inches)	Minimum Sleeve Size (inches)
1/2	2
3/4	2-1/2
1, 1-1/4 and 1-1/2	3
2 and 2-1/2	4
3 and 4	6

6.7 Setting of Valves, and Boxes. Valves and valve boxes shall be installed where shown or directed, and shall be set plumb. Valve boxes shall be centered on the valves. Valves shall be located outside the area of roads and streets. Earthfill shall be carefully tamped around each valve or meter box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face if less than 4 feet. Valves shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and the valve shall be inspected in open and closed positions to insure that all parts are in working condition.

6.8 Reaction Backing.

6.8.1 Thrust blocks shall be concrete mixed not leaner than one cement: 2-1/2 sand: 5 gravel. Blocks shall be placed between solid ground and the fitting to be anchored. The area of bearing shall be as indicated or as approved.

6.9 Remote Control Valves.

6.9.1 Install remote control valves in locations as shown on the drawings. Install a union on downstream side of all valves not provided with a union type connection. Fit with concrete valve box and cover. Top of valve box shall be 1/2-inch above finish grade.

5.16 Pipe straps shall conform to the applicable requirements of MSS SP 58 and SP 69.

5.17 Drip System Accessories.

5.17.1 Fillers shall be plastic "y" type 150 mesh or finer, with flush valve, at the sizes indicated on the drawings.

5.17.2 Regulators shall be plastic with an opening pressure between 10 to 80 psi and with an outlet pressure between 15 to 30 psi, as indicated on the drawings.

5.17.3 Self flushing end caps with concrete or plastic boxes with locking lids, shall be provided at dead ends of all lateral lines and drip tubing runs.

5.17.4 Holder stakes for pipe (tubing) are to be galvanized steel at least 14-1/2 inches in length (7 inches when bent double as a staple).

5.17.5 All drip system accessories including pipe (tubing) and emitters, shall be the product of a manufacturer regularly and continually engaged in manufacturing of drip irrigation products for at least the past 5 years, as approved by the Contracting Officer. Polyethelene tubing and emitters shall be manufactured for underground installation.

5.18 Valve Boxes (Valve and Drip System Components). All boxes shall be concrete or plastic and shall be installed only in location not subjected to vehicular traffic. Boxes shall be the standard product of the manufacturer of valve box equipment and shall have lockable metal covers. The boxes shall be of sufficient dimensions to allow easy maintenance and replacement of components. The boxes shall be of such length as will be adapted, without full extension, to the depth of cover required over the pipe at valve location.

6.10 Remote Control Wiring. Connections of wiring, other than in the controller housing, shall be made with epoxy encapsulated connectors. Where more than one wire is placed in a trench, the wiring shall be taped together at maximum intervals of 10 feet.

6.11 Automatic Sprinkler Controller. Controller shall be mounted on concrete with expansion shield type anchors or embedded anchor bolts. Connect electrical panel as shown on the drawings. Connection to control wiring shall be made within the pedestal or head of the controller. Electrical wiring shall be in a rigid conduit from controllers to panel provided under SECTION: ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. The work under this section shall include all wiring to the panels or elsewhere as required, in order to complete the installation of the control system.

7. TESTS.

7.1 After completion of the piping system and prior to backfilling and the installation of the sprinkler heads, the entire system shall be tested for leaks and thoroughly flushed under pressure to remove any dirt, scale or other material. Lines shall be tested at 100 psi for a minimum of one hour duration. Cracked or defective pipe, fittings, or accessories disclosed in the pressure tests shall be replaced by the Contractor with sound material at no additional cost to the Government, and the test shall be repeated until results are satisfactory to the Contracting Officer.

7.1.1 No line shall be covered until inspection and approval has been given by the Contracting Officer.

7.1.2 Testing of plastic pipe shall not be done until all joints have had at least 24 hours to set and cure. During cold weather, 48 hours elapsed time shall be allowed for setting prior to testing. No water under pressure shall come in contact with any joint during the specified curing period. In hot weather, water shall not be permitted to stand in pipes until after backfilling is completed. Water used in testing shall be drained from pipes after completion of testing.

7.2 Coverage Test. When the irrigation system is completed the entire system shall be adjusted and operated to demonstrate the water coverage is complete and adequate and that the system conforms to the requirements of the plans and specifications. All deficiencies and inadequacies resulting from defective or inadequate materials and/or workmanship shall be corrected at no additional cost to the Government. In the event any modifications to the system or deviation from the approved plans and specifications are directed, an adjustment in contract price will be made.

8. DISINFECTION. The completed line from the backflow prevention unit to the connection to the existing waterline shall be disinfected as prescribed by AWWA C 601.

9. TOOLS. Three sets of special wrenchs for removal and/or installation of sprinkler heads shall be provided at locations designated by the Contracting Officer.

10. CLEANUP. Upon completion of the installation of the irrigation system and appurtenances, all debris and surplus materials resulting from the work shall be removed.

11. VARIATION IN ARRANGEMENT OF SPRINKLERS from those shown on drawings will be permitted. The Contractor shall submit a shop drawing for approval in accordance with the SPECIAL CLAUSES. If any conflicts occur necessitating departures from the contract drawings, details of departures, hydraulic calculation and reasons shall be submitted as soon as practicable for written approval of the Contracting Officer. Hydraulic calculations shall include application rate per hour, maximum triangular spacing of heads for design flow rate and pressure, overlap including wind loss allowance and friction loss through pipe fittings, valves and accessories.

12. GUARANTEE. The following equipment to be furnished under this specification shall be guaranteed for a period of one year from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier, against defective materials, design, and workmanship:

Backflow prevention units
Quick coupling valves and keys

~~Water meters~~

Control valves

Automatic controller, AND RELATED EQUIPMENT

Emitters

Filters

Pressure regulators

FERTILIZER INJECTOR AND BERKELY PUMP

13. SUBMITTALS. Manufacturer's literature on the following materials shall be submitted for approval:

Backflow prevention units

Quick coupling valves and keys

Control valves

Automatic controller and enclosure

Pressure regulator

Filters

Fertilizer injector and Berkely Pump

14. CONNECTION TO EXISTING WATER LINES.

1.4.1 The Contractor shall make all necessary arrangements as specified in SECTION: GENERAL REQUIREMENTS. Water meters and taps to the City of Phoenix (COP) water mains shall be provided/installed by the city. Costs shall be paid by the Contractor. The Contractor shall install metal vault as per COP specifications. POC: Mr. Jerry Arakaki, COP.

2J
SECTION 2K

CONCRETE SIDEWALKS, AND CURBS, AND GUTTERS AND DRIVEWAY ENTRANCES

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

1.1 Federal Specification (Fed. Spec.).

SS-S-1401C

Sealing, Joint, Non-Jet-Fuel-Resistant, Hot Applied, for Portland Cement and Asphalt Pavements

1.2 American Association of State Highway and Transportation Officials (AASHTO) Publication.

M 182-60
(R 1974)

Burlap Cloth Made From Jute or Kenaf

1.3 American Society for Testing and Materials (ASTM) Standards.

C 94-84

Ready-Mixed Concrete

C 171-69
(R 1980)

Sheet Materials for Curing Concrete

C 173-78

Air Content of Freshly Mixed Concrete by the Volumetric Method

C 231-82

Air Content of Freshly Mixed Concrete by the Pressure Method

C 309-81

Liquid Membrane-Forming Compounds for Curing Concrete

D 1751-83

Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

D 1752-84

Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

2. **FIELD-CONTROL TESTS.** Preparation of field-control samples and testing of samples shall be by the Contractor at no additional cost to the Government. The taking of samples, the making of test specimens, and the testing thereof shall be performed under the supervision of the Contracting Officer.

3. **MATERIALS.** Materials shall conform to the respective publications and other requirements specified herein.

3.1 **Concrete Curing Materials.**

3.1.1 **Burlap.** AASHTO M 182 having a weight of 14 ounces or more per square yard when dry.

3.1.2 **Impervious Sheeting.** ASTM C 171.

3.1.3 **Liquid Membrane Curing Compound.** ASTM C 309 Type 1D. Compound shall be free of paraffin or petroleum.

3.2 **Concrete Protection Materials.** Linseed oil mixture shall be 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.

3.3 **Joint Materials.**

3.3.1 **Expansion Joint Fillers.** ASTM D 1751 or ASTM D 1752 or shall be resin impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

3.3.2 **Joint Sealers.** ASTM D 1850 or Fed. Spec. SS-S-1401.

4. **CONCRETE STRENGTH AND USAGE.**

4.1 **Sidewalk Concrete.** Concrete and materials therefore shall conform to the applicable requirements of SECTION: CONCRETE and ASTM C 94, Alternative No. 2 except as specified below. Concrete shall have a minimum compressive strength of 2,500 psi. The maximum size of aggregate shall be one inch. Concrete shall have a slump of not more than 3 inches. The concrete mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately as the concrete is placed in the forms, except in those situations in which concrete is placed by use of pumps. Where concrete is placed pumps, air content measurements will be taken in the forms after pumping. 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.

4.2 **Curb, ~~and~~ Gutter, ^{AND DRIVEWAY ENTRANCE} Concrete.** Concrete and the equipment, workmanship and materials therefor shall conform to the applicable requirements of SECTION: CONCRETE and ASTM C 94, except as specified below. Concrete shall have a minimum compressive strength of 3,000 psi. The maximum size of aggregate shall be 1-1/2 inches. Concrete shall have a slump of not more than 3 inches. The concrete

mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately as the concrete is placed in the forms, except in those situations in which concrete is placed by use of pumps. Where concrete is placed pumps, air content measurements will be taken in the forms after pumping.

4.3 Color. An integral color admixture shall be added to the concrete. The colors shall conform to the requirements of the SECTION: CONCRETE. Exceptions are as indicated on the drawings.

5. FORMS.

5.1 Sidewalk. Sidewalk forms shall be of wood or steel, straight of sufficient strength to resist springing during depositing and consolidating concrete, and of a height equal to the full depth of the finished sidewalk. Wood forms shall be surfaced plank, 2-inch nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet, with a minimum of three stakes per form, at maximum spacing of 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Radius bends may be formed with 3/4-inch 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. Form ends shall be interlocked and self-aligning. Forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Forms shall have a nominal length of 10 feet, with a minimum of two welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips, designed for use with steel forms.

5.2 Curb, ^{AND DEWEAK ENTRANCE} Gutter. Curb and gutter forms shall be of wood or steel, straight, and of sufficient strength to resist springing during depositing and consolidating the concrete. The 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. Straight forms of wood shall be surfaced plank, 2-inch nominal thickness, straight and free from warp, twist, loose knots, splits, or other defects. Wood forms shall have a nominal length of 10 feet, with a minimum of three stakes per form, at maximum spacing of 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Radius bends may be formed with 3/4-inch 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. Form ends shall be interlocked and self-aligning. Forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Forms shall have a nominal length of 10 feet, with minimum of two welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips, designed for use with steel forms. Rigid forms shall be provided for curb returns, except that benders of thin plank forms may be used for curb or curb returns with a radius of 10 feet 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 1-1/2 inch benders, for the full height of the curb, cleated together.

6. SUBGRADE PREPARATION. The subgrade shall be constructed to grade and cross section.

6.1 Sidewalk Subgrade. The subgrade shall be thoroughly wetted and then compacted with two passes of a 500-pound roller. Yielding material deflecting more than 1/2 inch under the specified roller shall be removed to a depth of not less than 4 inches below subgrade elevation and replaced with an approved granular material. The material shall then be compacted as described above. The completed subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

6.2 Curb, ^{AND DRIVEWAY ENTRANCE} and Gutter, Subgrade. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement and shall be placed and compacted to conform with applicable requirements of SECTION: FILLS AND SUBGRADE PREPARATION. The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter.

6.3 Maintenance of Subgrade. The subgrade shall be maintained in a smooth, compacted condition, in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected so as to produce a subgrade free from frost when the concrete is deposited.

7. FORM SETTING.

7.1 Sidewalk. Forms for sidewalks shall be set with the upper edge true to line and grade and shall be held rigidly in place by stakes placed at intervals not to exceed 4 feet. After forms are set, grade and alinement shall be checked with a 10-foot straightedge. Forms shall conform to line and grade with an allowable tolerance of 1/8 inch in any 10-foot long section. Forms shall have a transverse slope of 1/4 inch per foot with the low side adjacent to the roadway. Forms shall be 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. Side forms shall not be removed for less than 12 hours after finishing has been completed.

7.2 Curbs. Forms for curbs shall be carefully set to alinement and grade and to conform to the dimensions of the curb. Forms shall be held rigidly in place by the use of stakes placed at intervals not to exceed 4 feet. Clamps, spreaders, and braces shall be used where required to insure rigidity in the forms. The forms on 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. 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.

7.3 DRIVEWAY ENTRANCES.

8. CONCRETE PLACEMENT AND FINISHING.

8.1 Sidewalk Concrete. Concrete shall be placed in the forms in one layer of such thickness that when compacted and finished the sidewalk will 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 tamped and consolidated with a suitable wood or metal tamping bar, and the surface shall be finished to grade with a wood float. Finished surface of the walk shall not vary more than 3/16 inch from the testing edge of a 10 foot-straightedge. Irregularities exceeding the above shall be satisfactorily corrected. The surface shall be divided into rectangular areas by means of contraction joints spaced at not more than 5 feet on centers.

8.1.1 Concrete Finishing. After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished 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.

8.1.1.1 Colored and Textured Finish. Contractor shall submit installation procedures for colored concrete to the Contracting Officer for approval. Finishes shall conform to the requirements for Concrete Slab Finishes, and as specified herein. At locations indicated, on the drawings, the concrete will be colored with an integral color as described in the SECTION: CONCRETE. All sidewalk surfaces shall be given a rough texture by brooming with a fibre-bristle broom in a direction transverse to that of the main traffic flow. The rough texture finish shall also be applied to adjacent surfaces a sufficient distance in all directions to provide adequate texture for traction in turning areas.

8.1.2 Edge and Joint Finishing. All slab edges, including those at formed joints, shall be finished carefully with an edger having a radius of 1/8 inch. Transverse joints shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corner 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.

8.1.3 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 1/8-inch blade to the depth indicated. The time of sawing shall be varied, depending on existing and anticipated weather conditions, and such sawing shall be at the required rate. 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.

8.1.4 Expansion Joints. 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. Transverse expansion joints shall be filled with 1/2-inch joint filler strips. Joint filler shall be placed with top edge 1/4 inch 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 1/8 inch, and concrete over the joint filler shall be removed. Expansion joints shall be formed about structures and features that project

through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. The filler shall be installed in such manner as to form a complete, uniform separation between the structure and sidewalk pavement. At the end of the curing period, expansion joints shall be carefully cleaned and filled with joint sealer. Concrete at the joint shall be surface dry, and the atmospheric and pavement temperatures shall be above 50 degrees F. at the time of application of joint-sealing materials. Joints shall be filled flush with the concrete surface in such manner as to minimize spilling on the walk surface. Spilled sealing material shall be removed immediately and the surface of the walk cleaned. Dummy groove joints shall not be sealed.

8.1.5 Surface Uniformity. The completed surface shall be uniform in color and free of surface blemishes and tool marks.

8.2 Curb, ^{AND DRIVEWAY ENTRANCE} and Gutter, Concrete. Concrete shall be placed in layers not to exceed 6 inches. Concrete shall be thoroughly consolidated by tamping and spading or with approved mechanical vibrators.

8.2.1 Concrete Finishing. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 1/2-inch and the 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. 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 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. Except at grade changes or curves, finished surfaces shall not vary, from the testing edge of 10-foot straightedge, more than 1/8 inch for gutter and entrance and 1/4 inch for top and face of curb. Irregularities exceeding the above shall be satisfactorily corrected. Visible surfaces and edges of finished curb and gutter shall be free of blemishes and form and tool marks, and shall be uniform in color, shape, and appearance.

8.2.2 Joints. Expansion joints and contraction joints shall be constructed at right angles to the line of curb and gutter.

8.2.2.1 Contraction Joints. Contraction joints shall be constructed by means of 1/8-inch thick separators, of a section conforming to the cross section of the curb and gutter. Contraction joints shall be constructed directly opposite contraction joints in abutting portland-cement-concrete pavement. Where curb and gutter do not abut portland-cement-concrete pavements, contraction joints shall be so placed that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint. Separators shall be removed prior to finishing.

8.2.2.2 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 at the end of all returns. 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 1/2-inch in width shall be provided at intervals not exceeding 25 feet. Expansion joints shall be provided in non-reinforced concrete gutter at locations indicated.

9. CURING AND PROTECTION.

9.1 Curing. Immediately after the finishing operations, exposed concrete surfaces shall be cured by one of the following methods as the Contractor may elect.

9.1.1 Mat Method. The entire exposed surface shall be covered with two or more layers of burlap. Mats shall overlap each other at least 6 inches. 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.

9.1.2 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 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18 inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or by placing a bank of moist earth 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.

9.1.3 Membrane-Curing Method. The entire exposed surface shall be covered with a membrane-forming curing compound. Where type 1 curing compound is used, the concrete surface shall be shaded from the direct rays of the sun during the curing period. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet per gallon for 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. Apply an additional coat to all surfaces showing discontinuity, pinholes or other defects. Concrete surfaces that are subjected to heavy rainfall within 3 hours after curing compound has been applied shall be resprayed by the above method and at the above coverage at no additional cost to the Government. Expansion-joint openings shall be sealed at the top by inserting moistened paper or fiber rope or covering with strips of waterproof paper prior to application of the curing compound, in a manner to prevent the curing compound entering the joint. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected for 7 days from pedestrian and vehicular traffic and from any other action that might disrupt the continuity of the membrane. Any area covered with curing compound and damaged by subsequent construction operations within the 7-day curing period shall be resprayed as specified above at no additional expense to the Government.

9.2 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.

9.3 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.

10. SEALING JOINTS. The approximately horizontal sections of expansion joints and the top 1-inch depth of contraction-joint openings of gutter shall be sealed with joint sealer. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing shall be done so that the material will not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F. at the time of application of joint-sealing materials. Excess material on exposed surfaces of the concrete shall be removed immediately and exposed concrete surfaces cleaned.

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SECTION ~~2K~~

SIDE DRAINS AND ~~WATER LINES~~

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

1.1 Federal Specification (Fed. Specs.).

HH-P-117

Packing; Jute, Twisted

SS-S-210A

Sealing Compound, Preformed for
Expansion Joints and Pipe Joints

1.2 Federal Standard (Fed. Std.).

No. 601 and change
Notices 1 thru 7

Rubber: Sampling and Testing

1.3 American Association of State Highway and Transportation Officials (AASHTO) Publications.

Standard Specifications for Highway Bridges (1983) & Interim
Specifications (1984)

M 33-81

Preformed Expansion Joint Filler
for Concrete (Bituminous Type)

M 170-84I

Reinforced Concrete Culvert, Storm
Drain, and Sewer Pipe

M 198-75
(R 1982)

Joints for Circular Concrete Sewer
Culvert Pipe Using Flexible
Watertight Gaskets

M 199-84I

Precast Reinforced Concrete Manhole
Sections

1.4 American National Standards Institute (ANSI) Publications.

A 14.3-74

American National Standard Safety
Requirements for Fixed Ladders

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1.5 American Society for Testing and Materials (ASTM) Publications.

A 36-84a	Structural Steel
C 76-84a	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C 270-82	Mortar for Unit Masonry
C 443-79	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
C 478-84	Precast Reinforced Concrete Manhole Sections
D 1556-82	Density of Soil in Place by the Sand-Cone Method
D 1557-78	Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
D 1751-83	Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
D 1752-84	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

2. SUBMITTALS.

2.1 Manufacturers Recommendations. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Contracting Officer prior to installation. Installation of the item will not be allowed until the recommendations are received. Failure to furnish the recommendations can be cause for rejection of the material.

3. CERTIFICATION. Certified copies of test reports demonstrating conformance to applicable pipe specifications shall be delivered to the Contracting Officer before pipe is installed.

4. DELIVERY, STORAGE, AND HANDLING OF MATERIALS.

4.1 Delivery and Storage. Materials delivered to site shall be inspected for damage, unloaded, and stored with the minimum of handling. Do not store materials directly on the ground. Inside of pipes and fittings shall be kept free of dirt and debris.

4.2 Handling. Materials shall be handled in such a manner as to insure delivery to the trench in sound undamaged condition. Pipe shall be carried to the trench not dragged. Gasket materials and plastic materials that are not to be installed immediately shall not be stored in the direct sunlight.

5. PIPE FOR SIDE DRAINS AND STORM DRAINS shall be of the sizes indicated and shall be reinforced concrete pipe conforming to requirements for the following pertinent types. Reinforced Concrete Pipe. ASTM C 76 or AASHTO M 170, Class as indicated on the drawings.

6. DRAINAGE STRUCTURES.

JUNCTION STRUCTURES CATCA BASINS.

CAST IN PLACE

6.1 Manholes and Drop Inlets. Construction shall be ~~precast~~ reinforced concrete complete with frames and covers or gratings.

~~6.2 Walls and Headwalls. Construction shall be as indicated.~~

6.2 Ladders. Ladders shall be steel individual rung ladders in accordance to ANSI A14.3 or MAG Specs. Rungs shall be galvanized, solid-section rods imbedded into concrete as indicated on the drawings.

7. MATERIALS FOR DRAINAGE STRUCTURES.

7.1 Concrete. Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 3000 psi concrete under SECTION: CONCRETE. Expansion-joint filler material shall conform to ASTM D 1751, ASTM D 1752, or AASHTO M 33, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752. Color admixture shall be excluded for this item.

7.2 Mortar. Mortar for pipe joints ^{AND} connections to other drainage structures, ~~and brick or block construction~~ shall conform to ASTM C 270, Type M, except the maximum placement time shall be 1 hour. Color admixture shall be excluded for this item.

7.2.1 The quantity of water in the mixture shall be only that sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water.

7.2.2 The inside of the joint shall be wiped clean and finished smooth. In head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

~~7.3 Brick. Brick shall conform to ASTM C 62 or AASHTO M 114, Grade SW; ASTM C 55, Grade S-I or S-II; or ASTM C 32 or AASHTO M 91, Grade MS. 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 a quantity not more than 25 percent of the volume of cement. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.~~

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~~7.4 Precast Reinforced Concrete Manholes. Precast reinforced concrete manholes shall conform to ASTM C 478 or AASHTO M 199. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure.~~

7.5³ Frame and Cover or Gratings. Frame and cover or gratings shall be as shown on the drawings. Reinforced concrete shall conform to the requirements of SECTION: CONCRETE. Gratings shall be of the type and size as specified or shown on the drawings and shall be fabricated to accurately fit the supporting member. Openings shall be provided as shown on the drawings or as required. Steel gratings shall be galvanized after fabrication. Gratings shall be fabricated of steel conforming to ASTM A 36. Proof load test, test bars, and certification shall be provided for any component which must support a structural live load.

8. JOINTS FOR CONCRETE PIPE.

8.1 Cement-Mortar Bell-and-Spigot Joint. The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be carefully cleaned with a wet brush and the lower portion of the bell filled with mortar to such depth as to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into the bell so that sections are closely fitted. After each section is laid, remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. Cement mortar, finish, and protection of joints shall be as specified in paragraph MATERIALS FOR DRAINAGE STRUCTURES. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

8.2 Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe. A closely twisted gasket shall be made of jute or oakum in accordance to Fed. Spec. HH-P-117, of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket then shall be lapped at the top of the pipe and driven home in the annular space with a calking tool. The remainder of the annular space then shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheese-cloth. Placing of this type joint shall be kept at least five joints behind laying operations. The cement mortar, finish, and protection of joints shall be as specified in paragraph MATERIALS FOR DRAINAGE STRUCTURES.

8.3 Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe. The pipe shall be centered so that the annular space is uniform. The annular space shall be calked with jute or oakum. Before calking, the inside of the bell and outside of spigot shall be cleaned.

8.3.1 Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut into such lengths that they will extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 8 inches apart. Wires shall be cut into lengths to pass around pipe with sufficient extra length for ends to be twisted at top of pipe to hold band securely in place; bands shall be accurately centered around lower portion of joint.

8.3.2 Grout shall be poured between band and pipe from only the high side of band, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to insure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be carefully forced out by pouring and removed.

8.3.3 The remaining unfilled upper portion of the joint shall then be filled with mortar and a bead formed around outside of this upper portion of joint with sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved. The cement mortar, finish, and protection of joints shall be as specified in paragraph MATERIALS FOR DRAINAGE STRUCTURES.

8.3.4 The inside of the joint and the annular space shall be cleaned by brooming or other approved methods. The inside of the joint and the annular space shall then be dry packed so as to supply an unbroken flow line between adjacent pipe segments.

8.4 Cement-Mortar Tongue-and-Groove Joint: The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The groove end of the first pipe shall be carefully cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned carefully with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe then shall be inserted in the groove end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside. The cement mortar, finish, and protection of joints shall be as specified in the paragraph MATERIALS FOR DRAINAGE STRUCTURES.

8.5 Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe. The joint shall be of the type described for Cement-Mortar Tongue-and-Groove Joint, in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2-inch thick, and the width of the diaper band shall be at least 8 inches. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. No

backfilling around the joints shall be done until the joints have been fully inspected and approved. The cement mortar, finish, and protection of joints shall be as specified in the paragraph MATERIALS FOR DRAINAGE STRUCTURES.

8.6 Self-Centering Tongue and Groove Pipe. "Self-centering" tongue and groove pipe 36 inches or greater in diameter will not require outside grouting except where the pipe is used on curves or angle points. All joints shall be butted together. The overlap of the tongue and the groove portion of the joint shall not be less than 50 percent of the overlap measured from the manufacturer's designed full seat position. Material and layout drawings shall specify the maximum inside annular space that satisfies this specifications. Non-conforming joints shall require grouting or a concrete collar as determined by the Contracting Officer.

8.6.1 The annular space between pipe sections shall be completely filled with mortar and finished smooth with the inside pipe surface. All joints shall be cleaned with a wire brush and wetted before mortaring. Joints shall not be mortared before the next two joints in advance are laid. The entire depth of the finished inside joint shall be filled with mortar in such a manner as to insure a strong tight joint.

8.6.2 Tongue and groove joints will not be permitted for pipe under 36 inches in diameter.

8.7 Rubber Gasket Joint. Design of joints and physical requirements for rubber-type gaskets shall conform to ASTM C 443 or AASHTO M 198. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber gasket type are permitted if nominal diameter of pipe being gasketed exceeds 54 inches. Material conforming to Fed. Spec. SS-S-210 is acceptable as an alternate to ASTM C 443 provided the necessary installation instructions are furnished. Gaskets or jointing materials shall not swell more than 100 percent by volume by volume immersed in accordance with Method 6211 of Fed. Std. 601, in immersion medium No. 3 for 70 hours at 212 degrees F. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished if specifically approved. Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint, the gasket or jointing material becomes loose and can be seen through the exterior joint recess when joint is pulled up to within one inch of closure, the pipe shall be removed and the joint remade.

9. EXCAVATION AND TRENCHING FOR SIDE DRAINS AND STORM DRAINS. Excavation of trenches side drains, storm drains and appurtenances, ~~except for the 96-inch storm drain, the 42-inch and 12-inch water lines at 35th Avenue, the 12-inch water line at 39th Avenue and the 8-inch water line at 31st Avenue, shall be in accordance the following requirements. Excavation for the aforementioned storm drain and water lines shall be in accordance to the drawings.~~

9.1 Trenching. All excavations shall be made by open cut unless otherwise specified. The banks of trenches shall be kept as nearly vertical as practicable. Unless otherwise indicated, the banks of trenches below the level of the top of the pipe shall be not less than 12 inches wider nor more than 16 inches wider than the outside diameter of the pipe to be laid therein, and shall be excavated true to line, so that a clear space not less than 6 inches nor more than 8 inches in width is provided on each side of the pipe. The maximum width of trench specified applies to the width at any point below the top of the pipe; the width of the trench above the top of the pipe may be made as wide as necessary for sheathing and bracing; and the proper installation of the work. Care shall be taken not to overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures shall be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government. The bottom of trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for the proper sealing of pipe joints.

9.2 Removal of Unstable Material. Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in bottom of trench, such material shall be removed to depth required and replaced to the proper grade with selected material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, resulting material shall be excavated and replaced. Removal of unstable material shall be done at no additional cost of the Government.

9.3 Excavation for Drainage Structures. Excavation for ^{JUNCTION STRUCTURES AND} manholes, catch basins, ~~drop inlets or similar structures~~ shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as indicated on the drawings. Removal of unstable material shall be specified hereinbefore. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade shall not be made until just before the concrete or masonry is to be placed.

10. MATERIALS FOR BEDDING AND BACKFILLING.

10.1 General. Bedding for side drains shall consist of sand fill placed around the pipe in accordance with paragraph: BACKFILLING. Compacted fill above the ^{SAND FILL} bedding shall be placed in accordance with the paragraph: BACKFILLING. Material for the ^{SAND FILL} bedding for the side drain shall be clean sand, free of trash, organic materials, debris and with 100 percent passing No. 4 sieve and not more than 10 percent passing the No. 100 sieve.

Sand fill

10.2 Material for compacted fill above the bedding shall not contain any stone larger than 3/4 inch and may consist of sand, gravelly sands, silty sands and clayey sands. Organic material, trash debris, silt, sandy silt, clay, sandy clay, broken concrete or pavement and other objectionable material shall not be used.

Sand fill

11. BEDDING. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. Pipe shall be bedded carefully in a layer of bedding material accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe for the entire length of pipe. The layer of bedding material shall be at least 4 inches ~~except for the 96-inch storm drain, the 42-inch and 12-inch water lines at 35th Avenue, the 12-inch water line at 39th Avenue, and the 8-inch water line at 31st Avenue, which shall be in accordance with the drawings.~~ When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be only of such length, depth, and width as required for properly making the particular type of joint.

12. PLACING PIPE. Each pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and alinement indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe be laid in water; and no pipe shall be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. All pipe in place shall be inspected before backfilling, and those damaged during placement shall be removed and replaced at no additional cost to the Government. Laying shall proceed upgrade with spigot ends of bell-spigot pipe and tongue ends of tongue-and-groove pipe painting in the direction of flow.

13. BACKFILLING.

13.1 Backfilling Pipe in Trenches. After the bedding has been prepared and the pipe installed, ~~except for the 96-inch storm drain, the 42-inch and the 12-inch water lines at 35th Avenue, the 12-inch at 39th Avenue and the 8-inch water line at 31st Avenue,~~ sand fill material shall be placed along both sides of pipe in a single lift to the springing line (maximum horizontal dimension of a pipe). The sandfill shall be brought up evenly on both sides of pipe for the full length of pipe. Water shall be applied to the sand fill by jetting in a manner quantity, and at a rate sufficient to thoroughly saturate the entire lift. Vibrating compacting equipment shall be used to obtain not less than 90 percent of maximum density. Care shall be taken to insure thorough compaction of the sand fill under the haunches of the pipe. Above the springing line, the trench shall be filled with material conforming to paragraph: Materials for Bedding and Backfill. The completed fill material, shall be placed along both sides of pipe in layers not exceeding 4 inches in compacted depth of pipe at a moisture content that will facilitate compaction. The ~~completed~~ ^{compacted} fill shall be brought up evenly on both sides of pipe for the full length of pipe. Each layer shall be thoroughly compacted with mechanical tampers or vibrators to not less than 90 percent of maximum density. This method of filling and compacting shall continue until the fill has reached an elevation of at least 24 inches above the top of the pipe or to the bottom of the Aggregate Base Course. The remainder of the trench shall be backfilled and compacted by spreading and rolling parallel with the pipe in layers not exceeding 6 inches or by mechanical tampers or vibrators in layers not exceeding 6 inches compacted to 90 percent to maximum density. Where it is necessary in the opinion of the Contracting Officer, and sheeting and/or portions

of bracing used shall be left in place, and the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

13.1.1 ~~Backfilling Pipe Trenches for the 96-inch storm drain, the 42-inch and the 12-inch water lines at 35th Avenue, the 12-inch water line at 39th Avenue, and the 8-inch water line at 31st Avenue. For pipe placed in the trenches at 31st, 35th, and 39th Avenues, the backfill material shall be in accordance with the details of the drawings and the placement and compaction procedures shall be as specified hereinabove.~~

13.2 Backfilling Pipe in Fill Sections. For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified above. The fill material above the springing line shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 4 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or vibrating to obtain not less than 90 percent of maximum density. Prior to commencing normal filling operations, the crown width of the fill at a height of 24 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 24 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 6 inches.

13.3 Movement of Construction Machinery. In compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a ~~culvert or storm drain~~ at any stage of construction shall be at the Contractor's risk. Any pipe damaged thereby shall be repaired or replaced at no additional cost to the Government.

13.4 Backfilling for Drainage Structures. ^{THE JUNCTION STRUCTURE OR} After ~~manhole, catch basin, drop inlet or similar structure~~ has been constructed, backfill shall be placed in accordance to the requirements of paragraph: BACKFILLS of SECTION: FILLS AND SUBGRADE PREPARATION and as specified herein.

13.4.1 The structures shall not be damaged by the shock of falling earth and the backfill shall be placed in such a manner as to prevent eccentric loading and excessive stress on the structures. Any damaged structure ~~thereby~~ shall be repaired or replaced at no cost to the Government. ^{thereby}

13.5 Compaction.

13.5.1 Laboratory Control. The moisture-density relationships shall be determined in a laboratory in accordance with ASTM D 1557.

13.5.2 Field Control. Tests shall be well distributed and shall average not less than ^{one} ~~one~~ test for each 200 lineal feet of trench for each 2 feet or less of backfill. At least one test shall be made in each trench. Field in-place density shall be determined in accordance with ASTM D 1556.

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SECTION 2L

RIVER-RUN STONE PROTECTION

Index

1. Applicable Publications
2. Materials
3. Foundation Preparation and Stone Placement
4. Scales
5. Waybills and Delivery Tickets

1. **APPLICABLE PUBLICATIONS.** The American Society for Testing and Materials (ASTM) Standards listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

C 88-83	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 127-84	Specific Gravity and Absorption of Coarse Aggregate
C 295-85	Petrographic Examination of Aggregates for Concrete
C 535-81	Resistance to Abrasion of Large Size Coarse Aggregate by Use of the Los Angeles Machine
D 1141-75 (R 1980)	Substitute Ocean Water

2. MATERIALS.

2.1 Definitions.

~~a. Cobblestone. Stone which is obtained from alluvial deposits and is nearly spherical and well rounded, ranging from 6 to 12 inches in size.~~

a. Stone. Sound, durable, weather-resistant rock ^{SPHERICAL AND WELL ROUNDED (RIVER-RUN)} over ^{4 TO 12} 6 inches in diameter _{FROM} resulting from alluvial deposits.

2.2 Source and Material Approval. No stone shall be placed without prior written acceptance of stone from the source by the Contracting Officer. The Contractor shall make all arrangements, pay all royalties, and secure all permits for the procurement, furnishing and transporting of stone. The source(s) from which the Contractor proposes to obtain the material shall be selected and a sample submitted a minimum of 45 days in advance of the time when the material will be required in the work. Stone from a proposed source or sources will be tested by the Government for quality compliance. The Government will test one sample at its expense. If the stone sample fails the tests, or if the Contractor desires to utilize more than ^{one} ~~three~~ sources, additional testing will be accomplished by the Government for the sum of \$1600 for each additional sample tested. The costs of

such additional tests will be deducted from payment due the Contractor. All test samples (500 pounds minimum) shall be representative of the stone source and shall be obtained by the Contractor under the supervision of the Contracting Officer and delivered at the Contractor's expense to the South Pacific Division Laboratory, U.S. Army Engineer Division, South Pacific, Sausalito, California. The Contractor shall vary the quarrying, processing, loading and placing operations to secure the type and quality of stone protection specified. If the stone being furnished by the Contractor does not fully meet all the requirements of these specifications, the Contractor shall furnish, at no additional cost to the Government, other stone meeting the requirements of these specifications. Approval of a source shall not be construed as a waiver of the right of the Government to require the Contractor to furnish stone which complies with these specifications. Materials produced from localized areas, zones or strata will be rejected when such stone does not comply with the specifications.

2.2.1 It is anticipated that significant amounts of acceptable stone will not be available from the required excavation. The required stone will need to be obtained from offsite commercial sources. ~~It is also anticipated that acceptable stone from more than one source will need to be utilized to obtain the required quantity for the project.~~ If sufficient amounts of stone conforming to these specifications are not available from a source or sources used in the work, the Contractor shall submit stone from another source for approval.

Insert P 2.2.2 SEE Pg. 2L-3

2.3 Quality Compliance. Test results and/or service records will be used by the Contracting Officer to determine the acceptability of the stone protection materials. In the event complete or current compliance test reports and/or service records are not available, the material shall be subjected to the tests outlined in these specifications to determine its acceptability for use in the work. In the event stone is accepted based on service records, samples of the actual stone to be used for construction shall be taken and shall be subjected to the tests outlined in these specifications. Before a proposed source or sources of cobblestone will be considered for sampling and testing the Contractor must demonstrate that the gravel plant(s) has sufficiently stockpiled cobblestone and results of sufficient explorations must be made available to the Government to demonstrate that an adequate quantity of cobblestone is available to fulfill the contract requirements.

2.3.1 Service records are considered to be acceptable if stone from a proposed source has remained sound with no significant deterioration after 10 or more years of exposure.

2.4 Quality Compliance Tests for Stone Protection. Stone shall meet the following test requirements.

Test	Test Method	Requirement
Specific Gravity (Bulk SSD)	ASTM C 127	2.50 minimum
Absorption	ASTM C 127	2.0% maximum
Wetting & Drying	SPD Test Procedure ⁽¹⁾	No fracturing ⁽³⁾
Magnesium Sulfate	ASTM C 88 ⁽²⁾	10% max. loss
Abrasion Loss	ASTM C 535	50% max. loss

2.2.2 Potential Stone Sources. The Contractor may elect to obtain cobblestone materials from the following potential sources in the Phoenix metropolitan area which have either undergone recent quality compliance testing for use on Corps of Engineers projects or have acceptable service records:

Arizona Crushers, Inc. POC: Damon Defriates (602) 242-5143

Johnson-Stewart-Johnson POC: Dan James (602) 834-1044
(SALT RIVER)

Kilauea Crushers POC: Bill Nichols (602) 843-1888

Sunstate Rock and Materials POC: Larry Walker (602) 848-8911

Stone may be furnished from the sources listed above, or at the option of the Contractor, may be furnished from other sources designated by the Contractor and approved by the Contracting Officer subject to the conditions stated herein. Listing of a stone source is not to be construed as approval of all materials from the source, nor as a waiver of inspection and testing of a designated source. Stone produced from a listed potential source must meet all the requirements set forth in this section. Listing of a stone source is also not to be construed as an indication that an individual potential source can produce the total quantity of stone required for the project.

In addition to the above tests, the stone shall be subjected to a petrographic and X-ray diffraction analysis in accordance with ASTM C 295. The stone must not contain any swelling type clay (illite or montmorillonite).

NOTE: (1): Test procedure wetting-and-drying tests. The initial step of the test is the careful examination of the entire sample and the selection of representative test specimens. The piece should be large enough to produce two cut slabs, one inch thick ($\pm 1/4$ inch) with a minimum surface area of 30 square inches on one side. Two chunks approximately three by four inches are also chosen. The slabs and chunks are carefully examined under a low-power microscope and all visible surface features are noted and recorded. The specimens are then oven dried at 140 degrees F., for eight hours, cooled and weighed to the nearest tenth of a gram. The test specimens are photographed to show all surface features before the test. The chunks and slabs are then subjected to fifteen cycles of wetting and drying. One slab and one chunk are soaked in fresh tap water, the other slab and chunk are soaked in salt water prepared in accordance with ASTM D 1141. Each cycle consists of soaking for sixteen hours at room temperature and then drying in an oven for eight hours at 140 degrees F. After each cycle the specimens are examined with the low-power microscope to check for opening or movement of fractures, flaking along edges, swelling of clays, softening of rock surfaces, heaving of micaceous minerals, breakdown of matrix material and any other evidence of weakness developing in the rock. The cycle in which any of these action occurs is recorded. After fifteen cycles, the slabs and chunks are again carefully examined and all changes in the rocks are noted and recorded. The test specimens together with all flakes or particles which come off during the test are oven dried, weighed and photographed.

NOTE: (2): The test shall be made on 50 particles each weighing 100 grams, ± 25 grams, in lieu of the gradation given in C 88.

NOTE: (3): Weakening and loss of individual surface particles is permissible unless bond of the surface grains softens and causes general disintegration of the surface material.

2.4.1 Stone to be used in the work shall be of the same lithology as the stone sampled for testing and for which service records are provided as a basis for approval. All stone shall be rounded smooth cobble stone, and shall be sound, durable, hard, and free from laminations, weak cleavages or undesirable weathering. Stone shall be of such character that it will not disintegrate from the action of air, water, or the conditions of handling and placing. All stone shall be clean and free from earth, clay, refuse, and adherent coatings.

2.5 Gradation Sampling and Testing for Stone Protection performed by an approved testing laboratory on samples selected by the Contracting Officer. The Government reserves the right to perform check tests and to use the Contractor's sampling and testing facilities to make the tests. Each sample shall consist of not less than five tons of materials and shall be selected at random from the production run. One gradation test is required at the beginning of production prior to delivery of stone to the project and a minimum of one additional test for each (10,000) tons of material placed. All sampling and gradation tests performed by the Contractor shall be under the supervision of the Contracting Officer.

2.6 Gradation.

2.6.1 General. All points on individual grading curves shall be between the boundary limits as defined by smooth curves drawn through specified grading limits plotted on a mechanical analysis diagram. The individual grading curves shall not exhibit abrupt changes in slope denoting skip grading or scalping of certain sizes. Specified grading of all material shall be met both at the source and as delivered to the project. In addition, material not meeting the required grading due to segregation or degradation during placement shall be rejected. If best results show that stone does not meet the required grading, the hauling operation will be stopped immediately and will not resume until processing procedures are adjusted and a gradation test is completed showing gradation requirements are met. All gradation tests shall be at the expense of the Contractor.

2.6.2 Stone may be obtained from any source approved by the Contracting Officer and shall be reasonably well graded between 4 and 12 inches with not less than 40 nor more than 70 percent 6 inches in size. 4

3. FOUNDATION PREPARATION AND STONE PLACEMENT.

3.1 Prior to placing stone, the subgrade shall have been compacted in accordance with the requirements of SECTION: FILLS AND SUBGRADE PREPARATION, and shall be inspected, in sufficient time prior to each stone placement by the Contractor in order to certify to the Contracting Officer that it is ready to receive stone. The results of each inspection shall be reported in writing.

3.2 Stone shall be placed to produce a surface in which the tops of the individual stones have a tolerance of plus 2 inches to 0 inches from true grade. Double decking of the flat stones to bring the surface up to the required grade will not be permitted.

4. SCALES shall be standard truck scales of the beam type. The scales shall be of sufficient size and capacity to accommodate all trucks used in hauling the material. Scales shall be tested, approved, and sealed by an inspector of the State Inspection Bureau charged with scales inspection within the state in which the project is located. Scales shall be calibrated and resealed as often as necessary to insure continuous accuracy. The necessary number of standard weights for testing the scales shall be on hand at all times and, if an official inspection bureau of the state is not available, the scales will be tested by the Contracting Officer.

5. WAYBILLS AND DELIVERY TICKETS. Copies of waybills or delivery tickets shall be submitted to the Contracting Officer within 24 hours of delivery of stone. Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and/or certified delivery tickets for all stone actually used in the construction covered by the contract.

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SECTION 21
RIVER-RUN
GROUTED STONE PROTECTION
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- | | |
|----------------------------|--------------------------|
| 1. Applicable Publications | 4. Placing |
| 2. Materials | 5. Curing and Protection |
| 3. Mixing | 6. Test Panel |

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

1.1 American Society for Testing and Materials (ASTM), Publications.

C33-84 86	Concrete Aggregates
C150-84 85a	Portland Cement

1.2 U.S. Department of the Army, Corps of Engineers, Handbook for Concrete and Cement.

CRD-C 300-77	Membrane-Forming Compounds for Curing Concrete
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2. MATERIALS.

2.1 Aggregate shall conform to the requirements specified for fine aggregate of the SECTION: CONCRETE.

2.2 Portland Cement shall conform to the requirements of ASTM C150, Type II. The alkali content of the cement shall not exceed 0.6 percent.

2.3 Water shall be fresh, clean, and potable.

2.4 Color Admixture. The color admixture shall conform to the requirements of the color admixture specified in the SECTION: CONCRETE.

3. MIXING. Grout shall be composed of cement, sand, and water mixed in the proportions as directed. The Contractor shall add color admixture to all grout (except grout used in grouted stone toe below 2 feet vertically under the channel invert). Color of colored grout shall be considered satisfactory based on the comparative analysis of color produced from test panel(s) in accordance with the paragraph: TEST PANEL, and Munsell color samples in accordance with U.S. Department of Agriculture Handbook 18 - Soil Survey Manual. Color of test panel shall conform to Munsell color number 10YR 5/3 with respect to hue, value, and chroma. Evaluation of color shall be made within the time limits prescribed in paragraph: TEST PANEL. The estimated cement content requirement per cubic yard of grout shall be 7-1/2 sacks. The water content of the mix shall not exceed 8-1/2 gallons per sack of cement. In calculating total water content of the mix, the amount of moisture carried on the surfaces of aggregate particles shall be included. Slump of grout mix shall be between 9 and 10 inches for the first course and between 7 and 8 inches for the second course or where one course is

placed. The grout shall be mixed in a concrete mixer in the manner specified for concrete, except that time of mixing shall be as long as is required to produce a satisfactory mixture, and the grout shall be used in the work within a period of 30 minutes after mixing. Retempering of grout will not be permitted. The consistency of the grout shall be such as to permit gravity flow into the interstices of the stones with the help of spading, rodding, and brooming. Grout batches in the same course shall be uniform in mix, size, and consistency. The color admixture shall be batched in a manner that will assure that the admixture is completely and thoroughly mixed throughout the batch.

4. PLACING.

4.1 Prior to grouting, the stone shall be thoroughly washed with water to wash down the fines and to prevent absorption of water from the grout. The stone shall be kept wet just ahead of the actual placing of grout.

4.2 The grout shall be placed in one course in flat areas and in 2 courses in side slopes. Each course shall be placed full width or in successive lateral strips approximately 10 feet in width, as applicable, extending from toe of slope to top of side slopes. The grout shall be brought to the place of final deposit by approved means and discharged directly on the stone. A splash plate of metal or wood shall be used where necessary to prevent displacement of stone directly under discharge. The flow of grout shall be directed with brooms or other approved baffles to cover the entire area and to assure that all crevices are filled. Sufficient barring shall be done to loosen tight pockets of stone and otherwise aid the penetration of grout. The first course shall fully penetrate the stone blanket. The second course shall be placed as soon as the first course has sufficiently stiffened so that it will not flow when additional grout is added. On side slopes, all brooming shall be uphill.

4.3 Placement and brooming of the grouted surface shall be such that the outer layer of rock projects $\frac{1}{3}$ to $\frac{1}{4}$ their diameter above the grouted surface. After the top course has stiffened the entire surface shall be rebroomed to eliminate runs in the top course and to fill voids caused by sloughing of the layers of grout.

4.4 All surfaces of grouted stone, above the embedment depth specified, shall be cleaned by air-water blasting, sandblasting or a combination thereof.

4.4.1 Air-water Blasting.

4.4.1.1 Equipment used for air-water blasting shall be capable of producing a minimum pressure of 150 psi and shall be of such nature as to adequately perform the work required.

4.4.1.2 The grout will be allowed to set for a minimum of one hour, or other length of time as direct by the Contracting Officer before air-water blasting is commenced. The air-water blasting shall be at right angles to the surface of the grout.

4.4.2 Sandblasting. All grouted stone surfaces to which grout has been applied and cannot be cleaned adequately by air-water blasting will be sandblasted, in order to remove grout paste remaining on the surface. Sandblasting will not commence at least 14 days after placement of the grout.

4.5 After completion of any strip or panel, to include cleaning, no workmen or other load shall be permitted on the grouted surface for a period of 24 hours. The grouted surface shall be protected from injurious action of the sun; shall be protected from rain, flowing water, and mechanical injury; and shall be moist cured or membrane cured at the Contractor's option.

4.6 Test Panel. The Government has prepared a sample panel of approximately 10 feet by 10 feet. The panel has been prepared to a full depth of stone to be used in the grouted stone. The approved sample panel will be used for quality control of the application of grouted stone for the contract. The approved sample panel can be viewed at the Maricopa County Resident Office located at 9601 N. 21st Drive, Phoenix, Arizona. The sample panel will remain for observation and conformance evaluation of placement during construction.

5. CURING AND PROTECTION.

5.1 Moist curing shall consist of covering the grout with a uniform thickness of 2 inches of sand which shall be kept continuously saturated for a period of 14 days.

5.2 Curing compounds shall be applied as soon as the free water disappears and shall be applied in a 2-coat continuous operation by approved power-spraying equipment at a rate of not to exceed 200 square feet per gallon for the combined coats. The second coat shall be applied to overlap the first coat in a direction approximately at right angles to the direction of the first application.

5.2.1 Membrane curing compound shall be a non-pigmented curing compound conforming to Corps of Engineers Serial No. CRD-C 300 except that the compound shall contain a fugitive dye. All concrete cured with non-pigmented curing compound shall be shaded from the direct rays of the sun for the first 7 days of the curing period.

6. TEST PANEL. The Contractor shall place a test panel for colored grout with a dimension of 20 feet by 20 feet by 12 inches thick. The test panel shall be placed in the presence of the Contracting Officer, and the stone and grout mix design shall conform in all respects to those proposed for use in the project. The grouted stone shall be finished, protected, and cured on a 2H to 1V slope on the site of proposed construction using methods proposed for use by the Contractor on the features of the project which shall receive colored grout. The test panel shall not be protected from the effects of the sun while curing. Color comparisons as a basis for acceptance of color shall not be made in less than 17 days after placement of grout for the test panel. Wetting of the grouted stone shall not be permitted within a period of 3 days prior to making color comparisons. No grouting of stone shall be scheduled for placement within 30 days of construction of test panel, and no grout shall be placed prior to demonstrating compliance with finishing and color requirements herein. In the event that the test panel color does not conform to the color requirements of these specifications, the Contractor shall be required to place additional test panels for grout similar to the panels required for concrete under the SECTION: CONCRETE until a final mix design has been approved which supplies colored grout conforming to the requirements specified above. Approval of test panel color and mix design shall not relieve the Contractor of the requirements of these specifications. The Contractor shall not remove the test panel until all grouting stone work has been completed. At completion of grouting stone work, the test panel shall be considered scrap materials.

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CIVIL WORKS CONSTRUCTION
GUIDE SPECIFICATION

FOR
STEEL SHEET PILING

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SECTION 2 N
STEEL SHEET PILING

1. SCOPE. The work covered by this section consists of furnishing all plant, equipment, labor and materials ~~(except materials specified to be furnished by the Government)~~ and performing all operations in connection with the installation ~~(and removal)~~ of steel sheet piling in accordance with these specifications and applicable drawings.

2. RELATED WORK SPECIFIED ELSEWHERE. Section 5 , METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS.

3. APPLICABLE PUBLICATIONS. The following American Society for Testing and Materials (ASTM) standards of the issues listed below and referred to thereafter by basic designation only form a part of this specification to the extent indicated by the references thereto:

- | | |
|-------------------|--|
| A 36- <u>84a</u> | Structural Steel |
| *A 307- <u>84</u> | Carbon Steel Externally Threaded Standard Fasteners |
| *A 325- <u>84</u> | High-Strength Bolts for Structural Steel Joints |
| *A 328- <u>84</u> | Steel Sheet Piling |
| *A 490- <u>84</u> | Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints |
| A 502- <u>83a</u> | Steel Structural Rivets |
| A 514- <u>84a</u> | High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding |
| *A 572- <u>84</u> | High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality |
| A 588- <u>84a</u> | High-Strength Low-Alloy Structural Steel with 50 ksi [345 MPa] Minimum Yield Point to 4 in. [100 mm] Thick |

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- *A 90- ~~51~~ High-Strength Low-Alloy Steel H-Piles and Sheet Piling for Use in Marine Environments
- *A 857- ~~---~~ Steel Sheet Piling, Cold-Formed, Light Gage

4. QUALITY ASSURANCE. Requirements for material tests, workmanship and other measures for quality assurance shall be as specified herein and in Section 5 ____, METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS.

4.1 Materials Tests. Sheet piling and appurtenant materials shall be tested and certified by the manufacturer to meet the specified chemical, mechanical and section property requirements prior to delivery to the site.

4.2 Interlock Tension Strength Test. The interlock tension strength test shall conform generally to the piling manufacturer's standard test, include testing at least two 3-inch long coupons taken randomly from different as-produced pilings of each heat and must be approved by the Contracting Officer.

5. SUBMITTALS. The Contractor shall submit descriptions of sheet piling driving equipment, shop drawings, test procedures, test reports and certificates, sheet piling driving records and other required submittals to the Contracting Officer for approval as required. Submittals and associated work not satisfactory to the Contracting Officer will be rejected.

5.1 Equipment Descriptions. Complete descriptions of sheet piling driving equipment including hammers, ~~(jetting equipment,)~~ extractors, protection caps and other installation appurtenances shall be submitted for approval prior to commencement of work.

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5.2 Shop Drawings. Shop drawings for sheet piling including fabricated sections shall show complete dimensions and details of piling and the driving sequence and location of piling. Shop drawings shall include details and dimensions of templates and other temporary guide structures for installing the piling. Shop drawings shall provide details of the method of handling piling to prevent permanent deflection, distortion or damage to piling interlocks.

5.3 Materials Test Certificates shall be submitted for each shipment and identified with specific lots prior to installing piling. Identification data should include piling type, dimensions, chemical composition, mechanical properties, section properties, heat number and mill identification mark.

5.4 Interlock Tension Strength Test Procedure. The procedure for testing the tension strength of piling interlocks as required herein 4.2 must be submitted and approved prior to testing sheet piling.

5.5 Driving Records. Records of the sheet piling driving operations shall be submitted after driving is completed. These records shall provide a system of identification which shows the disposition of approved piling in the work, driving equipment performance data, piling penetration rate data, piling dimensions and top and bottom elevations. *(The format for driving records shall be as directed by the Contracting Officer.)

6. DELIVERY, STORAGE AND HANDLING. Materials delivered to the site shall be in a new and undamaged condition and shall be accompanied by certified test reports. The manufacturer's logo and mill identification mark shall be provided on the sheet piling as required by the referenced specifications.

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Sheet piling shall be stored and handled in the manner recommended by the manufacturer to prevent permanent deflection, distortion or damage to the interlocks. Storage of sheet piling should also facilitate required inspection activities. ~~*(Sheet piling over 80 feet in length shall be handled using a minimum of two pickup points.)~~

7. MATERIALS.

7.1. Steel Sheet Piling. Steel sheet piling shall be of the type and meet the requirements specified herein and shown on the drawings. ~~(Light gage sheet piling shall conform to ASTM A 857, Grade _____.)~~ Heavy gage hot-rolled sheet piling shall conform to ASTM ~~(A 328) (A 690)~~ A 572, Grade 50. ~~Type _____~~. ~~*(Heavy gage cold formed sheet piling shall be formed from hot-rolled steel meeting the chemical and mechanical requirements of ASTM (A 328) (A 690) (A 572, Grade _____, Type _____.)~~ The minimum section properties of sheet piling shall be as shown on the drawings. The interlocks of sheet piling shall be free-sliding, allow a swing angle of at least 5 degrees when threaded and maintain continuous interlocking when installed. Sheet piling ~~(including special fabricated sections)~~ shall be ~~(full length)~~ ^{STET} sections of the dimensions shown on the drawings. ~~*(Fabricated sections shall conform to the requirements herein and the piling manufacturer's recommendations for fabricated sections.)~~ ~~*(Fabricated sections connecting cofferdam cells and adjacent arcs composed of pilings from different manufacturers shall be Y-sections fabricated from the respective manufacturer's pilings.)~~ ~~*(Fabricated tees, wyes and cross pieces shall be fabricated of piling sections with a minimum web thickness of 1/2 inch. *(Sheet piling to be placed in a circular cell or a connecting arc shall be of the same~~

~~IF ITS NOT TO BE REMOVED - THIS ISNT NECESSARY~~
manufacture.) Sheet piling shall be provided with standard pulling holes

Metalwork fabrication for sheet piling sections shall conform to the requirements of Section 5, METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS.

NOTE 1: LIGHT GAGE SHEET PILING SHOULD BE USED FOR PILING WITH A REQUIRED MINIMUM THICKNESS OF 0.250 IN. OR LESS, LOW BENDING AND CORROSION RESISTANCES AND MINIMAL DESIGN INTERLOCK TENSION STRENGTH. THE CORROSION RESISTANCE OF LIGHT GAGE SHEET PILING CAN BE INCREASED BY APPLYING A PROTECTIVE COATING.

NOTE 2: HEAVY GAGE HOT-ROLLED STEEL SHEET PILING ONLY SHOULD BE USED FOR APPLICATIONS OF WHICH INTERLOCK TENSION STRENGTH AND SECTION STABILITY ARE PRIMARY DESIGN REQUIREMENTS. SECTION STABILITY (BIAXIAL STRESS) IS A CONSIDERATION IN HIGHLY STRESSED APPLICATIONS ONLY.

NOTE 3: HEAVY GAGE COLD-FORMED STEEL SHEET PILING SHOULD BE USED AS AN OPTION TO HEAVY GAGE HOT-ROLLED STEEL SHEET PILING FOR APPLICATIONS OF WHICH INTERLOCK TENSION STRENGTH AND SECTION STABILITY ARE NOT PRIMARY DESIGN REQUIREMENTS.

NOTE 4: FOR APPLICATIONS IN SALT OR BRACKISH WATER USE THE MOST ECONOMICAL OF A 690 STEEL SHEET PILING WHICH OFFERS GREATER CORROSION RESISTANCE OR A 328 STEEL SHEET PILING WITH A PROTECTIVE COATING IN THE SPLASH ZONE. A PROTECTIVE COATING SHOULD BE APPLIED TO A 690 SHEET PILING IN THE SPLASH ZONE OF WATERWAY BULKHEADS LOCATED IN SALT OR BRACKISH WATER.

NOTE 5: CONSIDERATION SHOULD BE GIVEN IN DESIGN TO THE USE OF A 572 HIGH-STRENGTH STEEL SHEET PILING WHERE ECONOMICAL. IN FLOODWALL APPLICATIONS THE ALLOWABLE WORKING STRESS SHOULD NOT EXCEED 0.5 OF THE YIELD STRENGTH OF THE STEEL. IN OTHER APPLICATIONS THE ALLOWABLE WORKING STRESS SHOULD NOT EXCEED 0.6 OF THE YIELD STRENGTH OF THE STEEL.

NOTE 6: THE FOLLOWING TABLES LIST SECTION PROPERTIES OF COMMERCIALY AVAILABLE SHEET PILING. BASED UPON THE DESIGN REQUIREMENTS FOR EACH PILING SECTION SELECT THE MOST SUITABLE CORRESPONDING SECTION FROM THESE TABLES OR OTHER COMMERCIAL SOURCES AND PLACE THE PERTINENT SECTION PROPERTIES OF THIS SECTION ON THE DRAWINGS AS MINIMUM REQUIREMENTS.

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HEAVY GAGE HOT-ROLLED SECTIONS

SECTION	NOMINAL WEB THICKNESS (IN)	SECTION MODULUS PER LIN FT OF WALL (IN ³)	WEIGHT PER SQ FT OF WALL (LBS)	WEIGHT PER LIN FT OF PILING (LBS)	MINIMUM INTERLOCK STRENGTH IN TENSION (LBS PER LIN IN)
PZ 22	0.375	18.1	22.0	40.3	
PZ 27	0.375	30.2	27.0	40.5	
PZ 35	0.50	48.5	35.0	66.0	
PZ 40	0.50	60.7	40.0	65.6	
PSA 23	0.375	2.4	23.0	30.7	12,000
PS 27.5	0.40	2.0	27.5	45.1	16,000
PS 31	0.50	2.0	31.0	50.9	16,000

HEAVY GAGE COLD-FORMED SECTIONS

SECTION	NOMINAL THICKNESS (IN)	SECTION MODULUS PER LIN FT OF WALL (IN ³)	WEIGHT PER SQ FT OF WALL (LBS)	WEIGHT PER LIN FT OF PILING (LBS)
Z	0.315	15.53	19.46	35.15
Z	0.335	31.60	23.40	46.80
Z	0.355	33.48	24.78	49.60
Z	0.375	35.34	26.22	52.28
Z	0.413	39.06	28.88	57.92
U	0.256	11.16	16.18	26.54
U	0.315	13.28	19.46	31.92
U	0.375	15.80	23.15	38.05

LIGHT GAGE SECTIONS

GAGE	NOMINAL THICKNESS (IN)	LAYING WIDTH (IN)	SECTION MODULUS PER LIN FT OF WALL (IN ³)	WEIGHT PER SQ FT OF WALL (LBS)	WEIGHT PER LIN FT OF PILING (LBS)
12	0.1046	18.00	1.65	5.60	8.40
12	0.1046	19.67	1.71	6.00	9.90
10	0.1345	15.00	1.82	10.40	10.40
10	0.1345	18.00	2.20	7.20	10.80
10	0.1345	19.67	2.20	7.60	12.50
8	0.1644	15.00	1.31	10.25	12.80
8	0.1644	16.00	2.59	10.00	13.00
8	0.1644	18.00	2.60	8.80	13.20

~~2N-8~~
2N-8

8	0.1644	19.00	2.60	8.70	13.80
8	0.1644	19.67	2.65	9.30	15.20
7	0.1793	18.00	2.60	9.20	13.61
7	0.1793	18.00	2.67	9.60	14.40
7	0.1793	16.00	2.82	10.90	14.50
7	0.1793	19.67	2.87	10.00	16.40
5	0.2093	14.37	2.72	11.10	13.20
5	0.2093	16.00	3.26	12.71	16.90
5	0.2093	19.67	3.36	11.60	19.10
3	0.2391	16.00	3.69	14.54	19.40
3	0.2391	19.00	4.00	12.60	20.00

NOTE 1: Z-SECTIONS AND X-SECTIONS ARE PARTICULARLY ADAPTED TO CANTILEVER AND ANCHORED TYPE RETAINING WALLS IN THAT THEY DEVELOP A MAXIMUM RESISTANCE TO BENDING PER UNIT WEIGHT.

NOTE 2. SHALLOW-ARCH (SA) SECTIONS ARE MULTIPLE PURPOSE SECTIONS WHICH HAVE SOME RESISTANCE TO BENDING AND CONSIDERABLE INTERLOCK FLEXIBILITY AND TIGHTNESS.

NOTE 3: STRAIGHT-WEB (S) SECTIONS HAVE THEIR INTERLOCKS DESIGNED FOR MAXIMUM FLEXIBILITY AND TENSILE STRENGTH AND ARE PARTICULARLY ADAPTED TO CELLULAR RETAINING WALLS AND CELLULAR COFFERDAM CONSTRUCTION.

7.2 Steel Plates. Structural steel plates for splices and other fabrication appurtenances shall conform to ASTM *(A 36), (A 514, Grade ___) (A 572, Grade ___, Type ___) (A 588, Grade ___).

7.3 Rivets. ASTM A 502, Grade ___.

7.4 Bolts, Nuts and Washers. ASTM *(A 307, Grade ___) (A 325, Type ___ or A 490, Type ___).

8. INSTALLATION.

8.1 Piling Driving Equipment.

8.1.1 Driving Hammers. Hammers shall be steam, air, or diesel drop, single-acting, double-acting, differential-acting *(, or vibratory) type. The driving energy of the hammers shall be between 8,750 and 16,000 foot-pounds as recommended by the manufacturer for the piling weights and subsurface materials to be encountered.

NOTE. INSERT DESIRED ENERGY RATINGS IN PARAGRAPH 8.1.1 ABOVE. HAMMERS WITH ENERGY RATINGS BETWEEN 8,750 AND 16,000 FOOT-POUNDS ARE RECOMMENDED.

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*8.1.2 Jetting Equipment shall have not less than two removable or fixed jets of the water or combination air-water type. Water jets shall be designed so that the discharge volume and pressure are sufficient to freely erode the material under and adjacent to the piling.

8.2 Placing and Driving.

8.2.1 Placing. Any excavation required within the area where sheet pilings are to be installed shall be completed prior to placing sheet pilings. ~~*(Pilings to be placed in cofferdam cells and connecting arcs shall be picked up and completely threaded to demonstrate that they slide freely in interlock.)~~ Pilings shall be carefully located as ~~shown on the drawings~~ (as directed by the contractor). Pilings shall be placed plumb with out-of-plumbness not exceeding 1/8 inch per foot of length and as true to line as possible. Temporary wales, templates, ~~*(master pilings,)~~ (current deflectors) or guide structures shall be provided to insure that the pilings are placed and driven to the correct alignment. At least two templates shall be used in placing each piling and the maximum spacing of templates shall not exceed 20 feet. ~~*(Master pilings shall be used to maintain plumbness and proper configuration in placing cofferdam cells over 90 feet in height in water flowing at a velocity of more than four feet per second.)~~ Pilings properly placed and driven shall be interlocked throughout their length with adjacent pilings to form a continuous diaphragm throughout the length or run of piling wall.

8.2.2 Driving. ~~*(Prior to driving pilings in water a horizontal line shall be painted on both sides of each piling at a fixed distance from the~~

bottom so that it will be visible above the water line after installation. This line will indicate the profile of the bottom or tip elevation of installed pilings and potential problem areas will be identified by abrupt changes in its elevation.) Pilings shall be driven with the proper size hammer and by approved methods so as not to subject the pilings to damage and to insure proper interlocking throughout their lengths. Driving hammers shall be maintained in proper alignment during driving operations by use of leads or guides attached to the hammer. ~~(~~Caution should be taken in the sustained use of vibratory hammers when a hard driving condition is encountered to avoid interlock melt or damages. The use of vibratory hammers should be discontinued and impact hammers employed when the penetration rate due to vibratory loading is one foot or less per minute.) A protecting cap shall be employed in driving when using impact hammers to prevent damage to the tops of pilings. Pilings damaged during driving or driven out of interlock shall be removed and replaced at the Contractor's expense. ~~(Government furnished pilings damaged during driving shall be stored at the site as directed.)~~ Pilings shall be driven without the aid of a water jet ~~*(unless otherwise authorized).~~ ~~*(Authorized jetting shall be performed on both sides of the pilings simultaneously and must be discontinued at least feet before final seating of pilings.)~~ Adequate precautions shall be taken to insure that pilings are driven plumb. If at any time the forward or leading edge of the piling wall is found to be out of plumb in the plane of the wall the partly driven pilings shall be driven to full depth and tapered pilings shall be provided and driven to interlock with the out of plumb

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leading edge or other approved corrective measures shall be taken to insure the plumbness of succeeding pilings. The maximum permissible taper for any tapered piling will be 1/8 inch per foot of length. Pilings in each run or continuous length of piling wall shall be driven alternately in increments of depth to the required depth or elevation. No piling shall be driven to a lower elevation than those behind it in the same run except when the pilings behind it cannot be driven deeper. ~~*(For cofferdam cells the driving increments shall be such that no piling loads the adjacent piling by more than ___ feet and the direction of advancing the driving hammer shall be reversed after each pass around the cell.)*~~ If the piling next to the one being driven tends to follow below final elevation it may be pinned to the next adjacent piling. Should obstructions restrict driving a piling to the specified penetration the obstructions should be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical the Contractor shall make changes in the design alignment of the piling structure as directed by the Contracting Officer to insure the adequacy and stability of the structure. Pilings shall be driven to depths shown on the drawings and shall extend up to the elevation indicated on the drawings for the top of pilings. ~~*(Piling driven to rock shall be seated individually on the rock.)*~~ A tolerance of ___ inches above the indicated top elevation will be permitted. ~~*(The first sheet piling of connecting areas shall be threaded through the wyes in cofferdam cells prior to filling the cells.)*~~ Pilings shall not be driven within 100 feet of concrete less than 7 days old.

8.3 Cutting and Splicing. Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the

required top elevation in excess of the specified tolerance shall be cut off to the required elevation. Pilings driven below the required top elevation and pilings damaged by driving and cut off to permit further driving shall be extended as required to reach the top elevation by splicing when directed by the Contracting Officer at no additional cost to the Government. ~~§~~If directed by the Contracting Officer pilings shall be spliced as required to drive them to depths greater than shown on the drawings and extend them up to the required top elevation~~§~~. Pilings adjoining spliced pilings shall be full length unless otherwise approved. ~~§~~If splices are allowed in adjoining pilings the splices must be spaced at least __ feet apart in elevation~~§~~. ~~Splicing of pilings shall be as indicated on the drawings. Welding of splices shall conform to the requirements of Section 5 __, METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS. Ends of pilings to be spliced shall be squared before splicing to eliminate dips or camber. Pilings shall be spliced together with concentric alignment of the interlocks so that there are no discontinuities, dips or camber at the abutting interlocks. Spliced pilings shall be free sliding and able to obtain the maximum swing with contiguous pilings. The tops of pilings excessively battered during driving shall be trimmed when directed at no cost to the Government. Piling cut-offs *(except for Government furnished pilings) shall become the property of the Contractor and shall be removed from the site. The Contractor shall cut holes in pilings for bolts, rods, drains or utilities as shown on the drawings or as directed. All cutting shall be done in a neat and workmanlike manner. A straight edge shall be used in cuts made by burning to avoid abrupt nicks. Bolt holes shall be drilled or may be burned and reamed by approved methods~~

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which will not damage the surrounding metal. Holes other than bolt holes shall be reasonably smooth and the proper size for rods or other items to be inserted. ~~*(All holes in pilings on the wet side of cofferdams shall be made watertight by welding steel plates over the holes after the piling installation is completed.)~~

8.4 Inspection of Driven Piling. The Contractor shall inspect the interlocks of the portion of driven pilings that extend above ground. Pilings found to be out of interlock shall be removed and replaced at the Contractor's expense. ~~*(The Contractor shall use divers to inspect the underwater portions of cofferdam sheet piling interlocks. Government divers may also inspect the interlocks. The inspection of cofferdams shall be performed after driving is completed, prior to filling each cell and connecting arc and within 48 hours after filling each cell and arc.)~~

8.5 Pulling and Redriving. The Contractor may be required to pull selected pilings after driving to determine the condition of the underground portions of pilings. The method of pulling pilings must be approved by the Contracting Officer. Any piling so pulled and found to be damaged to the extent that its usefulness in the structure is impaired shall be removed and replaced at the Contractor's expense. Pilings pulled and found to be in satisfactory condition shall be redriven. ~~*(Government furnished pilings pulled and not redriven shall be stored at the location and in the manner directed by the Contracting Officer.)~~

~~*9 REMOVAL. The removal of sheet pilings shall consist of pulling, sorting, cleaning the interlocks, inventoring and storing previously~~

~~installed sheet pilings as shown on the drawings and directed by the Contracting Officer.~~

~~*9.1 Pulling. The method of pulling piling must be approved by the Contracting Officer. Pulling holes shall be provided in pilings as required. Extractors shall be of suitable type and size. Care shall be exercised during pulling of pilings to avoid damaging the interlocks and adjacent work. If the Contracting Officer determine that permanent work has been damaged during pulling the Contractor will be required to repair this work at no cost to the Government. Pilings shall be pulled one sheet at a time. Pilings fused together shall be separated prior to pulling unless the Contractor demonstrates to the satisfaction of the Contracting Officer that the pilings cannot be separated. The Contractor will not be paid for the removal of pilings damaged beyond structural use due to care not being exercised during pulling.~~

~~*9.2 Sorting, Cleaning, Inventorying, and Storing. Pulled pilings shall be sorted, cleaned, inventoried and stored by type into groups as (1) piling usable without reconditioning, (2) piling requiring reconditioning and (3) piling damaged beyond structural use.~~

10. QUANTITIES. The estimated quantities of sheet piling listed in the unit price schedule of the contract as to be furnished by the Contractor are given for bidding purposes only. Sheet piling quantities for payment shall consist of the linear feet of piling acceptably installed ~~*(and removed)~~. Installed quantities shall consist of all piling including fabricated sections driven between the required top and bottom elevations of pilings plus any

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additions thereto resulting from changes in design or alignment as provided herein 8.2.2. ~~*(Removed quantities shall consist of the lengths of piling pulled from below the ground level.)~~

11. MEASUREMENT AND PAYMENT.

11.1 Measurement. The length of sheet piling installed ~~*(and removed)~~ will be measured to the nearest tenth of a linear foot. For installed pilings directed to be cut off before reaching the penetration depth shown on drawings the portion cut off will be measured for payment as the difference between the total length of piling shown on the plans for that location and the length of piling installed below the point of cut-off.

11.2 Payment.

11.2.1 Furnished and Installed Sheet Piling. Payment for steel sheet piling quantities will be made at the applicable contract price per linear foot for ~~*(Item No. _____, "Steel Sheet Piling, Type _____,")~~ (Item No. _____, "Steel Sheet Piling - Fabricated Sections, Type(s) _____," (Item No. _____, "Steel Sheet Piling - Government Furnished"). Payment shall cover all cost of furnishing, handling, storing and installing piling including placing, driving, cutting holes and other materials and work incident thereto ~~*(except the cost of furnishing piling shall not be included in the contract price for Government furnished piling).~~

11.2.2 Cut-Offs. When pilings which have not been driven to penetration depths shown on drawings are directed to be cut off except for cut-offs due to excessive battering a lump sum payment of \$ _____ will be made for cutting off each piling. An additional sum will be paid for each linear foot of the

CORPS OF ENGINEERS GUIDE SPECIFICATION
MILITARY CONSTRUCTION

SECTION ⁰~~2.1~~

(B)

FENCE, CHAIN-LINK

(A)

PART 1 - GENERAL

(C)

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

1.1 Federal Specifications (Fed. Spec.):

~~FF-P-101F~~

~~Padlocks~~

RR-F-191J/GEN

Fencing, Wire and Post Metal (And Gates, Chain-Link Fence Fabric, and Accessories) (General Specification)

RR-F-191/1C

Fencing, Wire and Post, Metal (Chain-Link Fence Fabric) (Detail Specification)

RR-F-191/2C

Fencing, Wire and Post, Metal (Chain-Link Fence Gates) (Detail Specification)

RR-F-191/3C

Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces) (Detail Specification)

RR-F-191/4C

Fencing, Wire and Post, Metal (Chain-Link Fence Accessories Detail Specification)

1.2 American Society for Testing and Materials (ASTM) Publication:

C 94-84

Ready-Mixed Concrete

2. SHOP DRAWINGS shall be submitted in accordance with the SPECIAL CLAUSES. Drawings shall show post sizes and sections; post setting and bracing, gate details, barbed wire support arms; details of attachment of fabric and barbed wire to support members; and any other details required to erect the fence along the lines indicated.

PART 2 - PRODUCTS

3. MATERIALS shall conform to the following:

3.1 Chain Link Fence: Fed. Spec. RR-F-191 and detailed specifications forming the various parts thereto.

(D)

3.1.1 Fabric: Fed. Spec. RR-F-191/1, Type I or Type II, with 9-gage wire woven in 2-inch mesh; height, ~~{6 feet}, {..... feet} [as shown].~~

(E)

~~3.1.2 Gates: Fed. Spec. RR-F-191/2. Gate shall be the type and swing shown. Gate frames shall be constructed of Class 1, steel pipe, size SP2, as specified in RR-F-191/3. Gate fabric shall be as specified for chain-link fabric. [Each end member of gate frames shall be extended sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence.] Vertical members of gate leaves shall be spaced so that no members are more than 8 feet apart. Gates over 10 feet wide shall be additionally braced with a 5/16-inch, minimum thickness, diagonal truss rod. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that padlock will be accessible from both sides of the gate regardless of the latching arrangement.~~

3.1.3 Posts: Fed. Spec. RR-F-191/3, zinc-coated; Class 1, steel pipe; Class 3, formed steel sections; ~~or Class 6, steel square sections. Class 4, steel H-section may be used for line posts in lieu of line post shapes specified for the other classes.~~ Sizes shall be as ^{indicated on the drawings} specified in Fed. Spec. RR-F-191/3 for the class used. Line posts shall be of the same class throughout the fence. ~~Terminal (corner, gate, and pull) posts selected shall be of the same class throughout the fence. Gate post shall be either round or square, subject to the limitation specified in Fed. Spec. RR-F-191/3.~~

(F,G)

³ 3.1.4 ~~Braces and Top Rails~~: Fed. Spec. RR-F-191/3, zinc-coated; Class 1, steel pipe, size SP1 Class 3, form steel sections, size FS1, conforming to Fed. Spec. RR-F-191/3, may be used as ~~braces and top rails~~ if Class 3 line posts are furnished.

3.1.4 Accessories: Fed. Spec. RR-F-191/4. Ferrous accessories shall be zinc- or aluminum-coated.

~~3.1.5.1 Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment.~~

- 3.1.5-2^{4.1} Barbed wire shall be zinc- or aluminum-coated steel wire.
- 3.1.5-3^{4.2} Barbed wire support arms shall be the ~~(single)~~ ^(VVA) -arm type and of the design required for the post furnished.
- 3.2 Concrete: ASTM C 94, using 3/4-inch maximum-size aggregate, and having minimum compressive strength of 2000 psi at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.
- ~~3.3 Padlocks: FF-P-101, Type EPB, Size, 1 3/4 inch. Padlocks shall be keyed alike and each lock shall be furnished with two keys.~~

PART 3 - EXECUTION

(H)

4. GENERAL: Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line post shall be spaced equidistant at intervals not exceeding 10 feet. ~~Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment.~~ Fabric shall be continuous between terminal posts, however, runs between terminal posts shall not exceed 500 feet. ^{for the ENTIRE LENGTH OF NEW FENCE CONSTRUCTION.}

(I)

5. POSTS shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth of ~~36 inches~~. ^{STATION IN THE SECTION} Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to a ~~minimum~~ ^{minimum} depth of ~~36 inches~~ ^{as shown} unless a penetration of 18 inches in solid rock is achieved before reaching the ~~36-inch~~ ^{required} depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than ~~[10] [16]~~ ^{AS INDICATE} inches in diameter for terminal post and ~~[8] [12]~~ inches in diameter for line posts. Diameters of holes in solid rock shall be at least 1 inch greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post so as to be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. ~~Class 3 type line posts may be mechanically driven provided soil conditions are such that the driven posts develop strengths at least equal to posts set in concrete and rock is not encountered. Driven posts shall be set to a minimum depth of 3 feet and shall be protected with drive caps when being set.~~

(F)

6. TOP RAIL shall be supported at each post in a manner that a continuous brace between terminal posts is formed. Where required, ^{For the entire length of new fence construction}

sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail.

(G)

7. ~~BRACES AND TRUSS RODS~~ shall be installed as required and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 6 feet in height. A center brace or two diagonal truss rods shall be installed on 12-foot fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences 6 feet high or less if a top rail is installed.

(F)

7.8. TENSION WIRES shall be installed along the ~~top and~~ bottom of the fence line and attached to the ~~terminal~~ posts of each stretch of the fence. ~~[Top tension wires shall be installed within the top 1 foot of the installed fabric.]~~ Bottom tension wire shall be installed within the bottom 6 inches of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

CONSTRUCTION.

(H, J)

8.9. CHAIN-LINK FABRIC shall be installed on the ~~side~~ ^{CHANNEL} of the posts. ~~indicated.~~ Fabric shall be attached to ~~terminal~~ ^{CHANNEL} posts with stretcher bars and tension bands. Bands shall be spaced at approximately 15-inch intervals. Fabric shall be pulled taut to provide a smooth uniform appearance free from sag. Fabric shall be fastened to line posts at approximately 15-inch intervals and fastened to ~~top rails and~~ ^{CHANNEL} tension wires at approximately 24-inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be 2 inches (plus or minus 1/2 inch) above the ground. ~~The contractor shall use the existing fabric if in the opinion of the contracting officer, the fabric is still of acceptable quality.~~

9.10. BARBED WIRE SUPPORTING ARMS AND BARBED WIRE shall be installed as indicated and as recommended by the manufacturer. Supporting arms shall be anchored to the posts in such a manner to prevent easy removal with hand tools. Barbed wire shall be pulled taut and attached to the arms with clips or other means that will prevent easy removal.

(E)

11. GATES shall be installed at the locations shown. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. ~~[[Slide] [Lift] gates shall be installed as recommended by the manufacturer.]~~ Padlocks shall be attached to gates or gate posts with chains to prevent padlock removal.

(K)

12. GROUNDING: ~~Fences crossed by overhead powerlines in excess of 600 volts shall be grounded as specified in SECTION: LIGHTNING PROTECTION~~

SECTION ^{2P} ~~2~~

SCOUR GAGES

1. GENERAL. The scour gages shall be of the dimensions shown on the drawing and installed at the locations indicated.

2. MATERIAL.

2.1 Concrete. Scour gages shall be integrally colored precast concrete. Concrete shall conform to the requirements of SECTION: CONCRETE for Mix Design. The maximum aggregate size may be reduced to 3/8". The finish surface of the concrete shall be finished smooth and without blemish.

2.2 Color Additive shall be manufacturers' standard black pigmented color additive. Additive shall be mixed in accordance with manufacturers' written instructions and in sufficient quantities to provide vivid coloration of the concrete.

3. INSTALLATION. Scour gages shall be installed perpendicular and flush to finish surfaces.

* * * * *

2P-1
~~2P-1~~

2B

SECTION 29

PEDESTRIAN BRIDGES

Z PEDESTRIAN BRIDGES, DESIGNED BY
MARICOPA COUNTY FLOOD CONTROL DISTRICT,
WILL BE INCLUDED LATER.

ZQ-1

SECTION 3A
~~CIVIL WORKS CONSTRUCTION~~
~~GUIDE SPECIFICATION~~

~~FOR~~

CAST-IN-PLACE STRUCTURAL CONSTRUCTION

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SECTION 3^A
CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 - GENERAL

1. RELATED WORK SPECIFIED ELSEWHERE.
 - 1.1 Expansion, Contraction and Construction Joints in Concrete - Section 3.
*(03150)
 - 1.2 Steel Bars, Welded Wire Fabric, and Accessories for Concrete Reinforcement - Section 3. *(03210)
 - 1.3 Formwork for Concrete - Section 3. (03101)
 - 1.4 Stressing Tendons and Accessories for Prestressed Concrete - Section 3. *(03230)
2. REFERENCE STANDARDS.
 - 2.1 American Concrete Institute (ACI) Standards.

ACI 211.1-__	Standard Practice for Selecting Proportions
(CRD-C99)	for Normal, Heavyweight and Mass Concrete
ACI 214-__	Recommended Practice for Evaluation of
	Strength Test Results of Concrete
ACI 305	Hot Weather Concreting
 - 2.2 American Society for Testing and Materials (ASTM with Corresponding CRD Standard Indicated Where Available.

C 31- 85	(CRD-C 11)	Making and Curing Concrete Test
		Specimens in the Field
C 33- 86	(CRD-C 133)	Concrete Aggregates
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C 70- <u>79</u> (CRD-C 111) (R 1985)	Surface Moisture of Fine Aggregate
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C 136- <u>8Aa</u> (CRD-C 103)	Sieve Analysis of Fine and Coarse Aggregates
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C 171- <u>69</u> (CRD-C 310) (R 1986)	Sheet Materials for Curing Concrete
C 172- <u>82</u> (CRD-C 4)	Sampling Fresh Concrete
C 192- <u>81</u> (CRD-C 10)	Making and Curing Concrete Test Specimens in the Laboratory
C 231- <u>82</u> (CRD-C 41)	Air Content of Freshly Mixed Concrete by the Pressure Method
C 260- <u>86</u> (CRD-C 13)	Air-Entraining Admixtures for Concrete
C 494- <u>86</u> (CRD-C 87)	Chemical Admixtures for Concrete
C 566- <u>84</u> (CRD-C 113)	Total Moisture Content of Aggregate by Drying
C 595- <u>85</u> (CRD-C 203)	Blended Hydraulic Cements
C 618- <u>85</u> (CRD-C 255)	Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
C 989- <u>85a</u> (CRD-C 205)	Ground Iron Blast-Furnance Slag for Use in Concrete and Mortars
D 75- <u>84</u> (CRD-C 155)	Sampling Aggregates

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~~CRD-C 500~~
E 329-22 (CRD-C 500)
(R-1983)

~~Calcium chloride~~

Inspection and Testing Agencies for
Concrete, Steel and Bituminous
Materials as Used in Construction

2.3 Concrete Plant Material's Bureau (CPMB).
Edition Concrete Plant Standards

2.4 National Standards (NBS) Handbook.

Specifications, Tolerance and Other Technical Requirements
for Commercial Weighing and Measuring Devices (4th Edition
1971 with Replacement Sheets)

2.5 U.S. Army Corps of Engineers Handbook for Cement and Concrete (CRD).

- CRD-C 55-___ Concrete Mixer Performance
- CRD-C 100-___ Concrete Aggregate and Aggregate Sources
and Selection of Material for Testing
- CRD-C 112-___ Surface Moisture in Aggregate by Water
Displacement
- *(CRD-C 143-___ Meters for Automatic Indication of
Moisture in Fine Aggregate)
- CRD-C 300-___ Membrane-Forming Compounds for Curing
Concrete
- ~~CRD-C 312-___ Curing compound, concrete~~
- CRD-C 400-___ Water for Use in Mixing or Curing Concrete
- CRD-C 621-___ Non-Shrink Grout

3. QUALITY ASSURANCE

3.1 Preconstruction Sampling and Testing.

3.1.1 Aggregates. The aggregate sources listed in SP _____ have been determined to be capable of producing materials of a quality acceptable for this project. Proposed materials produced from similar strata, or of similar quality, will be approved. If the Contractor proposes to furnish aggregates from a source not listed in SP-___, samples consisting of not less than pounds of each size coarse aggregate and _____ pounds of fine aggregate taken under the supervision of the Contracting Officer in accordance with CRD-C 100 shall be delivered to _____ within 15 days after notice to proceed. Sampling and shipment of samples shall be at the Contractor's expense. From _____ to ___ days will be required to complete evaluation of the aggregates. Testing by and at the expense of the Government will be in accordance with the applicable CRD or ASTM test method. Tests to which aggregate may be subjected are specific gravity, absorption, freezing-and-thawing in concrete, alkali-aggregate reaction, organic impurities and any other test necessary to demonstrate that the aggregate is of a quality which is at least equivalent to those sources listed in SP ___.

3.1.2 Cementitious Materials, Admixtures, Curing Compound. At least 60 days in advance of concrete placement the contractor will notify the Contracting Officer of the source of materials, along with sampling location, brand name, type and quantity to be used in the manufacture and/or curing of the concrete. *(Sampling and testing will be performed by and at the expense of the Government except as otherwise specified. No material shall be used until notice has been given by the Contracting Officer that test results are satisfactory and all movement of materials after sampling shall be as directed. The Government will sample and test the following:)

~~3-1~~
3A-7

*(Air-entraining admixture)

*(Chemical admixture)

*(Curing compound)

*(Cementitious materials)

NOTE: ONLY WHEN ANY OF THE ABOVE OPTIONS ARE DELETED WILL THE CORRESPONDING MANUFACTURER'S CERTIFICATION DESCRIBED IN PARAGRAPH 5.1 OR 5.2 BE USED AND THE CORRESPONDING

SUBPARAGRAPHS 3.1.2.1, 3.1.2.2, 3.1.2.3, 3.1.2.3.1,

3.1.2.3.2 AND/OR 3.1.2.4 WILL BE DELETED.

*(3.1.2.1 Air-entraining admixture or other chemical admixtures which has been in storage at the project site for longer than 6 months or which has been subjected to freezing will be retested at the expense of the Contractor when directed by the Contracting Officer and shall be rejected if test results are not satisfactory.)

*(3.1.2.2 Air-entraining or other chemical admixtures will be accepted based on compliance with applicable specification, except that 6-month and 1-year compressive strength requirements are waived.)

*(3.1.2.3 Cement and Pozzolan. If cement or pozzolan is to be obtained from more than one source, the initial notification shall state the estimated amount to be obtained from each source and the proposed schedule of shipments.)

*(3.1.2.3.1 Prequalified Cement Sources. Cement shall be delivered and used directly from a mill of a producer designated as a qualified source. Samples of cement for check testing will be taken at the project site or concrete producing plant by a representative of the Contracting Officer for

~~3A-8~~
3A-8

testing at the expense of the Government. A list of prequalified cement sources is available from Commander and Director, U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, Mississippi 39180.)

*(3.1.2.3.2 Prequalified Pozzolan Sources. Pozzolan shall be delivered and used directly from a producer designated as a qualified source. Samples of pozzolan for check testing will be taken at the project site by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified pozzolan sources is available from the Commander and Director, U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180.)

*(3.1.2.3.3. Cement, if not from a prequalified source will be sampled at the source and stored in sealed bins pending completion of certain tests. Sampling, testing and the shipping inspection from the point of sampling, when the point is other than at the site of the work, will be made by, or under the supervision of the government and at its expense. No cement shall be used until notice has been given by the Contracting Officer that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the request of the Contractor, at his expense. When the point of sampling is other than at the site of the work, the fill gates of the sampled bin and conveyances used in shipment will be sealed under Government supervision and kept sealed until shipment from the bin has been completed. If tested cement is rehandled at transfer points the extra cost of inspection will be at the Contractor's expense. The cost of testing cement excess to the project requirements will also be at the expense of the Contractor. The charges for testing cement at the expense of the Contractor will be deducted from the

~~20~~
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payments due the Contractor at a rate of _____ dollars per ton of cement represented by the tests.)

*(3.1.2.3.4 Pozzolan, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of certain tests. Pozzolan will also be sampled at the site when determined necessary. All sampling and testing will be by and at the expense of the Government. Release for shipment and approval for use will be based on compliance with 7-day lime-pozzolan strength requirements and other physical and chemical and uniformity requirements for which tests can be completed by the time the 7-day lime-pozzolan strength test is completed. Release for shipment and approval for use on the above basis will be contingent on continuing compliance with the other requirements of the specifications. If a bin fails, the contents may be resampled and tested at the Contractor's expense. In this event the pozzolan may be sampled as it is loaded into cars, trucks or barges provided they are kept at the source until released for shipment. Unsealing and resealing of bins and sealing of shipping conveyances will be done by or under the supervision of the Government. Shipping conveyances will not be accepted at the site of the work unless received with all seals intact. If pozzolan is damaged in shipment, handling, or storage, it shall be promptly removed from the site of the work. Pozzolan which has not been used within six months after test will be retested at the expense of the Contractor when directed by the Contracting Officer and shall be rejected if the test results are not satisfactory. If tested pozzolan is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense. The cost of testing excess pozzolan will be at the Contractor's expense at a rate of ___ cents per ton. The amount will be deducted from payment to the Contractor.)

~~3A-10~~

3A-10

3.2 Construction Testing By Government. The Government will sample and test aggregates and concrete to determine compliance with the specifications. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Concrete will be sampled in accordance with ASTM C 172. Slump and air content will be determined in accordance with ASTM C 143 and ASTM C 231, respectively. Compression test specimens will be made and laboratory cured in accordance with ASTM C 31 and compression test specimens tested in accordance with ASTM C 39.

4. EVALUATION AND ACCEPTANCE.

4.1 Concrete Strength. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equal or exceed the required specified strength f'_c and no individual test result falls below the specified strength f'_c by more than 500 pounds per square inch. Additional analysis or testing may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient. Concrete work judged inadequate shall be reinforced with additional construction as directed by the Contracting Officer or shall be replaced at the Contractor's expense.

4.2 Construction Tolerances. Variation in alignment, grade and dimensions of the structures from the established alignment, grade and dimensions shown on the drawings shall be within the tolerances specified in the following tables:

~~3A-11~~
3A-11

b. Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement but not more than.....	2-inches
c. Reduction in thickness	Minus.....	5 percent of specified thickness
(8) Variation in steps:		
a. In a flight of stairs	Riser.....	1/8-inch
	Tread.....	1/4-inch
b. In consecutive steps	Riser.....	1/16-inch
	Tread.....	1/8-inch

TABLE II

CONSTRUCTION TOLERANCES FOR TUNNEL LININGS AND CONDUITS

(1) Departure from established alignment or from established grade	Free-flow tunnels and conduits.....	1-inch
	High-velocity tunnels and conduits.....	1/2-inch
	Railroad tunnels.....	1-inch
(2) Variation in thickness, at any point	Tunnel lining.....	minus 0
	Conduits.....	minus 2-1/2 percent or 1/4-inch, whichever is greater
(3) Variation from inside dimensions	Conduits.....	plus 5 percent or 1/2-inch, whichever is greater
	1/2 of 1 percent

TABLE III

TOLERANCES FOR CONCRETE CANAL LINING

(1) Departure from established alignment	2-inches on tangents
	4-inches on curves
(2) Departure from established profile grade	1-inch

~~3A-12~~
3A-12

- (3) Reduction in thickness in lining 10 percent of specified thickness: provided that average thickness is maintained as determined by daily batch volumes
- (4) Variation from specified width of section at any height 1/4 of 1 percent plus 1-inch
- (5) Variation from established height of lining 1/2 of 1 percent plus 1-inch
- (6) Variations in surfaces Invert 1/4-inch in 10 feet
..... Side slopes 1/2-inch in 10 feet

TABLE IV

TOLERANCES FOR BRIDGES, EROSION PROTECTION STRUCTURES AND SMALL HYDRAULIC STRUCTURES

- (1) Departure from established alignment 1-inch
- (2) Departure from established grades 1-inch
- (3) Variation from the plumb or the specified batter in the lines and surfaces of columns, piers, walls, and in arrises
Exposed, in 10 feet..... 1/2-inch
Backfilled, in 10 feet..... 1-inch
- (4) Variation from the level or from the grades indicated on the drawings in slabs, beams, horizontal grooves, and railing offsets
Exposed, in 10 feet..... 1/2-inch
Backfilled, in 10 feet..... 1-inch
- (5) Variation in cross-sectional dimensions of columns, piers slabs, walls, beams, and similar parts
Minus..... 1/4-inch
Plus..... 1/2-inch
- (6) Variation in thickness of bridge slabs
Minus..... 1/8-inch
Plus..... 1/4-inch
- (7) Footings: Same as footings for buildings
- (8) Variation in the sizes and locations of slab and wall openings 1/2-inch

(9) SILLS AND SIDEWALLS FOR RADIAL GATES AND SIMILAR WATERTIGHT STRUCTURES VARIATION FROM THE PLUMB OR LEVEL - - - - - NOT GREATER THAN 1/8 INCH IN 10 FEET.

~~3.3~~ Colors. Colors of pigmented concrete shall be considered satisfactory based on the comparative analysis of color produced from test panel(s) in accordance with paragraph: TEST PANEL, and Munsell color samples in accordance with U.S. Department of Agriculture Handbook 18 - Soil Survey Manual. Color of concrete shall conform to Munsell color number 10YR5/3 with respect to hue, value, and chroma. Evaluation of color shall be made within the time limits prescribed in paragraph: TEST PANEL.

4.3 Surface Requirements. The surface requirements for the classes of finish required by Section 3__, Formwork for Concrete, paragraph 5.1, shall be as hereinafter specified. Allowable irregularities are designated "abrupt" or "gradual" for purposes of providing for surface variations. Offsets resulting from displaced, misplaced or mismatched forms, or sheathing, or by loose knots in sheathing, or other similar form defects, shall be considered "abrupt" irregularities. Irregularities resulting from warping, unplaneness or similar uniform variations from planeness, or true curvature, shall be considered "gradual" irregularities. "Gradual" irregularities will be checked for compliance with the prescribed limits with a 5-ft template, consisting of a straightedge for plane surfaces and a shaped template for curved or warped surfaces. In measuring irregularities, the straight edge or template may be placed anywhere on the surface in any direction, with the testing edge held parallel to the intended surface.

<u>Class of Finish</u>	<u>Irregularities</u>	
	<u>Abrupt, inches</u>	<u>Gradual, inches</u>
A	1/8	1/4
B	1/4	1/2
C	*	1/4
D	1	1
F	1/8	1/4

*Variation for Class C finish shall not exceed zero positive and 1/8-inch negative in the direction of flow of the water.

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

5. SUBMITTALS.

~~3A-14~~

3A-14

5.1 Test Reports.

5.1.1 Concrete mixture proportions shall be determined by the contractor and submitted for approval. The proportions of all ingredients and nominal maximum coarse aggregate size that will be used in the manufacture of each quality of concrete shall be stated. Proportions shall indicate weight of cement and water and weights of aggregates in a saturated surface-dry condition. The submission shall be accompanied by test reports from a laboratory complying with ASTM E 329 which show that proportions thus selected will produce concrete of the qualities indicated. No substitution shall be made in the source or type of materials used in the work without additional tests to show that the new materials and quality of concrete are satisfactory.

*(5.1.2 Cement and pozzolan will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports that materials meet the requirements of the specification under which it is furnished. Certification and mill test reports shall identify the particular lot furnished. No cement or pozzolan shall be used until notice of acceptance has been given by the Contracting Officer. Cement and pozzolan will be subject to check testing from samples obtained at the mill, at transfer points or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Material not meeting specifications shall be promptly removed from the site of work).

5.1.3 Ground iron blast furnace slag will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports that the materials meet the requirements of the specification under which it

is furnished. Certification and mill test reports shall identify the particular lot furnished. No ground iron blast furnace slag shall be used until notice of acceptance has been given by the Contracting Officer. Ground iron blast furnace slag will be subject to check testing from samples obtained at the mill, at transfer points or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Material not meeting specifications shall be promptly removed from the site of work.

5.1.4 Non-shrink Grout.

5.1.4.1 General. Descriptive literature of the grout proposed for use shall be furnished together with a certificate from the manufacturer stating that it is suitable for the application or exposure for which it is being considered. In addition, a detailed plan shall be submitted for approval, showing equipment and procedures proposed for use in mixing and placing the grout.

5.1.4.2 Prepackaged material requiring only the addition of water will be accepted on the basis of certified laboratory test results showing that the material meets the requirements of CRD-C 621. When fine aggregate is to be added, the Contractor shall also furnish for approval the design mix proportions together with certified copies of laboratory test results indicating that the mix is in conformance with the requirements of CRD-C 621.

5.1.4.3 Mixture proportions using a volume-change controlling ingredient shall be submitted for approval. The submittal shall include the design mix proportions of all ingredients and certified copies of laboratory test results indicating that the materials and the mix is in conformance with the requirements of CRD-C 621.

5.2 Manufacturers' Certificate.

5.2.1 Accelerating admixture shall be certified for compliance with all specification requirements.

5.2.2 Impervious sheet curing materials shall be certified for compliance with all specification requirements.

~~5.2.3~~ Air-entraining admixture shall be certified for compliance with all specification requirements.

~~5.2.4~~ Water-reducing admixture shall be certified for compliance with all specification requirements.

~~5.2.5~~ Curing compound shall be certified for compliance with all specification requirements.

5.3 Review of Plant, Equipment and Methods.

5.3.1 Batch Plant. Details of the data on concrete plant shall be submitted for review by the Contracting Officer for conformance with para. 8.2.

5.3.2 Mixers. The make, type and capacity of concrete mixers proposed for mixing concrete shall be submitted for review by the Contracting Officer for conformance with paragraph 8.3. The results of the initial mixer uniformity tests as required in paragraph 15.2.12 shall be submitted within five days of the initiation of placing.

5.3.3 Conveying Equipment. The methods and equipment for transporting, handling, and depositing the concrete shall be submitted for review by the Contracting Officer for conformance with paragraph 9.

5.3.4 Placing. All placing equipment and methods shall be submitted for review by the Contracting Officer for conformance with paragraph 11.

5.3.5 Joint Clean-up. The method and equipment proposed for joint clean-up and waste disposal shall be submitted for review by the Contracting Officer for conformance with paragraph 10.4.

5.3.6 Curing. The curing medium and methods to be used shall be submitted for review by the Contracting Officer for conformance with paragraph 13.

5.3.7 Cold-weather Requirements. If concrete is to be placed under cold weather conditions, the proposed materials, methods and protection shall be in accordance with the requirements of paragraph 11.3 and 13.5 for approval by the Contracting Officer.

5.3.8 Hot-weather Requirements. If concrete is to be placed under hot weather conditions, the proposed materials and methods shall be in accordance with the requirements of paragraph 11.4 and 13.6 for approval by the Contracting Officer.

PART II - PRODUCTS

6. MATERIALS.

6.1 Cementitious Materials shall be portland cement, ~~portland blast furnace slag cement~~, portland-pozzolan cement or portland cement in combination with pozzolan ~~or ground iron blast furnace slag~~ and shall conform to appropriate specifications listed below. Usage for architectural concrete shall be restricted to one color and one type.

6.1.1 Portland Cement. ASTM C 150, Type ~~II~~ ~~except that the maximum amount of C₃A in Type I cement shall be 15 percent (including false set, requirements) (Low alkali, when used with aggregates listed to require it in SP-)~~ (including heat of hydration requirement at 7 days).

6.1.2 High-Early-Strength Portland Cement. ASTM C 150, Type III ~~with tricalcium aluminate limited to (5)(8) percent (low alkali)~~, used only when specifically approved in writing.

~~6.1.3 Portland Blast-Furnace Slag Cement. ASTM C 595, Type I S ~~(MS)~~ (MH) (the portland cement or clinker shall meet the requirements of ASTM C 150 for low alkali cement.)~~

6.1.4 Portland-Pozzolan Cement - ASTM C 595 Type IP ~~(MS) (MH)~~. ~~(the portland cement or clinkers shall meet the requirements of ASTM C 150 for low alkali cement; the pozzolan shall meet the requirements of ASTM C 618 Table 1A, available alkali.)~~

6.1.5 Pozzolan. Pozzolan shall conform to ASTM C 618 Class F, with the optional requirements of Table 1A for magnesium oxide and Table 2A. *The loss on ignition of the pozzolan shall be limited to 6 percent.*

~~6.1.6 Pozzolan - Modified Portland Cement. ASTM C 595 Type I (PM) (MS) (MH).~~

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6.1.7 Slag-Modified Portland Cement shall conform to ASTM C 595 Type I (SM).
6.1.8 Portland Blast-Furnace Slag Cement shall conform to ASTM C 595 Type IS.
6.1.9 Ground Iron Blast-Furnace Slag. Ground Iron Blast-Furnace Slag shall conform to ASTM C 999 Grade .

6.2 Aggregates shall be produced from the sources and under the conditions described in para 3.1.1. Fine and coarse aggregates shall conform to the grading requirements of ASTM C-33. The nominal maximum size shall be as listed in paragraph 7.2. ~~Where the use of highway department gradations are permitted, proposed gradations shall be submitted for approval.~~

6.3 Admixtures to be used, when required or permitted shall conform to the appropriate specification listed below:

6.3.1 Air-entraining admixture. ASTM C 260.

6.3.2 Accelerating admixture. Calcium chloride shall conform to ASTM D 98. When approved or directed the contractor shall use not more than 1 percent of calcium chloride, by weight, of the cement, added to the batch in solution in a portion of the mixing water. ~~Other accelerators shall meet the requirements of ASTM C 494 type C *(or E).~~

6.3.3 Water-reducing or retarding admixtures ASTM C 494, Type A, B or D.

6.3.4 High Range Water-Reducer. ASTM C 494 Type F *(or G). The admixture may be used only when approved by the Contracting Officer, such approval being contingent upon particular mixture control as described in the contractors' Quality Control Plan.

6.4 Curing Materials.

6.4.1 Impervious sheet materials ASTM C 171, type optional except polyethylene film, if used, shall be white opaque.

6.4.2 Membrane-forming curing compound CRD-C 300, pigmented, ~~non-~~ pigmented. ~~Non-pigmented compound shall contain a fugitive dye.~~

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

6.6 Non-Shrink Grout shall conform to CRD-C 621. The type shall be *(Gas-Liberating) (Metal-Oxidizing) (Gypsum-Forming) (Expansive-Cement).

7. MIXTURE PROPORTIONING.

7.1 Quality and Location. For each portion of the structure, mixture proportions shall be selected so that the following strength and water-cement ratio requirements are met.

7.1.1 Strength. Specified compressive strength f'_c shall be as follows:

<u>Compressive Strength @ 28 days, psi</u>	<u>Structure or Portion of Structure</u>
5000 @*(28) (90) () days	
4000 @*(28) (90) () days	
3000 @*(28) (90) () days	
2500 @*(28) (90) () days	

7.1.2 Maximum Water - Cement Ratio. Maximum water cement ratio shall be as follows:

<u>Water-Cement Ratio, by wt</u>	<u>Structure or Portion of Structure</u>
0.45	
0.50	
0.55	
0.60	
0.65	

7.2 Nominal Maximum size coarse aggregate shall be *(1-1/2)(1) inches except 3/4-inch nominal maximum size coarse aggregate shall be used when any

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of the following conditions exist: the narrowest dimension between sides of forms is less than 7-1/2 inches, the depth of the slab is less than 4-1/2 inches or when the minimum clear spacing between reinforcing is less than 2 inches.

7.3 Air Content as determined by ASTM C 231 shall be between 4 and 7 percent except that when the nominal maximum size coarse aggregate is 3/4-inch it shall be between 5 and 7 percent.

7.4 Slump. The slump shall be determined in accordance with ASTM C-143 and shall be within the range of 1"-4". Where placement by pump is approved, the slump shall not exceed 6 inches and shall remain within a 3" band. Where the use of chemical admixtures conforming to ASTM C 494, Type F or G is approved, the slump shall not exceed 8 inches.

~~7.5 Concrete Proportioning. Trial design batches and testing requirements for various qualities of concrete specified shall be the~~

~~responsibility of the Contractor. Samples of approved aggregates shall be~~

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

~~the project and shall be accompanied by test reports indicating~~

representative of those proposed for the project and shall be accompanied by manufacturer's test reports indicating compliance with applicable specified requirements. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on ACI Standard 211.1. The water-cement ratios required in paragraph: MAXIMUM WATER-CEMENT RATIO will be converted to a weight ratio of water to cement plus pozzolan or by weight equivalency as described in ACI Standard 211.1 to determine the maximum allowable water. Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each maximum aggregate size selected at each water-cement ratio at least three test cylinders or each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results a curve shall be plotted showing the relationship between water-cement ratio and strength.

Item	Maximum Slump	3-20 Placement Restrictions
Invent & Footings	2"	No pumping
Side Slopes	1 1/2"	No pumping
Vertical Walls & other Elements	As Above	Stated

Standard 211.1. ~~In the case where ground iron blast furnace slag is used the weight of the slag will be substituted in the equations for the term P which is used to denote the weight of pozzolan.~~ Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. ~~From these test results a curve shall be plotted showing the relationship between water-cement ratio and strength.~~

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6.6. Average Strength. In meeting the water-cement ratio and strength requirements specified in paragraph: QUALITY AND LOCATION above, the selected mixture proportion shall produce an average strength (f_{cr}) exceeding the specified strength f'_c by the amount indicated below with a water-cement ratio at or below that specified above. Where a concrete production facility has a large amount of test records, verifying that concrete of the strengths and water-cement ratios specified are being produced, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, including admixtures and colors, quality control procedures, and conditions similar to those expected. Changes in materials and proportions within the test records shall not have been more restricted than those for the proposed work and shall represent concrete produced to meet a specified strength or strengths f'_c meeting or exceeding that specified for proposed work at or below water-cement ratio specified; and shall consist of at least 30 consecutive tests or two groups of consecutive tests totalling at least 30 tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at other test age designated for determination of f'_c .

produced to meet a specified strength or strengths f'_c within 1000 psi of that specified for proposed work; shall consist of at least 30 consecutive tests or two groups of consecutive tests totalling at least 30 tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at other test age designated for determination of f'_c .

7.6.1 Required average compressive strength f_{cr} used as the basis for selection of concrete proportions shall be the larger of the equations which follow using the standard deviation as determined above:

$$f_{cr} = f'_c + 1.34S \text{ where } S = \text{standard deviation}$$

$$f_{cr} = f'_c + 2.33S - 500$$

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

No. of tests*	Modification factor for standard deviation
less than 15	Use table in 7.6.3
15	1.16
20	1.08
25	1.03
30 or more	1.00

* Interpolate for intermediate numbers of tests.

7.6.3 When a concrete production facility does not have field strength test records for calculation of standard deviation the required average strength f_{cr} shall be determined as follows:

If the specified compressive strength f'_c is less than 3000 psi,

$$f_{cr} = f'_c + 1000.$$

If the specified compressive strength f'_c is 3000 to 5000 psi,

$$f_{cr} = f'_c + 1200.$$

If the specified compressive strength f'_c is over 5000 psi,

$$f_{cr} = f'_c + 1400.$$

PART III - EXECUTION

8. PRODUCTION EQUIPMENT.

8.1 Capacity. The batching and mixing equipment shall have a capacity of at least 100 cubic yards per hour.

8.2 Batching Plant shall conform to the requirements of the Concrete Plant Standards of CPMB and as specified; however, rating plates attached to batch plant equipment are not required.

8.2.1 Equipment. The batching controls shall be ~~*(partially automatic)~~, ~~(semi-automatic)~~ ~~(or)~~ ~~(automatic)~~. ² The semi-automatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. ³ The semi-automatic or automatic batching system shall be equipped with an accurate recorder or recorders which meet the requirement of the Concrete Plant Standards of CPMB. Separate bins or compartments shall be provided for each size group of aggregate and cement, pozzolan and slag. Aggregates shall be weighed either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cement, pozzolan, or slag. If both cement and pozzolan or slag are used they may be batched cumulatively provided portland cement is batched first. If measured by weight, water shall not be weighed cumulatively with another ingredient. Water batcher filling and discharging valves shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. An accurate mechanical device for measuring and dispensing each admixture shall be provided. Each dispenser shall be interlocked with the batching and discharging operation of

the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. Where use of truck mixers make this requirement impracticable, the admixture dispensers shall be interlocked with the sand batcher. Admixtures will not be combined prior to introduction in water or sand. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment.

8.2.2 Scales. The weighing equipment shall conform to the applicable requirements of NBS Handbook 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. The tests shall be made at the frequency required in paragraph 15.2.4 and in the presence of a Government inspector.

8.2.3 Batching Tolerances.

8.2.3.1 Weighing Tolerances. Whichever of the following tolerances is greater shall apply, based on required scale reading.

<u>Material</u>	<u>Percent of Required Weight</u>	<u>Percent of Scale Capacity</u>
Cementitious Materials	+1	+0.3
Aggregate	+2	+0.3
Water	+1	+0.3
Admixture	+3	+0.3

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

Water: Plus or minus 1 percent.

Admixtures: Plus or minus 3 percent.

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

8.3 Mixers.

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

8.3.2 Concrete plant mixers shall be tilting, non-tilting, horizontal shaft or vertical-shaft type and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the paragraphs in ASTM C-94 applicable to central-mixed concrete.

8.3.3 Truck Mixers. Truck mixers, the mixing of concrete therein, and concrete uniformity, shall conform to the requirements of ASTM C-94. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be

equipped with two counters from which it will be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

9. CONVEYING EQUIPMENT.

9.1 General. Concrete shall be conveyed from mixer to forms as rapidly as practicable and within the time interval in paragraph 11.2 by methods which will prevent segregation or loss of ingredients. Any concrete transferred from one conveying device to another shall be passed through a hopper which is conical in shape and shall not be dropped vertically more than eight feet, except where suitable equipment is provided to prevent segregation and where specifically authorized. Telephonic or other satisfactory means of rapid communication between the mixing plant and the forms in which concrete is being placed shall be provided and available for use by Government inspectors.

9.2 Buckets. The interior hopper slope shall be not less than 50 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum size aggregate and the area of the gate opening shall be not less than two-square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically or hydraulically operated except for buckets larger than 2 cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

9.3 Transfer Hoppers. Concrete may be charged into non-agitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of

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receiving concrete directly from delivery vehicles, and have conical-shaped discharge features. The machine shall be equipped with a hydraulically-operated gate and with a means of external vibration to effect complete and facile discharge. Concrete shall not be held in non-agitating transfer hoppers more than 30 minutes.

9.4 Trucks. Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C-94. Non-agitating equipment may be used for transporting plant mixed concrete over a smooth road when hauling time is less than 15 minutes. Bodies of non-agitating equipment shall be smooth, watertight, metal containers equipped with gates that will permit the discharge of the concrete.

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

9.6 Belt Conveyors. Belt conveyors may be used when approved. Such conveyors shall be designed and operated to assure uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall meet the additional requirements as follows: The idler spacing shall not exceed 36 inches. If concrete is to be placed through installed horizontal or sloping reinforcing bars the conveyor will discharge concrete into a pipe or elephant trunk which is long enough to extend through

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the reinforcing bars. In no case will concrete be discharged to free fall through the reinforcing bars.

9.7 Pump Placement. Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure type. The pipeline shall be rigid steel pipe or heavy duty flexible hose. *↳ Invert and side slope concrete will not be pumped.*
The inside diameter of the pipe shall be at least three times the nominal maximum size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. The maximum size coarse aggregate will not be reduced to accommodate the pumps. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the concrete pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms.

10. PREPARATION FOR PLACING.

10.1 Embedded Items. Before placing concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Embedded items shall be free of oil and other foreign matter such as loose coatings or rust, paint and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids.

10.2 Concrete on Earth Foundations. Earth surfaces upon which concrete is to be placed shall be clean, damp, and free from frost, ice, and standing

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or running water. Prior to placing concrete the earth foundation shall have been satisfactorily compacted in accordance with the provisions of Section .

10.3 Concrete on Rock Foundations. Rock surfaces upon which concrete is to be placed shall be clean, free from oil, standing or running water, ice, mud, drummy rock, coatings, debris and loose, semi-detached or unsound fragments. Faults or seams shall be cleaned to a satisfactory depth and to firm rock on the sides. Immediately before concrete is placed, all rock surfaces shall be cleaned thoroughly by the use of air-water jets, sandblasting or other approved methods. All rock surfaces shall be kept continuously wet for at least 24 hours immediately prior to placing concrete thereon. All approximately horizontal surfaces shall be covered, immediately before the concrete is placed, with a layer of mortar approximately similar to that in the concrete mixture.

10.4 Construction Joint Treatment.

10.4.1 General. Concrete surfaces to which other concrete is to be bonded shall be prepared for receiving the next lift or adjacent concrete by cleaning with either air-water cutting, sandblasting, high pressure water jet, or other approved method.

10.4.2 Cleaning.

10.4.2.1 Air-Water Cutting. Air-water cutting of a construction joint shall be performed at the proper time and only on horizontal construction joints. The surface shall be cut with an air-water jet to remove all laitance and to expose clean, sound fine aggregate, but not so as to undercut the edges of the larger particles of aggregate. The air pressure used in the jet shall be 100 psi or minus 10 psi and the water pressure shall be just sufficient to

bring the water into effective influence of the air pressure. ~~(When approved by the Contracting Officer, a retarder complying with the requirements of CRD C 94 may be applied to the surface of the lift in order to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, the contractor shall furnish samples of the material to be used and shall demonstrate the method to be used in applications).~~ After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. The surface shall again be washed just prior to placing the succeeding lift. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, sandblasting will be required as the last operation before placing the next lift.

10.4.2.2 High-Pressure Water Jet. A stream of water under a pressure of not less than 3000 psi may be used for cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse aggregate particles where the cleaning occurs more than two days prior to placing the next lift or where work in the area subsequent to the cleaning causes dirt or debris to be deposited on the surface, the surface shall be cleaned again as the last operation prior to placing the next lift. If the water jet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

10.4.2.3 Sandblasting. When employed in the preparation of construction joints, sandblasting shall be performed as the final operation completed before placing the following lift. The operation shall be continued until all accumulated laitance, coatings, stains, debris, and other foreign materials are removed. The surface of the concrete shall then be washed thoroughly to

remove all loose materials. The surface shall again be washed just prior to placing the succeeding lift.

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

11. PLACING.

11.1 General. Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement and consolidation. Concrete shall be deposited as close as possible to its final position in the forms, and in so depositing there shall be no vertical drop greater than eight feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it may be effectively consolidated in horizontal layers 1-1/2 feet or less in thickness with a minimum of lateral movement. The amount deposited in each location shall be that which can be readily and thoroughly consolidated. The surfaces of construction joints shall be kept continuously wet for the first twelve hours during the twenty-four hour period prior to placing concrete. Free water shall be removed prior to placement of concrete. Sufficient placing capacity shall be provided so that concrete placement can be kept plastic and free of cold joints while concrete is being placed.

11.2 Time Interval Between Mixing and Placing. Concrete shall be placed within thirty minutes after discharge into non-agitating equipment. When

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concrete is truck mixed or when a truck mixer or agitator is used for transporting concrete mixed by a concrete plant mixer, the concrete shall be delivered to the site of the work and discharge shall be completed within 1-1/2 hours after introduction of the cement to the aggregates. When the length of haul makes it impossible to deliver truck mixed concrete within these time limits, batching of cement and a portion of the mixing water shall be delayed until the truck mixer is at or near the construction site. Not more than 80 percent of the water and all other materials except cement shall be batched at the distant batch plant and transported to the cement batcher without mixing.

11.3 Cold-Weather Placing. Concrete shall not be placed without a procedure approved in accordance with paragraph 5.3.7 when the concrete is likely to be subjected to freezing temperatures before the expiration of the curing period. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be above 32°F. The placing temperature of the concrete having a minimum dimension less than 12 inches shall be between 60°F and 75°F. The placing temperature of the concrete having a minimum dimension greater than 12 inches shall be between 50° and 75°F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperatures. Materials entering the mixer shall be free from ice, snow or frozen lumps. Salt, chemicals or other materials shall not be mixed with the concrete to prevent freezing, except that ~~calcium chloride~~ or a chemical accelerator may be used.

11.4 Hot-Weather Placing. Concrete shall be properly placed and finished with approved procedures in accordance with paragraph 5.3.8. The concrete placing temperature shall not exceed ___°F. Cooling of the mixing water

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and/or aggregates will be required to obtain an adequate placing temperature. An approved retarder may be used to facilitate placing and finishing. Steel forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 120°F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete placing temperature.

11.5 Consolidation. Immediately after placing, each layer of concrete shall be consolidated by internal vibrating equipment. Vibrators will not be used to transport concrete within the forms. Hand spading may be required if necessary with internal vibrating along formed surfaces permanently exposed to view. Form or surface vibrators shall not be used unless specifically approved. Vibrators of the proper size, frequency and amplitude shall be used for the type of work being performed in conformance with the following requirements:

<u>Application</u>	<u>Head Diameter (inches)</u>	<u>Frequency VPM</u>	<u>Amplitude (inches)</u>
Thin walls, beams, etc.	1-1/4 - 2-1/2	9000 - 13500	0.02 - 0.04
General construction	2 - 3-1/2	8000 - 12000	0.025 - 0.05

The frequency and amplitude shall be within the range indicated in the table above as determined in accordance with paragraph 15.2.9. The vibrator shall be inserted vertically at uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if such exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly.

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*(11.6 Placing Concrete in Spillway Weir. The unformed portion of the ogee crest and spillway bucket shall be finished by placing concrete slightly above grade and striking off to grade by accurate screeding. Screeding may be accomplished by semi-mechanical devices or by a mechanical screed which consolidates and screeds the surface in one operation. Ribs embedded in the fresh concrete as guides for screeds will not be permitted).

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

12. FINISHING.

12.1 Unformed Surfaces.

12.1.1 General. The ambient temperature of spaces adjacent to surfaces being finished shall not be less than 50°F. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305, may reasonably be expected to exceed 0.2 pounds per square feet per hour,

provision for windbreaks, shading, fog spraying, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as finishing operations will allow.

12.1.2 General. The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 50°F. All unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, unless a steel trowel finish is specified, and shall be true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to elevation shown on the drawings and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise shown on the drawing or as directed. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions.

12.1.3 Float Finish. Surfaces shall be screeded and darbied or bull-floated to bring the surface to the required finish level with no coarse aggregate visible. No cement or mortar shall be added to the surface during the finishing operation. The concrete, while still green but sufficiently hardened to bear a man's weight without deep imprint, shall be floated to a true and even plane. Floating may be performed by use of suitable hand floats or power driven equipment. Hand floats shall be made of magnesium or aluminum. Tolerance for a floated finish shall be true plane within 5/16-inch in ten feet as determined by a 10-foot straight edge placed anywhere on the slab in any direction.

12.1.4 Trowel Finish. A steel trowel finish shall be applied to the following surfaces: channel invert and sideslopes

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Concrete surfaces shall be finished with a float finish and after surface moisture has disappeared, the surface shall be steel-troweled to a smooth, even, dense finish free from blemishes including trowel marks. Tolerance shall be true planes within 5/16-inch in ten feet as determined by a 10-foot straightedge placed anywhere on the slab in any direction.

12.1.5 Abrasive aggregate finish shall be applied to the following surfaces _____

The concrete surface shall be finished with a float finish. Abrasive aggregate shall be uniformly sprinkled over the floated surface at a rate of not less than 1/4-pound per square foot. The surface shall be steel-troweled to a smooth, even finish that is uniform in texture and appearance and free from blemishes including trowels marks. Immediately after curing, cement coating or laitance covering the abrasive aggregate shall be removed by steel brushing, rubbing with abrasive stone or sandblasting to expose the abrasive particles.

12.1.5 Broom finish shall be applied to the following surfaces: _____

The concrete surface shall be finished with a float finish and trowel finish. The troweled surface shall be broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

12.1.6 Bonded two-course floor shall be constructed by placing a bonded topping on thoroughly hardened concrete slab left a distance below final grade as shown on the drawings. The floor topping mixture shall have a specified compressive strength of 6000 pounds per square inch at 28 days, a 1-inch maximum slump, 1/2-inch maximum size coarse aggregate and shall be propor-

tioned to obtain required finishability. The surface of the base slab shall be thoroughly cleaned by sandblasting in accordance with paragraph 10.4.2.2. The base slab shall be kept continuously wet for the first 12 hours during the 24 hour period immediately prior to placing the finished floor. After all free water has evaporated or has been removed from the surface, a grout shall be scrubbed in. The grout shall be a 1:1 mixture of portland cement and sand passing the No. 8 sieve mixed to a cream-like consistency. The grout shall be applied just ahead of the concrete placing operation. While grout is still damp, reinforcement shall be placed as shown on the drawings, and the top course spread and screeded by the use of disc-type power floats or equivalent, followed by a minimum of two power trowelings. Trowel marks left by the machine shall be removed by final, hard steel troweling done by hand. The finished floor shall be moist cured in accordance with paragraph 13.2.

12.2. Formed Surfaces. After form removal, all fins and loose materials shall be removed. All voids, and honeycombs exceeding 1/2 inch in diameter and all tie rod holes permanently exposed to view shall be reamed or chipped and filled with dry pack mortar. Defective areas larger than 36 square inches in any surface, permanently exposed or not shall be delineated in a rectangular shape by a saw cut a minimum depth of 1-inch and repaired with concrete replacement. The cement used in the mortar or concrete for all surfaces permanently exposed to view shall be a blend of portland cement and white cement properly proportioned so that the final color when cured will be the same as adjacent concrete. Temperature of the concrete, ambient air, replacement concrete or mortar during remedial work including curing shall be above 50°F. The prepared area shall be dampened, brush-coated with a neat

cement grout or with an approved epoxy resin, and filled with mortar or concrete. The mortar shall consist of 1 part cement to 2-1/2 parts fine aggregate. The quantity of mixing water shall be the minimum necessary to obtain a uniform mixture and permit placing. Mortar shall be thoroughly compacted in place and struck off to adjacent concrete. Replacement concrete shall be drier than the usual mixture and thoroughly tamped into place and finished. Forms shall be used if required. Metal tools shall not be used to finish permanently exposed surfaces. The patched areas shall be cured for seven days.

12.2.1 General. Surfaces, unless other type of finish is specified, shall be left with the texture imparted by the forms except defective surfaces shall be repaired as described above. Other type of finishes shall be applied to the following structures or portions of structures:

<u>Type of Finish</u>	<u>Structure or Portion of Structure</u>
Sack-rubbed Textured Exposed aggregate	

Unless painting of surfaces is required, uniform color shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure which is exposed to view or on which a special finish is required. The form panels used to produce the finish shall be orderly in arrangement, with joints between panels planned in approved relation to openings, building corners and other architectural features. The finished surface of sack-rubbed, textured, and exposed aggregate finishes shall duplicate the pre-approved sample panel, prepared in accordance with Section 3, Formwork for Concrete, paragraph 3.3. Forms shall not be reused if there is any evidence of surface wear or defects which would impair the quality of the surface.

12.2.2 Sack-rubbed Finish. This type of finish shall be applied where specified or shown on the drawings. As approved by the Contracting Officer and after all required patching, cleaning, and correction of major imperfections have been completed, the concrete surface shall be given a sack-rubbed finish as hereinafter described. In order to achieve uniformity of appearance and reduce the chance of discoloring caused by subsequent construction operations, sack-rubbing will be delayed until near the end of construction on all surfaces not to be painted. The temperature of the air adjacent to the surface shall be not less than 50°F for 24 hours prior to and 48 hours following the application of the finish. The finish for any area shall be made at natural breaks in the finished surface. The sack-rubbed finish shall consist of thoroughly wetting the surface to prevent absorption of water from the mortar and then coating the surface with mortar. The mortar shall be applied as soon as the surface of the concrete approaches surface dryness and shall be vigorously and thoroughly rubbed over the area with clean burlap pads so as to fill all voids. The mortar shall be composed of one part portland cement to two parts by volume of well-graded sand passing a No. 30 sieve mixed with water to the consistency of thick paint. White cement shall be used for all or part of the cement as approved by the Contracting Officer to give the desired color. The applied coating shall be uniform, completely filling all pits, air bubbles, and surface voids. While the mortar is still plastic, excess mortar shall be scraped off with a trowel and the surface shall be sack-rubbed with a dry mix of the same proportions and materials specified above, except that no water will be used. The burlap pads used for this operation shall be stretched tightly around a board to prevent dishing the

mortar in the voids. No material shall remain on the surface except that within the voids. The sack-rubbing with a dry mix shall be performed at a time when the mortar will not be pulled from the voids or depressions. In hot, dry weather the sack-rubbed finish treatment shall be made in shaded areas. If it is absolutely necessary to perform sack-rubbed finishing in areas subject to direct rays of the sun, the concrete surfaces shall be covered with damp burlap, or a continuous fog spray applied, or some other suitable method used to moisten the concrete surface for a minimum of one hour before finishing operations are begun. Immediately after the sack-rubbed treatment is completed, the surface shall be continuously moist cured for 48 hours.

12.2.3 Textured Finish. This type of finish shall be applied where specified to conform to details shown on the drawings by use of approved textured form liners. Liner panels shall be secured in the forms by cementing or stapling, but not by methods which will permit impressions or nail heads, screw heads, washers or the like to be imparted to the surface of the concrete. Edges of textured panels shall be sealed to each other to prevent grout leakage. The sealant used shall be non-staining to the surface.

12.2.4. Exposed Coarse Aggregate Finish. Coarse aggregate shall be exposed by a method pre-approved by the Contracting Officer.

12.2.5 Abrasive-blast Finish. The concrete surface shall be blasted to obtain a *(brush) (light) (medium) (heavy) uniform finish.

12.2.6 Tooled finish. The thoroughly cured concrete shall be dressed with electric, air, or hand tools to a uniform texture, and shall be given a *(hand tooled) (rough) (or) (fine pointed) (crandalled) (or) (bush-hammered) surface texture.

13. CURING AND PROTECTION.

13.1 General. All concrete shall be cured by an approved method for a period of 7 days. Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, and mechanical injury. All materials and equipment needed for adequate curing and protection shall be available and at the placement site prior to start of concrete placement. Concrete shall be protected from the damaging effects of rain for 12 hours, flowing water for 14 days (7 days with type III cement). *(Concrete shall be shielded from direct rays of the sun for 3 days). No fire or excessive heat shall be permitted near or in direct contact with concrete at any time.

13.2 Moist Curing. Concrete moist-cured shall be maintained continuously (not periodically) wet for the entire curing period. If water or curing materials stain or discolor concrete surfaces which are to be permanently exposed, they shall be cleaned as required in paragraph 4.4. When wooden form sheathing is left in place during curing, the sheathing shall be kept wet at all times. Horizontal surfaces shall be cured by ponding, by covering with a minimum uniform thickness of 2 inches continuously saturated sand, or by covering with saturated non-staining burlap or cotton mats ~~or sealed impervious sheet materials~~. Horizontal construction joints may be allowed to dry for twelve hours immediately prior to placing of the following lift.

13.3 Membrane Curing. Concrete may be cured with an approved curing compound in lieu of moist curing except that membrane curing will not be permitted on any surface to which sack rubbed finish is to be applied, or any surface containing protruding steel reinforcement, or on abrasive aggregate finish.

Curing Requirements

<i>Structural Element</i>	<i>Method</i>
<i>Invent & Footings</i>	3A-43 <i>Moist Cure</i>
<i>Side Slopes</i>	<i>Moist Cure</i>
<i>Vertical Walls and Other Elements</i>	<i>Any</i>

13.3.1 A pigmented type curing compound conforming to CRD-C 300 may be used on surfaces which will not be exposed to view when the project is completed, or on surfaces that are to be painted. ~~(Only a chlorinated rubber base curing compound conforming to CRD-C 317 may be used on surfaces that are to be painted). A non-pigmented type curing compound, containing a fugitive dye, conforming to CRD-C 300 with the reflective requirements waived may be used on surfaces which will be exposed to view when the project is completed.~~

13.3.2 The curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. The surfaces shall be thoroughly moistened with water and the curing compound applied as soon as free water disappears. The curing compound shall be applied to unformed surfaces as soon as free water has disappeared. The curing compound shall be applied in a 2-coat continuous operation by approved motorized power-spraying equipment and at a uniform coverage of not more than 400 square feet per gallon for each coat. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage herein specified. All concrete surfaces on which the curing compound has been applied shall be adequately protected for the duration of the entire curing period from pedestrian and vehicular traffic and from any other cause which will disrupt the continuity of the curing membrane.

13.4 Impervious-Sheet Curing. The following concrete surfaces may be cured using impervious sheets: ----- All surfaces shall be thoroughly wetted and be completely covered with waterproof

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

NOTE: THE CONCRETE THAT MAY BE CURED USING IMPERVIOUS SHEET SHOULD BE HORIZONTAL OR NEAR HORIZONTAL FINISHED SURFACES SUCH AS ROOF SLABS, UNCOLORED FLOORS OR THE FIRST COURSE OF TWO COURSE FLOORS, OR FLOORS THAT ARE TO BE COVERED WITH TILE OR RESILIENT FLOORING.

13.5 Cold Weather. When the daily outdoor low temperature is less than 32°F, the temperature of the concrete shall be maintained above 40°F for at least the first three days and above 40°F for the remainder of the required curing period. In addition, during the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 25°F as determined by observation of ambient and concrete temperatures *(indicated by suitable thermometers furnished by the Government as required and installed adjacent to the concrete surface and 2 inches inside the surface of the concrete. The installation of the thermometers shall be made by the Contractor at such locations as may be directed.) Curing

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compounds shall not be used on concrete surfaces which are maintained at curing temperature by use of free steam.

*(14. SETTING OF BASE PLATES AND BEARING PLATES.

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

14.2 Damp-pack bedding mortar shall consist of 1 part type I portland cement and 2-1/2 parts of fine aggregate conforming to ASTM C 33, proportioned by weight, and not more than 4-1/2 gallons of water per bag of cement. The space between the top of the concrete or masonry bearing surface and the bottom of the plate shall be packed with the bedding mortar by tamping or ramming with a bar or rod until the voids are completely filled.

14.3 Non-shrink grout shall conform to the requirements of paragraphs 5.2.6 and 6.6. For clearance of two inches or more, the mix shall include by weight 1-1/2 parts of sound, clean uncrushed gravel conforming to size No. 8 Table 2 ASTM C-33 in combination with fine aggregate conforming to ASTM C-33, to one part portland cement unless otherwise recommended by the material manufacturer. Water content shall be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength.

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

14.3.2 Treatment of Exposed Surfaces. Those types containing metallic aggregate shall have, after the grout has set, the exposed surfaces cut back one-inch and immediately covered with a parge coat of mortar proportioned by weight of one part portland cement, two parts sand, and sufficient water to make the mixture placeable. The parge coat shall have a smooth, dense finish. The exposed surface of other types of non-shrink grout shall have a smooth, dense finish.

14.3.3 Curing. Grout and parge coats shall be cured in conformance with paragraph 13).

15. CONTRACTOR QUALITY CONTROL.

15.1 General. The Contractor shall perform the inspection and tests described in paragraph 15.2, and based upon the results of these inspections and tests he shall take the action required in paragraph 15.3 and submit reports as required in paragraphs 15.3 and 15.4. The laboratory performing the tests shall conform to ASTM E 329. The individuals who sample and test concrete or the constituents of concrete as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of concrete Field Testing Technicians, Grade I.

15.2 Inspection Details and Frequency of Testing.

15.2.1 Fine Aggregate.

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

15.2.1.2 Moisture Content. There shall be *(when in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily) at least four tests for moisture content in accordance with either ASTM C 70, C 566, or CRD-C 112 during each 8-hour period of mixing plant operation. The times for the tests shall be selected randomly within the 8-hour period. An additional test shall be made whenever the slump is

shown to be out of control or excessive variation in workability is reported by the placing foreman. *(When the electric moisture meter is operating satisfactorily, at least two direct measurements of moisture content shall be made per week to check the calibration of the meter).

15.2.2 Coarse Aggregate.

15.2.2.1 Grading. At least once during each shift concrete is being delivered, there shall be a sieve analysis in accordance with ASTM C 136 for each size group of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor is responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken shall show the results of the 5 most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than at the batch plant bins to allow for degradation during handling.

15.2.2.2 Moisture Content. A test for moisture content of each size of coarse aggregate in accordance with ASTM C 566 or CRD-C 112 shall be made at least once a shift. When two consecutive readings for smallest size coarse aggregate differ by more than 1.0 percent, frequency of testing shall be increased to that specified for fine aggregate in paragraph 15.2.1.2. These results shall be used to adjust the added water in the control of the batch plant.

15.2.3 Deleterious Substances. When in the opinion of the Contracting Officer, a problem exists in connection with deleterious substances in fine or coarse aggregates, tests shall be made in accordance with ASTM C 33. Testing frequency shall be not less than one per week.

15.2.4 Scales.

15.2.4.1 Weighing Accuracy. The accuracy of the scales shall be checked by test weights at least once a month for conformance with the applicable requirement of paragraph 8.2.2. Such tests shall also be made whenever there are variations in properties of the fresh concrete which could result from batching errors.

15.2.4.2 Batching *(and Recording) Accuracy. Once a week the accuracy of each batching *(and recording) device shall be checked during a weighing operation by noting and recording the required weight, *(recorded weight) and the actual weight batched. The contractor shall provide the necessary calibration devices and confirm that the admixture dispensers described in paragraph 8.2.1 are operating properly.

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

15.2.6 Concrete.

15.2.6.1 Air Content. At least two tests for air content shall be made on randomly selected batches of each class of concrete during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C 231. The average of each set of two tests shall be plotted on a control chart on which the average is set at 5.5 percent and the upper and lower control limits at 6.5 and 4.5 percent respectively. The range shall be plotted on a control chart on which the upper control limit is 2.0 percent. For concrete having a nominal maximum aggregate size of 3/4-inch, the average shall be set at 6.0 percent and the lower and upper control limits at 5.0 and 7.0 percent respectively.

15.2.6.2 Slump. At least two slump tests shall be made on randomly selected batches of each mixture of concrete during each day's concrete production in accordance with ASTM C 143. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. The average of each set of two tests shall be plotted on a control chart on which the upper and lower limits are set 1.5 inch above and below the mid-range value. The range shall be plotted on a control chart on which the upper control limit is 3.0 inches.

15.2.7 Preparation for Placing. Foundation or construction joints, forms and embedded items shall be inspected in sufficient time prior to each concrete placement by the Contractor in order to certify to the Contracting Officer it is ready to receive concrete. The results of each inspection shall be reported in writing.

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

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

15.2.10 Curing.

15.2.10.1 Moist Curing. At least once each shift an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.

15.2.10.2 Curing Compound. No curing compound shall be applied until it has been verified that the compound is properly mixed and ready for spraying. At the end of each operation the quantity of compound used and the area of

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concrete surface covered shall be reported and the rate of coverage in square feet per gallon shall be computed. The report shall state whether coverage is uniform.

15.2.10.3 Impervious Sheet Curing. At least once each shift an inspection shall be made of all areas being cured using impervious sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

15.2.11 Protection. At least once each shift an inspection shall be made of all areas subject to cold weather protection. Deficiencies shall be noted. During removal of protection, measurement of concrete and ambient temperature shall be made at least hourly.

15.2.12 Mixer Uniformity.

15.2.12.1 Concrete Plant Mixer. At the start of concrete placing, and at least once every six months when concrete is being placed, uniformity of concrete shall be determined. The tests shall be performed in accordance with ASTM C 94. Whenever adjustments in mixer or increased mixing times are necessary because of failure of any mixer to comply, the mixer shall be retested after adjustment. Results of tests shall be reported in writing.

15.2.12.2 Truck Mixers. At the start of concrete placing and at least once every three months when concrete is being placed, uniformity of concrete shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of blades may be regarded as satisfactory. Results of tests shall be reported in writing.

15.3 Action Required.

15.3.1 Fine Aggregate.

15.3.1.1 Grading. When the amount passing any sieve is outside the specification limits, the fine aggregate shall immediately be resampled and retested. If there is another failure on any sieve, the fact shall immediately be reported to the Contracting Officer, and immediate steps shall be taken to rectify the situation.

15.3.1.2 Moisture. Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, the scale settings for the fine aggregate batcher and water batcher shall be adjusted directly or by means of a moisture compensation device.

15.3.2 Coarse Aggregate.

15.3.2.1 Grading. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall immediately be resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. When two consecutive averages of 5 test are outside of specification limits, that fact shall be reported to the Contracting Officer and immediate steps shall be taken to correct the grading.

15.3.2 Deleterious Substances. When the results for a deleterious substance is outside the specification limit, the aggregate shall be resampled and retested for the deleterious substance that failed. If the second sample fails, that fact shall be reported to the Contracting Officer. When material finer than No. 200 sieve for coarse aggregate exceeds the specification limit, immediate steps, such as washing or other corrective actions, shall be initiated.

15.3.4 Scales. Whenever either the weighing accuracy or batching accuracy is found not to comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

15.3.5 Concrete.

15.3.5.1 Air Content. Whenever points on the control chart approach the upper or lower control limits an adjustment should be made in the amount of air-entraining admixture batched. If a single test result is outside the specification limit such adjustment is mandatory. As soon as practical after each adjustment another test shall be made to verify the correctness of the adjustment. Whenever a point falls above the upper control limit for range, the dispenser shall be calibrated to insure that it is operating correctly and with good reproducibility. Whenever two consecutive points either for average or range are outside the control limits, the Contracting Officer shall be notified. Whenever the air content departs from the specified range, the concrete shall not be delivered to the forms.

15.3.5.2 Slump. Whenever points on the control chart approach the upper or lower control limits an adjustment should be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total free water does not exceed that amount specified in the approved mixture proportions based on the free water available with the fine aggregate and that amount of water batched. If the adjustments to the batch weights or water and fine aggregate do not satisfactorily produce the required slump the mixture shall be re-proportioned to meet the specified criteria and re-submitted to the contracting officer for approval. When a single slump is outside the

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control limits such adjustment is mandatory. As soon as practical after each adjustment another test shall be made to verify the correctness of the adjustment. Whenever the slump exceeds the upper limit stipulated in paragraph 7.4 the concrete shall not be delivered to the forms. Whenever two consecutive slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range above the upper control limit, the slump shall be considered to be out of control and the additional testing for aggregate moisture content required in paragraph 15.2 shall be undertaken.

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15.3.A.3 Test Panel. The Contractor shall place a test panel for each colored concrete specified with a minimum dimension of 6 feet by 6 feet by 6 inches thick. The test panel shall be placed in the presence of the Contracting Officer, and the mix design shall conform in all respects to the mix proposed for use in the project. The Contractor shall also overlay on an area of the test panel not less than 12 inches square a dry-pack mortar sample using the same mix intended for use in setting of base plates for concrete fence posts. The concrete and mortar shall be finished, protected, and cured adjacent to the site of proposed construction using methods proposed for use by the Contractor on the features of the project which shall receive colored concrete. Only one half of the panel area will be cured with curing compound. The remaining portion will not be cured. The test panel shall not be protected from the effects of the sun while curing. Color comparisons as a basis for acceptance of color shall not be made in less than 14 days after placement of concrete for the test panel. Wetting of the concrete shall not be permitted within a period of 7 days prior to making color comparisons. No concrete shall be scheduled for placement within 30 days of construction of the test panel, and no concrete shall be placed prior to demonstrated compliance with the color requirements of these specifications. When, in the opinion of the Contracting Officer, the test panel do not conform to color requirements herein, the Contractor shall continue place additional test panel at no additional cost to the Government until a final mix design has been developed that produces concrete conforming to color requirements herein. Approval of test panel color and mix design shall not relieve the Contractor from the requirements of these specifications. The Contractor shall not remove the test panel until concrete work is complete. At completion of concrete work, the test panel shall be considered to be scrap materials and disposed of in accordance with SECTION: GENERAL REQUIREMENTS. Additionally, test panels will be constructed to document the quality of the color of the tinted curing compound. The test panel will be constructed of any of the proposed colored concrete mixes to be supplied by the Contractor. The curing compound will be applied to the panels in conformance with the paragraph: Curing and Protection. After a period of 3 days, the color of the exposed concrete surfaces will be evaluated to assure that the color of the curing compound as applied to the concrete conforms to the requirements of the paragraph: Color.

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

15.3.7 Curing.

15.3.7.1 Moist Curing. When a daily inspection report lists an area of inadequate curing, the required curing period for that area shall be extended by one day.

15.3.7.2 Curing Compound. When the coverage rate of curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

15.3.7.3 Impervious Sheet Curing. When a daily inspection report lists any tears, holes or laps of joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints



closed, and the required curing period for those areas shall be extended by one day.

15.3.8 Protection. When any concrete temperature during the period of protection or protection removal fails to comply with the specifications, that fact shall be reported to the Contracting Officer and immediate steps should be taken to correct the situation.

15.3.9 Mixer Uniformity. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased or adjustments shall be made to the mixer until compliance is achieved.

15.4 Reports. All results of tests conducted at the project site shall be reported as required. Each report shall include the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all Contractor quality control records.

16. PAYMENT.

16.1 Concrete. Measurement of concrete will be made on the basis of the actual volume of concrete within the paylines of the structures as indicated on the drawings. Measurement of concrete placed against the sides of any excavation without the use of intervening forms will be made only within the pay lines of the structure. No deductions will be made for rounded or beveled

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edge or space occupied by metal work, electrical conduits or timber, nor for voids or embedded items which are either less than 5 cubic feet in volume or one square foot in cross section. Unless otherwise specified, payment for concrete will be made at the respective contract prices per cubic yard for the various items of the schedule, which price shall include the cost of all labor, materials, and the use of all equipment and tools required to complete the concrete work; except reinforcement and embedded parts which are specified to be paid for separately. No payment will be made for concrete, as such, which is placed in structures for which payment is made as a lump sum.

Bidding schedule items for concrete under this contract are as follows:

Item No. ____ Concrete in _____. This item includes all concrete placed in the _____ as indicated on the drawings. Payment therefore will be made at the contract unit price per cubic yard for Item No. ____, "Concrete in _____."

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SECTION 3 B

SHOTCRETE

PART I - GENERAL

1. SCOPE. This section covers the requirements for materials, proportioning, application, and curing of shotcrete.

2. RELATED WORK SPECIFIED ELSEWHERE.

*(2.1 Steel Bars, Welded Wire Fabric and Accessories for Concrete Reinforcement. Section 3 _____. *(CW-03210))

*(2.2 Formwork for Concrete. Section 3 _____. *(CW-03101))

3. REFERENCE STANDARDS.

3.1 American Society for Testing and Materials (ASTM) with Corresponding U.S. Army Corps of Engineers Handbook for Cement and Concrete (CRD) Standard Indicated Where Available.

C 33 - 85 (CRD-C 133) Concrete Aggregates

C 42 - 84a (CRD-C 27) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

C 94 - 84 (CRD-C 31) Ready-Mixed Concrete

C 150 - 85 (CRD-C 201) Portland Cement

C 171 - 64(1980) (CRD-C 310) Sheet Materials for Curing Concrete

C 260 - 77 (CRD-C 13) Air Entraining Admixtures for Concrete

C 266 - 77 (CRD-C 223) Time of Setting

~~C 309 - 81 Liquid Membrane Forming Compounds for Curing Concrete~~

C 494 - 82 (CRD-C 87) Chemical Admixtures for Concrete

C 595 - 85 (CRD - C 203) Blended Hydraulic Cements

C 618 - 85 (CRD - C 255) Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

CRD-C-310?

C 685 - 85 (CRD - C 98) Volumetric Batching
and Continuous Mixing

~~D 98 (CRD - C 985) Calcium Chloride~~

3.2 U.S. Army Corps of Engineers Handbook for Cement and Concrete (CRD).

CRD-C 400 - 63 Water for Use in Mixing or Curing
Concrete

CRD-C 300 - 72 *Membrane-Forming Compounds for Curing Concrete*

4. QUALITY ASSURANCE. The Government will test shotcrete to determine compliance with this specification. The Contractor shall provide facilities and labor as may be necessary for obtaining representative test samples. Shotcrete will be sampled and tested by the method given in Paragraph 4.1.

~~(4.1 Test Cores. Cores will be drilled at least 40 hours prior to testing from the structure and tested in accordance with ASTM C 42. A set of three cores will be taken not less than once each shift nor less than once for each 50 cubic yards of shotcrete placed through the nozzle. The diameter of core specimens will be determined in accordance with ASTM C 42.)~~

~~4.1 Test Panel. One test panel will be made with minimum dimensions of 18 X 18 X 3 inches, gunned in the same positions as the work represented, for every 50 cubic yards of shotcrete placed, but at least one panel per shift. Panels shall be gunned during the course of the work by the Contractor's regular nozzleman. Panels shall be field cured in the same manner as in the job. Three 3 inches diameter cores will be drilled at least 40 hours prior to testing from each panel and tested in accordance with ASTM C 42.~~

5. EVALUATION AND ACCEPTANCE. The average compressive strength of three cores taken from the ~~(structure)~~ *(test panel)*, representing a shift or 50 cubic yards of shotcrete, tested at ~~(28)~~ *()* days of age shall equal or exceed the required compressive strength specified in Paragraph 7.6 with no individual core less than 85 percent of the required compressive strength. When the length of a core is less than twice the diameter, the correction factors given in ASTM C 42 will be applied to obtain the compressive strength of individual cores. Final acceptance of the shotcrete will be based on results obtained from cores.

6. SUBMITTALS. 90

6.1 Test Reports.

6.1.1 Cement and Pozzolanic Materials will be accepted on the basis of a manufacturer's certificate of compliance.

6.1.2 Aggregates will be accepted on the basis of test reports that show the material meeting the requirements of this specification.

6.2 Manufacturers Literature. Literature from suppliers which demonstrates compliance with applicable specifications for the following materials:

~~*(Air entraining agent)~~

~~*(Retarding admixture)~~

~~*(Water reducing admixture)~~

*Curing materials

~~*(Accelerating agents)~~

6.3 Mixture proportions and test data from prior experience if available may be submitted for approval. If test data from prior experience are not available or accepted, specimens shall be made and tested from three or more different mixture proportions in accordance with paragraph 6.4.2. The recommended mixture proportions, sources of materials, and all test results shall be submitted for acceptance. Mixture proportions shall be selected on the basis of compressive strength tests of specimens continuously moist cured until testing at ~~*(28)~~ ~~*()~~ days. For mixture acceptance purposes, average core compressive strength shall be at least equal to 1.2 times the required compressive strength specified in Paragraph 7.6.

6.4 Preconstruction Testing.

6.4.1 General Requirement. Test specimens shall be made by each application crew using the equipment, materials, mixture proportions and procedures proposed for the job.

6.4.2 Test Panel. A test panel at least 30 X 30 inches shall be made for each mixture being considered, and for each shooting position to be encountered in the job. ~~*(The same reinforcement as in the structure shall be provided in at least half of the panel to test for proper embedment of reinforcing steel.)~~ The test panels shall be fabricated to the same thickness as the structure, but not less than three inches. At least five three inch diameter cores from each panel shall be taken for testing as per ASTM C 42.

6.4.3 Alternate to preconstruction testing. When accepted by the Contracting Officer, preconstruction testing may be eliminated if it has been shown that mixture, materials, equipment, and personnel have given satisfactory results in similar work. In such case, test panels shall be made concurrently with the first shotcrete placed in the structure.

6.5 Operator Qualifications. The names and qualifications of the nozzlemen shall be submitted for approval. Any additional nozzlemen added to the job throughout the project shall be similarly submitted for approval.

~~*(6.6 Compatibility Test. When accelerators are to be used, the Contractor shall establish the compatibility of the job cement and the proposed accelerators using ASTM C 216 except as modified herein. The powdered accelerator shall be blended with 50 grams of cement until uniform and 15 ml of water shall then be added. The liquid accelerator shall first be mixed with 15 ml of water and then added to 50 grams of cement. Three percent of the proposed accelerator by weight of cement shall be used as a starting point. Mixing shall be accomplished within 15 seconds. The specimen shall be~~

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~~molded within one minute of adding the mixing water. If initial set is two minutes or less and a final set is 10 minutes or less, the accelerator is considered compatible. If these values are not achieved in the first test, additional tests shall be run using two percent and four percent of accelerator.~~

PART II - PRODUCTS

7. MATERIALS.

7.1 Cement shall be portland cement ~~or~~ blended hydraulic cement~~s~~ and shall conform to appropriate specifications listed below:

7.1.1 Portland Cement. ASTM C 150 Type ~~(I), (IA), (II), (IIA), (III), (IIIA), (IV) (low alkali) (with typical calcium aluminate limited to (5) (8) percent if Type III or Type IIIA cement is used.)~~

~~7.1.2 Blended Hydraulic Cement. ASTM C 595 Type IS, ISA, IP, or IPA (MS).~~

7.2 Aggregates shall conform to ASTM C 33, with the ~~combined gradation of coarse and fine aggregates conforming to the gradation shown below.~~

Sieve Size	Percent by Weight Passing Individual Sieves		
	(Grading No. 1)	(Grading No. 2)	(Grading No. 3)A
19.0 mm (3/4 inch)	--		100
12.5 mm (1/2 inch)	--	100	80-95
9.5 mm (3/8 inch)	100	90-100	70-90
4.75 mm (No. 4)	95-100	75-85	50-70
2.36 mm (No. 8)	80-100	50-70	35-55
1.18 mm (No. 16)	50-85	35-55	20-40
600. um (No. 30)	25-60	20-35	10-30
300. um (No. 50)	10-30	5-20	5-17
150. um (No. 100)	2-10	2-10	2-10

~~a fine and coarse aggregates shall be batched separately to avoid segregation.~~

7.3 Water. Fresh, clean, and potable mixing water or nonpotable water which meets the requirements of CRD-C 400 shall be used.

~~7.4 Admixtures to be used, when required or approved, shall comply with the appropriate specification listed below. Except as otherwise accepted, soluble admixtures shall be dissolved in water before introduction into the mixture.~~

- Say What?
- ~~(7.4.1 Air entraining admixture. ASTM C 260.)~~
- ~~(7.4.2 Water - reducing or retarding admixtures. ASTM C 494, Type A, B, or D.)~~
- ~~(7.4.3 Accelerating admixture. Calcium chloride shall conform to ASTM D 98. Accelerator for very rapid setting shall be "ACCEL-A-SET II" manufactured by the Protex Industries Inc., 1331 West Evans Avenue, Denver, CO 80223, or an approved equal.)~~

~~(7.4.4 Fly ash and pozzolanic materials. ASTM C 618.)~~

~~7.5 Curing Materials.~~

~~7.5.1 Impervious sheet materials ASTM C 171, type optional except polyethylene film, if used, shall be white opaque.~~

~~7.5.2 Membrane - forming curing compound ^{SPD C-300} ASTM C 300, Type 1 B or Type 2.)~~

7.6 Shotcrete Quality. The shotcrete shall be produced by ~~(dry-mix process)~~ ~~(wet-mix process)~~ (either dry-mix or wet-mix process). The required compressive strength shall be ~~(3,000)~~ ~~()~~ pounds per square inch at ~~(28)~~ ~~()~~ days.

PART III - EXECUTION

8. Production of Shotcrete.

~~8.1 Dry mix process.~~

~~8.1.1 Batching and Mixing.~~ Aggregate and cement may be batched by weight or by volume. If volumetric batching is used, a minimum of one weight batching check shall be made every four hours for control purposes to insure that the specified mixture design is being achieved. Weighing equipment shall be capable of batching with the accuracy specified in ASTM C 94. Volumetric equipment shall be capable of batching with the accuracy specified in ASTM C 685. The mixing equipment shall be capable of thoroughly mixing the materials in sufficient quantity to maintain placing continuity and be capable of discharging all mixed material without any carry over from one batch to the next.)

~~8.1.2 Delivery equipment.~~ The equipment shall be capable of discharging the aggregate-cement mixture into the delivery hose and delivering a continuous smooth stream of uniformly mixed material to the discharge nozzle. The discharge nozzle shall be equipped with a manually operated water injection system (water ring) for directing an even distribution of water through the aggregate-cement mixture. The water valve shall be capable of ready adjustment to vary the quantity of water, and shall be convenient to the nozzle man. The water pressure at the discharge nozzle shall be sufficiently greater than the operating air pressure to assure that the water is intimately mixed with the other materials. If the line water pressure is inadequate a water pump shall be introduced into the line. The water pressure shall be uniformly steady (nonpulsating). The delivery equipment shall be

thoroughly cleaned at the end of each shift. Equipment parts, especially the nozzle liner and water ring, shall be regularly inspected and replaced as required.)

8.2 Wet mix process

8.2.1 Batching and mixing shall be accomplished in accordance with the applicable provisions of ASTM C 94. If volumetric batching and mixing are used, the materials shall be batched and mixed in accordance with the applicable provisions of ASTM C 685. The mixing equipment shall be capable of thoroughly mixing the specified materials in sufficient quantity to maintain continuous placing. Ready-mix shotcrete complying with ASTM C 94 may be used.

8.2.2 Delivery equipment. The equipment shall be capable of delivering the premixed materials accurately, uniformly, and continuously through the delivery hose. Recommendations of the equipment manufacturer shall be followed on the type and size of nozzle to be used, and on cleaning, inspection, and maintenance of the equipment.

8.3 Air supply. Contractor shall provide a supply of clean, dry air adequate for maintaining sufficient nozzle velocity for all parts of the work and, if required, for simultaneous operation of a suitable blow pipe for clearing away rebound.

9. PREPARATION OF SURFACES.

9.1 Earth. Earth shall be compacted and trimed to line and graded before placing shotcrete. Surfaces to receive shotcrete shall be dampened.)

9.2 Existing concrete. All unsound and loose materials shall be removed by sandblasting, grinding, or high-pressure water jets before applying shotcrete. Any area to be repaired shall be chipped off or scarified to remove offsets which would cause an abrupt change in thickness without suitable reinforcement. Edges shall be tapered to leave no square shoulders at the perimeter of a cavity. The surface shall be dampened but without visible free water.

9.3 Rock. Rock surfaces with loose or dry material, mud, running water, and other foreign matter that will prevent bonding of shotcrete shall be cleaned. The rock surface shall be dampened prior to placing shotcrete.

9.3 Shotcrete. When a layer of shotcrete is to be covered by a succeeding layer at a later time, it shall first be allowed to develop its initial set. Then all laitance, loose material, and rebound shall be removed by brooming or scraping. Laitance which has been allowed to take final set shall be removed by sandblasting and the surface thoroughly cleaned.

10. PLACEMENT OF SHOTCRETE.

10.1 General. Shotcrete shall be placed using suitable delivery equipment and procedures. The temperature of surfaces to receive shotcrete shall not be less than 35 degrees Fahrenheit.

10.2 Placement Techniques.

10.2.1 Placement Control. Thickness, method of support, air pressure, and water content of shotcrete shall be controlled to preclude sagging or sloughing off. Shotcreting shall be discontinued or suitable means shall be provided to screen the nozzle stream if wind or air currents cause separation of the nozzle stream during placement.

10.2.2 Corners. Horizontal and vertical corners and any area where rebound cannot escape or be blown free shall be filled first.

10.3 Placement Around Reinforcement. The nozzle shall be held at such distance and angle to place material behind reinforcement before any material is allowed to accumulate on its face. In the dry-mix process, additional water may be added to the mix when encasing reinforcement to facilitate a smooth flow of material behind the bars. Shotcrete shall not be placed through more than one layer of reinforcing steel rods or mesh in one application unless demonstrated by preconstruction tests that steel is properly encased.

10.4 Cover of Reinforcement. The following minimum cover shall be provided.

- (a) For shotcrete used as linings or coatings: 3/4 inch for fine aggregate shotcrete and 1 1/2 inches for coarse aggregate shotcrete.
- (b) For principal reinforcement in beams, girders, and columns: 1 1/2 inches.
- (c) For reinforcement in slabs and walls: 3/4 inch for fine aggregate shotcrete and 1 1/2 inches for coarse aggregate shotcrete.)

10.5 Line and Thickness Control. Adequate ground wires or other accepted means shall be used to establish the thickness, surface planes, and finish lines of the shotcrete. The surfaces shall be within a tolerance of $\pm 3/8$ inch as determined by a 10 feet long straightedge placed on the surfaces.

10.6 Placement precautions. The following precautions shall be taken during placement.

- (a) Do not place shotcrete if drying or stiffening of the mix takes place at any time prior to delivery to the nozzle.
- (b) Do not use rebound or previously expended material in the shotcrete mix.
- (c) The area to which shotcrete is to be applied shall be clean and free of rebound or overspray.

11. REPAIR OF SURFACE DEFECTS.

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11.1 Surface Defects. Surface defects shall be repaired as soon as possible, after initial placement of the shotcrete. All shotcrete which lacks uniformity, which exhibits segregation, honeycombing, or lamination, or which contains any dry patches, slugs, voids, or sand pockets shall be removed in accordance with paragraph 9.2 and replaced with fresh shotcrete.

11.2 Core Holes. Core holes shall not be repaired with shotcrete. Instead, they shall be filled solid with patching mortar, after being cleaned and thoroughly dampened.

12. FINISHING.

~~*(12.1 Natural gun finish.~~ Unless otherwise specified, undisturbed final layer of shotcrete as applied from nozzle without hand finishing shall be provided.)

*(12.2 Cutting Screenshot. After the surface has taken its initial set (crumpling slightly when cut), excess material outside the forms and ground wires shall be sliced off with a downward cutting motion using a sharp-edged cutting screed).

*(12.3 Flash coat. A thin coat of shotcrete containing finer sand applied from a distance greater than normal shall be applied to the surface as soon as possible after the screeding.)

*(12.4 Float and trowel finish. Final surface finish shall be provided using *(wood float) *(rubber float) *(steel trowel). Troweling of thin sections of shotcrete shall be avoided unless both troweling and commencement of moisture curing take place within a relatively short period after placement of shotcrete.)

13. CURING AND PROTECTION.

13.1 Initial Curing. Immediately after finishing, shotcrete shall be kept continuously moist for at least 24 hours. One of the following materials or methods shall be used:

(a) Ponding or continuous sprinkling.

(b) Absorptive mat or fabric, sand, or other covering kept continuously wet.

(c) Curing compounds. ~~On natural gun or flash finishes, use the~~ application rate of 100 square feet per gallon. Curing compounds shall not be used on any surfaces against which additional shotcrete or other cementitious finishing materials are to be bonded unless positive measures, such as sandblasting, are taken to completely remove curing compounds prior to the application of such additional materials.

will be used for all gun shotcrete

13.2 Final Curing. Additional curing shall be provided immediately following the initial curing and before the shotcrete has dried. One of the following materials or methods shall be used:

- (a) Continue the method used in initial curing.
- (b) Application of impervious sheet material conforming to ASTM C171.

13.3 Formed Surface. If forms are to be removed during curing period, one of the curing materials or methods listed in Paragraph 13.1 shall be used immediately. Such curing shall be continued for the remainder of the curing period.

Initial Curing

13.4 Duration of Curing. Curing shall be continued for the first seven days after shotcreting or until the required strength is obtained. During the curing period, shotcrete shall be maintained above 55 degrees Fahrenheit and in a moist condition as specified in Paragraphs 13.1 and 13.2.

above Initial Curing and Final Curing

14. CONSTRUCTION JOINTS. Unless otherwise specified, construction joints shall be tapered to a shallow edge form, about one inch thick. If nontapered joints are specified, special care shall be taken to avoid or remove trapped rebound at the joint. The entire joint shall be thoroughly cleaned and wetted prior to the application of additional shotcrete.

15. PAYMENT. The method of payment for shotcrete in this contract will be based on *(the quantity in cubic yards of solid material gunned through the nozzles with maximum allowable rebound percent.) *(the quantity per cubic yard, based on *(a unit length) *(area) shotcreted to the thickness, shown on the contract drawings.) *(a lump sum).

Include in measurement/payment

SECTION 3C
CIVIL WORK CONSTRUCTION
GUIDE SPECIFICATION
FOR

FORMWORK FOR CONCRETE

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SECTION 3^C

FORMWORK FOR CONCRETE

PART 1 - GENERAL

1. RELATED WORK SPECIFIED ELSEWHERE.

1.1 Concrete. Section 3.

1.2 Reinforcing Steel. Section 3.

2. REFERENCE STANDARDS.

2.1 American Concrete Institute (ACI) Standards.

ACI 347-__ Recommended Practice for Concrete Formwork

2.2 American Society for Testing and Materials (ASTM) with Corresponding CRD Standard Indicated where Available.

- | | |
|----------------------------|--|
| A 446- <u>83</u> | Steel Sheet, Fine-Coated (Galvanized) by Hot Dip Process, Physical (Structural) Quality. |
| C 31- <u>84</u> (CRD-C 11) | Making and Curing Concrete Test Specimens in the Field. |
| C 39- <u>84</u> (CRD-C 14) | Compressive Strength of Cylindrical Concrete Specimens. |

2.3 U. S. Department of Commerce, National Bureau of Standards (NBS)

Product Standard.

PS 1-74 For Construction and Industrial Plywood

3. SUBMITTALS.

3.1 Shop Drawings. Drawings and computations for all formwork required shall be submitted at least 15 days before either fabrication on site or before delivery of prefabricated forms. The drawing and data

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submitted shall include the type, size, quantity and strength of all materials of which the forms are made, the plan for jointing of facing panels, details affecting the appearance, and the assumed design values and loading conditions. ~~(If resurfacing is permitted, the method, including location, order and time of erection and removal shall also be submitted.)~~

3.2 Manufacturers Literature shall be submitted for plywood, concrete form hard board, form accessories, prefabricated forms, form coating *(and form lining materials).

3.3 Sample Panels. After shop drawings have been approved, sample ~~panels~~^{posts} for ~~*(Class A) (or) (Class F)~~ finish with applied architectural treatment shall be built on the project site where directed. Panels shall be of sufficient size to contain joints and shall be not less than 6 feet long and 4 feet wide. The panels shall be of typical wall thickness and constructed containing the full allocation of reinforcing steel that will be used in the structure, with the forming system that duplicates in every detail the one that will be used in construction of the structure. The same concrete mix design and materials, the same placement techniques and equipment, and the same finishing techniques and timing shall be used that are planned for the structure. Construction of ~~*(Class A) (or) (Class F)~~ finish will not be permitted until sample ~~panels~~^{posts} have been approved. Sample panels

~~IF A SINGLE ASTERISK THROUGHOUT THIS GUIDE INDICATES THAT INAPPLICABLE PROVISIONS ARE TO BE DELETED.~~

shall be protected from construction operations in a manner to protect approved finish and are not to be removed until all ~~(Class A) (or)~~ ~~(Class F)~~ finish concrete has been accepted.

~~SECTION 2 - PRODUCTS~~

4. DESIGN. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor. The formwork shall be designed for loads, lateral pressure and allowable stresses in accordance with Chapter 1 of ACI Standard 347. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances. ~~(For (Class A) (or) (Class F) finish, the design shall be made to limit deflection of facing material between studs as well as deflection of studs and walers to 0.0025 times the span).~~

5. MATERIALS.

5.1 Forms shall be fabricated with facing materials that produce the specified construction tolerance requirements ~~as specified in~~ ~~paragraph~~ ~~(Concrete)~~ and the surface requirements of Section ~~2.1~~ ~~paragraph~~ ~~(Concrete)~~.

5.1.1 Class "A" Finish. This class of finish shall apply to _____
_____. The form facing material shall be composed of new, well-

matched tongue and groove lumber; or new plywood panels conforming to NBS
→ Product Standard PS-1 grade B-B concrete form class I. * (High Density
→ Overlay shall be used in _____ locations.) *(Structural I shall
→ be used in _____ locations.)

5.1.2 Class "B" Finish. This class of finish shall apply to all
surfaces except those specified to receive ~~Class A~~, ~~(Class C)~~, ~~(Class~~
~~D)~~, ~~(Class E)~~, or ~~Class F~~. The sheathing shall be composed of tongue-
and-groove or shiplap lumber, plywood conforming to NBS Product Standards
→ PS-1 grade B-B concrete form, tempered concrete form hardboard, or
steel. Steel lining on wood sheathing will not be permitted.

5.1.3 Class "C" Finish. This class of finish shall apply to ---
---. The sheathing may be of either tongue-and-groove lumber,
plywood, concrete form hardboard, or steel. Wood sheathing for curved or
warped surfaces shall be composed of splines of lumber which can be bent
to the required shape without splitting or cracking to form a smooth
tight form.

5.1.4 Class "D" Finish. This class of finish shall apply to ---
---. The sheathing may be of wood or steel.

5.1.5 Class "E" Finish. This class of finish shall apply to ---
---. The forms, which are allowed to remain in place permanently,
shall consist of galvanized steel conforming to ASTM A 466

~~Grades A, C, or E, coating class 1.5 ounces per square foot.~~

5.1.6 ~~Class "F" Finish. This class of finish shall apply to~~
~~It shall be obtained by use of textured form liners~~
~~conforming to the details shown on the drawing. These liners may be of~~
~~plastic sheet, wood, sheet metal or other approved material.~~

5.2 Form Accessories. Ties and other similar form accessories to be partially or wholly embedded in the concrete shall be of a commercially manufactured type. After the ends or end fasteners have been removed, the embedded portion of metal ties shall terminate not less than 2-inches from any concrete surface either exposed to view or exposed to water. Plastic snap ties may be used in locations where the surface will not be exposed to view. Form ties shall be constructed so that the ends or end fasteners can be removed without spalling the concrete.

5.3 Form Coating shall be a commercial formulation of satisfactory and proven performance that will not bond with, stain or adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

~~PART 3 - EXECUTION~~

6. INSTALLATION. Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the sur-

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face requirements of ~~Section 3, paragraph (Concrete)~~ and conforming to construction tolerances of ~~Section 3, paragraph (Concrete)~~. Where concrete surfaces are to be permanently exposed to view, joints in form panels shall be arranged to provide a pleasing appearance. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be re-used if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. All surfaces of forms and embedded materials shall be cleaned of any mortar from previous concreting and of all other foreign material before concrete is placed in them.

7. CHAMFERING. All exposed joints, edges and external corners shall be chamfered by molding placed in the forms unless the drawings specifically state that chamfering is to be omitted or as otherwise specified. Chamfered joints shall not be permitted where earth or rockfill is placed in contact with concrete surfaces. Chamfered joints shall be terminated a sufficient distance outside the limit of the earth or rockfill so that the end of the joints will be clearly visible.

8. COATING. Forms for exposed or painted surfaces shall be coated with form oil or a form-release agent before the form or rein-

~~32-8~~
32-8

forcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for unexposed surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

9. REMOVAL. Forms shall not be removed without approval and all removal shall be accomplished in a manner which will prevent injury to the concrete. Forms shall not be removed before the expiration of the minimum time indicated below, except as otherwise directed or specifically authorized. When conditions of the work are such as to justify the requirement, forms will be required to remain in place for a longer period.

9.1 Unsupported Concrete. Formwork for walls, columns, sides of beams, gravity structures and other vertical type forms not supporting the weight of concrete shall not be removed in less than 24 hours. The time depends on temperature, lift heights and type and amount of cementitious material in the concrete. Where forms for columns, walls and sides of beams also support formwork for slabs or beam soffits, the removal time of the latter shall govern.

9.2 Supported Concrete. *(Pan joist forms of the type which can be removed without disturbing shoring shall not be removed in less than

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4 days.) Supporting forms and shoring shall not be removed until structural members have acquired sufficient strength to support safely their own weight and any construction load to which concrete may be subjected. In no case shall forms and shoring be removed until both minimum time and sufficient strength have been attained.

	Concrete with Type I or II Portland Cement, Portland Blast Furnace Slag Cement, or Portland Pozzolan Cement	Concrete with Type IV Portland Cement or Blends of Port- land Cement with Other Cementitious Material
Archs, including gallery and con- duit roofs	7 days	10 days
Joist, beams or girder soffits where clear structural span between support is		
under 10 feet	4	6
10 to 20 feet	7	10
over 20 feet	14	21
Floor slab where clear structural span between supports is		
under 10 feet	3	5
10 to 20 feet	4	6
Over 20 feet	7	10

In addition to minimum times above, results of control tests conducted in accordance with ASTM C-31 and C-39 will be used as evidence that concrete has attained sufficient strength to permit removal of forms. Concrete cylinders shall be stored in the structure or as near the structure as possible, shall receive insofar as possible the same curing and protection as given those portions of the structure they represent,

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and shall be tested within 24 hours after removal from the structure.

Cylinders will be tested by and at the expense of the Government.

Supporting forms shall not be removed until after minimum time and control test specimens have attained at least 80 percent of strength

required for the structure in accordance with quality and location

requirements of Section ~~9.3~~ Concrete.

~~9.3 Tunnel forms.~~ Tunnel lining bulkhead forms shall not be removed in less than 12 hours and tunnel lining forms in not less than 16 hours.

10. FIELD QUALITY CONTROL. Forms and embedded items shall be inspected in sufficient time prior to each concrete placement by the Contractor 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.

11. PAYMENT. No separate payment will be made for formwork and all costs in connection therewith shall be included in the contract unit or lump sum prices for the items of work to which the work is incidental.

SECTION 3D
~~CIVIL WORKS CONSTRUCTION~~
~~GUIDE SPECIFICATION~~
FOR -

STEEL BARS, STEEL WELDED WIRE FABRIC, AND ACCESSORIES
FOR CONCRETE REINFORCEMENT

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*A SINGLE ASTERISK THROUGHOUT THIS GUIDE INDICATES THAT INAPPLICABLE PROVISIONS ARE TO BE DELETED.

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SECTION 3D

STEEL BARS, STEEL WELDED WIRE FABRIC, AND ACCESSORIES
FOR CONCRETE REINFORCEMENT

1. SCOPE. The work covered by this section consists of furnishing all equipment, materials, and labor for providing and placing steel bars, steel welded wire fabric, and accessories for concrete reinforcement *(except as provided in the SPECIAL PROVISIONS).

2. RELATED WORK SPECIFIED ELSEWHERE.

*2.1 Formwork. Section 3_, FORMWORK FOR CONCRETE

*2.2 Joints. Section 3_, EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE.

2.3 Concrete. ~~*(Section 3_, CAST-IN-PLACE STRUCTURAL CONCRETE)~~
~~*(and) *(Section 3_, CONCRETE)*.~~

3. APPLICABLE PUBLICATIONS. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

3.1 American Concrete Institute (ACI) Standards.

ACI 315-__ Details and Detailing of Concrete Reinforcement

ACI 318-__ Building Code Requirements for Reinforced Concrete

3.2 American Society for Testing and Materials (ASTM) Standards.

A 184-79 Fabricated Deformed Steel Bar Mats for Concrete Reinforcement

~~*A 185- Steel Welded Wire Fabric, Plain, for Concrete Reinforcement~~

A 370-77 Mechanical Testing of Steel Products

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- *A 497-79 Welded Deformed Steel Wire Fabric for Concrete Reinforcement
- A 615-82 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- A 706-82 Low-Alloy Steel Deformed Bars for Concrete Reinforcement
- ~~A 767- Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement~~
- ~~A 778- Epoxy-Coated Reinforcing Steel Bars~~
- ~~F 94- Recommended Practice for Radiographic Testing~~

3.3 American Welding Society (AWS) Code.

D 1.4- Structural Welding Code - Reinforcing Steel

4. QUALITY ASSURANCE. The Contractor shall have required material tests performed by an approved laboratory and certified to demonstrate that the materials are in conformance with the specifications. Tests shall be performed and certified at the Contractor's expense.

4.1 Reinforcement Steel Tests. Mechanical testing of steel shall be in accordance with ASTM A 370 except as otherwise specified herein or required by the material specifications. Tension tests shall be performed on full cross-section specimens using a gage length that spans the extremities of specimens with welds or sleeves included. The ladle analysis shall show the percentages of carbon, phosphorous, manganese, and sulfur present in the steel.

4.2 Qualification of Reinforcement Steel Butt Splicers. Splicers who will perform butt splicing of steel bars shall be certified to have satisfactorily completed a course of instruction in the proposed method of butt splicing or have satisfactorily performed similar work within the preceding year.

4.3 Qualification of Butt Splicing Procedure. As a condition of approval of the butt splicing procedure, the Contractor, in the presence of the Contracting Officer, shall make three test butt splices of steel bars of each size to be spliced using the proposed butt splicing method. These test butt splices and unspliced bars of the same size shall be tension tested to destruction with stress-strain curves plotted for each test. Test results must show that the butt splices meet the specified strength and deformation requirements in order for the splicing procedure to be approved by the Contracting Officer.

4.4 Radiographic Examination of Welds shall be in accordance with ASTM E 94 and shall be performed and evaluated by an approved testing agency adequately equipped to perform such services.

5. SUBMITTALS. The Contractor shall submit the following items to the Contracting Officer for approval.

5.1 Shop Drawings shall be in accordance with specified requirements and include the following:

- (1) Reinforcement steel schedules showing quantity, size, shape, dimensions, weight per foot and total weights, and bending details.
- (2) Details of bar supports showing types, sizes, spacing, and sequence.

5.2 Test Reports. Certified tests reports of reinforcement steel showing that the steel complies with the applicable specifications shall be furnished for each steel shipment and identified with specific lots prior to placement. Three copies of the ladle analysis shall be provided for each lot of steel and the Contractor shall certify that the steel furnished conforms to the ladle analysis.

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5.3 Butt Splicing Procedure. The Contractor shall submit the proposed procedure for butt splicing steel bars prior to making the test butt splices for qualification of the procedure. Properties and analyses of steel bars and splicing materials shall be included in the submitted procedure. Physical properties of splicing sleeves shall include length, inside and outside diameters, and inside surface details.

5.4 Weld Radiographs and Evaluations. Radiographs of welds and evaluations of the radiographs submitted for approval shall become the property of the Government.

5.5³ Disposition Records. A system of identification which shows the disposition of specific lots of approved materials in the work shall be established and submitted before completion of the contract.

6. MATERIALS.

6.1 Steel Bars shall conform to the grade, size, and length shown on drawings.

NOTE: THE GRADE OF STEEL BARS USED IN THE DESIGN MUST BE INDICATED ON THE DRAWINGS.

6.1.1 Billet-Steel Bars. ASTM A 615, deformed. ² If Grade 40 bars are shown on the drawings but are unavailable the Contractor may substitute Grade 60 bars of the same size and spacing as indicated for Grade 40 bars when authorized by the Contracting Officer. ²

NOTE: GRADE 40 BARS ARE FURNISHED ONLY IN SIZES 3 THROUGH 6. BAR SIZES 8 THROUGH 6 SHALL BE GRADE 40 OR GRADE 60. BARS SIZES 7 THROUGH 14 AND 18 SHALL BE GRADE 60.

*6.1.2 Zinc-Coated Bars. ASTM A 767, billet steel bars specified herein
6.1.1, Class coating, galvanized after fabrication.

*6.1.3 Epoxy-Coated Bars. ASTM A 775, billet-steel bars specified herein
6.1.1., requirements for certifications, material samples, patching material,
surface cleaning comparison and test frequency.

~~NOTE: ZINC COATED OR EPOXY COATED BARS SHALL BE USED IN
ALLOYS/DECK AND FLOOR PANELS WHERE BARS WOULD BE
SUBJECTED TO CORROSIVE ACTION~~

6.1.2 Low-Alloy Bars. ASTM A 706.

6.1.3 Fabricated Bar Mats. ASTM A 184, clipped or welded mats, billet-
steel bars specified herein 6.1.1.

6.2 Steel Welded Wire Fabric. ~~(ASTM A 185,)~~ (ASTM A 497, } wire spacing
and sizes as indicated on the drawings. For wire with a specified yield
strength (f_y) exceeding 60,000 psi, f_y shall be the stress corresponding to a
strain of 0.35 percent.

6.3 Accessories.

6.3.1 Bar Supports. ACI 315. Supports for formed surfaces exposed to view
or to be painted shall be plastic protected wire, stainless steel, or precast
concrete supports. Precast concrete supports shall be wedge-shaped, not
larger than 3-1/2 x 3-1/2 inches, of thickness equal to that indicated for
concrete cover, and have an embedded hooked tie-wire for anchorage. If formed
surface is exposed to view precast concrete supports shall be the same
quality, texture, and color as the finish surface.

6.3.2 Wire Ties shall be 16-gage or heavier black annealed wire. ~~(Ties
for epoxy coated bars shall be vinyl coated or epoxy coated.) *(Tie wires for
galvanized bars shall be galvanized.)~~

7. PLACEMENT. Reinforcement steel and accessories shall be placed as
specified and as shown on contract drawings and approved shop drawings.

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Placement details of steel and accessories not specified or shown on the drawings shall be in accordance with ACI 315 and ACI 318 or as directed by the Contracting Officer. Steel shall be fabricated to shapes and dimensions shown, placed where indicated within specified tolerances, and adequately supported during concrete placement. At the time of concrete placement all steel shall be free from loose, flaky rust, scale (except tight mill scale), mud, oil, grease, or any other coating that might reduce the bond with the concrete.

NOTE: DETAILS OF REINFORCEMENT WHICH ARE NOT IN ACCORDANCE WITH ACI 315 OR ACI 318 MUST BE INDICATED ON THE DRAWINGS

7.1 Hooks and Bends. Steel may be mill or field bent. All steel shall be bent cold unless otherwise authorized. No steel bars shall be bent after being partially embedded in concrete unless indicated on the drawings or otherwise authorized.

7.2 Welding of steel will be permitted only where indicated on the drawings or as otherwise directed by the Contracting Officer. Welding shall be performed in accordance with AWS D 1.4 except where otherwise specified or indicated on the drawings.

7.3 Placing Tolerances.

7.3.1 Spacing. The spacing between adjacent bars and the distance between layers of bars may not vary from the indicated position by more than one bar diameter nor more than one inch.

7.3.2 Concrete Cover. The minimum concrete cover of main reinforcement steel shall be as shown on the drawings. The allowable variation for minimum cover shall be as follows:

MINIMUM COVER

6"
4"
3"
2"
1-1/2"
1"
3/4"

VARIATION

+ 1/2"
+ 3/8"
+ 3/8"
+ 1/4"
+ 1/4"
+ 1/8"
+ 1/8"

7.4 Splicing. Splices in steel shall be made only as required. Bars may be spliced at alternate or additional locations at no additional cost to the Government, subject to the approval of the Contracting Officer.

7.4.1 Lap Splices shall be used only for bars smaller than size #14 and welded wire fabric. Lapped bars may be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6-inches.

7.4.2 Butt Splices shall be used only for splicing #14 and #18 bars and for splicing #11 bars to larger bars except where otherwise shown on the drawings or authorized by the Contracting Officer. Butt splices shall be made by a method which develops splices suitable for tension, compression, and stress reversal applications. Welded butt splices shall be full penetration butt welds. Butt splices shall develop 90 percent of the specified minimum ultimate tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be cleaned of all oil, grease, dirt, rust, scale, and other foreign substances and shall be flame dried before splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

SECTION 3E
CIVIL WORKS CONSTRUCTION
GUIDE SPECIFICATION

~~FOR~~

**EXPANSION, CONTRACTION AND
CONSTRUCTION JOINTS IN CONCRETE**

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SECTION 3 *E*

EXPANSION, CONTRACTION AND
CONSTRUCTION JOINTS IN CONCRETE

1. SCOPE. This section covers the materials, techniques and workmanship requirements for forming expansion, contraction and construction joints in concrete structures.

2. RELATED WORK SPECIFIED ELSEWHERE. Major requirements for concrete work are specified in Section A ~~CAST-IN-PLACE~~ CONCRETE.

3. APPLICABLE PUBLICATIONS. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

3.1 American Society for Testing and Materials (ASTM) Standards.
(With corresponding U.S. Army Corps of Engineers Handbook for Concrete and Cement (CRD) Specifications where indicated.)

- | | |
|----------------------------------|--|
| A 109- <i>85</i> | Steel, Carbon, Cold-Rolled Strip |
| A 167- <i>84</i> | Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| A 570- <i>84a</i> | Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality |
| D 1751- <i>83</i>
(CRD-C 508) | Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types) |

Sun Shell 602-683-2294

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D 1752-~~84~~⁸⁴
(CRD-C 509) Preformed Sponge Rubber and Cork
Expansion Joint Fillers and Concrete
Paving and Structural Construction

D 2628-~~81~~⁸¹
(CRD-C 531) Preformed Polychloroprene Elastomeric
Joint Seals for Concrete Pavements

D 2835-~~72~~⁷²
(CRD-C 532)
(R 1982) Lubricant for Installation of
Preformed Compression Seals in Concrete
Pavements

3.2 American Society of Mechanical Engineers (ASME) Boiler and
Pressure Vessel Code.

Section IX Welding and Brazing Qualifications
(Addenda: Summer & Winter 1977; Summer &
Winter 1978)

3.3 Federal Specifications (Fed. Spec.).
(With corresponding CRD standards where indicated)

QQ-C-576^b
~~QQ-C-576~~ Copper Flat Products With Slit, Slit and
Edge-Rolled, Sheared, Sawed, or Machined Edges
(Plate, Bar, Sheet and Strip)

TT-S-227^c
(CRD-C 506) Sealing Compound, Elastomeric Type,
Multi-Component (for Caulking, Sealing,
and Glazing in Buildings and Other
Structures)

3.4 U.S. Army Corps of Engineers Handbook for Concrete and Cement
(CRD) Specifications.

CRD-C 513-__ Rubber Waterstops

CRD-C 572-__ Polyvinylchloride Waterstops

4. QUALITY ASSURANCE.

4.1 Materials Tests.

4.1.1 Field-Molded Sealants. Samples of sealant and primer, when
use of primer is recommended by the manufacturer, as required in ~~4.1.1~~

SECTION: SUBMITTALS

below shall be tested by and at the expense of the Government for compliance with Fed. Spec. TT-S-227. If the sample fails to meet specification requirements, new samples shall be provided and the cost of retesting will be deducted from payments due the Contractor at a rate of \$ 2,000 per sample.

4.1.2. Non-Metallic Waterstops. Samples of materials and splices as required in 5.2.2 below shall be visually inspected and tested by and at the expense of the Government for compliance with CRD-C 513 or CRD-C 572, as applicable. If a sample fails to meet the specification requirements, new samples shall be provided and the cost of retesting will be deducted from payments due the Contractor at the rate of \$ _____ per material sample retested and \$ _____ per splice sample retested.

NOTE: TESTING OF NON-METALLIC WATERSTOPS WILL BE PERFORMED BY THE WATERWAYS EXPERIMENT STATION (WES).

4.2 Procedure and Performance Qualifications for Splicing Waterstops shall be demonstrated in the presence of the Contracting Officer.

4.2.1. Non-Metallic Waterstops. Procedure and performance qualifications for splicing non-metallic waterstops shall be demonstrated by the manufacture at the factory and the Contractor at the job site by each making three splice samples of each size and type of finished waterstop.

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4.2.2 Metal Waterstops. Procedure and performance qualifications for splicing metal waterstops shall be demonstrated at the job site by the Contractor. The brazing procedure, brazers and brazing operators for splicing copper waterstops shall be qualified in accordance with Part QB (Brazing), Article XI (Brazing General Requirements), Paragraph QB-170 (Peel Tests) and other applicable requirements of Articles XI, XII and XIII of Section IX (Welding and Brazing Qualifications) of the ASME Boiler and Pressure Vessel Code. The welding procedure and welders for splicing stainless steel waterstops shall be qualified in accordance with the manufacturer's recommendations.

5. SUBMITTALS.

5.1 Test Reports. Certified manufacturer's test reports shall be provided for premolded expansion-joint filler strips, ^{and} compression seals and lubricant, ~~and metallic waterstops~~ to verify compliance with the applicable specification.

5.2 Samples.

5.2.1 Field-Molded Sealant and Primer. One gallon of field-molded sealant and one quart of primer (when use of primer is recommended by the sealant manufacturer) shall be provided for testing.

5.2.2 Waterstops. Waterstop materials and splice samples shall be submitted for inspection and testing and shall be identified to indicate manufacturer, type of material, size and quantity of material and

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shipment represented. Each materials sample shall be a piece not less than 12 inches long cut from each 200 feet of finished waterstop furnished, but not less than a total of four linear feet of each type and size furnished. For spliced segments of waterstops to be installed in the work, one splice sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site shall be furnished for inspection and testing. The splice samples shall be made using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop. The total length of each splice sample shall be not less than 12 inches long.

6. MATERIALS.

6.1 Expansion Joint Filler Strips, Premolded shall conform ASTM D 1751 or ASTM D 1752, Type I or resin impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

6.2 Joint Sealants and Seals.

6.2.1 Field Molded Sealants shall conform to Fed. Spec. TT-S-227, Type II for vertical joints and Type I for horizontal joints, Class A. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, nonshrink, nonreactive with sealant, and nonabsorptive material type such as extruded butyl or polychloroprene foam rubber.

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6.2.2 Compression Seals shall conform to ASTM D 2628; lubricant for installation shall conform to ASTM D 2835.

6.3 Waterstops.

6.3.1 Non-Metallic. Rubber waterstops shall conform to CRD-C 513. Polyvinylchloride waterstops shall conform to CRD-C 572.

6.3.2 Metal.

6.3.2.1 Flexible Metal. Copper waterstops shall conform to Fed. Spec. QQ-C-376, temper soft annealed, 20-ounce weight sheet. Stainless steel waterstops shall conform to ASTM A 167, Type 304L, No. 1 Finish or equivalent, annealed, 20 gage (0.037 inch) strip.

6.3.2.2 Flat Steel Waterstops shall conform to ASTM A 109, temper No. 2, No. 2 edge, No. 1 finish or ASTM A 570, grade D.

7. INSTALLATION. Joint locations and details, including materials and methods of installation of joint fillers and waterstops, shall be as specified, shown on the drawings and as directed. In no case shall any fixed metal be continuous through an expansion or contraction joint.

7.1 Expansion Joints. Premolded filler strips shall have oiled wood strips secured to the top thereof and shall be accurately positioned and secured against displacement to clean, smooth concrete surfaces. The wood strips shall be slightly tapered, dressed and of the size required

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to install filler strips at the desired level below the finished concrete surface and to form the groove for the joint sealant or seals to the size shown on the drawings. Material used to secure premolded fillers and wood strips to concrete shall not harm the concrete and shall be compatible with the joint sealant or seals. The wood strips shall not be removed until after the concrete curing period. The groove shall be thoroughly cleaned of all laitence, curing compound, foreign materials, protrusions of hardened concrete and any dust which shall be blown out of the groove with oil-free compressed air.

7.1.1 Joints With Field-Molded Sealant. Joints shall not be sealed when the sealant, air or concrete temperature is less than 40°F. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

7.1.2 Joints With Preformed Compression Seals. The joint seals shall be installed with equipment which shall be capable of installing joint seals to the prescribed depth without cutting, nicking, twisting or otherwise distorting or damaging the seal and with no more than five percent stretching of the seal. The sides of the joint and, if necessary, the sides of the compression seal shall be covered with a coating of lubricant, and the seal shall be installed to the depth indicated with joint installation equipment. Butt joints shall be coated with liberal applications of lubricant.

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7.2. Contraction Joints. Joints requiring a bond breaker shall be coated with curing compound or with bituminous paint. Waterstops shall be protected during application of bond breaking material to prevent them from being coated.

7.3 Waterstops shall be carefully and correctly positioned during installation to eliminate faulty installation that may result in joint leakage. The bottom of each waterstop shall be embedded a minimum of 6 inches in firm rock or sealed to other cut-off systems. All waterstops shall be installed so as to form a continuous watertight diaphragm in each joint. Adequate provision shall be made to support and protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be replaced or repaired at the Contractor's expense. The concrete shall be thoroughly consolidated in the vicinity of the waterstop. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued.

7.3.1 Splices Joints in waterstops shall be spliced together by qualified splicers using the approved splicing procedures to form a continuous watertight diaphragm.

7.3.1.1 Non-Metallic Waterstops. All splices shall be made on a bench in a temporary shop provided at the site of the installation or at the manufacturer's plant. A miter guide and portable power saw shall be used to cut the ends to be joined to insure good alignment and contact

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SECTION 5A

MISCELLANEOUS METALS

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- | | |
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| 1. Applicable Publications | 4. Fabrication |
| 2. General | 5. Installation |
| 3. Materials | |

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

1.1 American National Standards Institute (ANSI) Standard.

A 14.3-1974	American National Standard Safety Requirements for Fixed Ladders
-------------	--

B 16.3-1977	Malleable Iron Threaded Fittings
-------------	----------------------------------

1.2 American Society for Testing and Materials (ASTM) Standards.

A 36-81a	Structural Steel
----------	------------------

A 120-84	Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses
----------	---

A 123-78	Zinc (Hot-Galvanized) Coatings on Shapes, Plates, Bars, and Strip
----------	---

A 320-84a	Alloy Steel Bolting Materials for Low-Temperature Service
-----------	---

A 500-84	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
----------	---

A 513-84a	Electrical-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
-----------	---

B 32-83	Solder Metal
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1.3 American Welding Society (AWSI).

D1.1-83	Structural Welding Code - Steel
---------	---------------------------------

1.4 Federal Specifications (Fed. Spec.).

FF-S-325 (Int Am-3)	Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
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RR-C-271B
Am-1

Chains and Attachments, Welded and
Weldless

TT-E-489G

Enamel, Alkyd, Gloss (for Exterior and
Interior Surfaces)

QQ-S-763D
(Notice 1, Am-2)

Steel Bars, Wire, Shapes, and
Forgings, Corrosion Resisting

VV-G-632A

Grease, Industrial, General Purpose

1.5 Military Specifications (Mil. Spec.).

MIL-F-3541A

Fittings, Lubrication

2. GENERAL.

2.1 Shop Drawings. Complete shop drawings for fabrication of fence panels, fence posts, pipe gates, and outlet gates shall be submitted for approval in accordance with the requirements of the SPECIAL CLAUSES.

2.2 Welding shall conform to the provisions of AWS D1.1. Welders who have not been certified within 2 years of the date of commencement of work under this contract will not be allowed to perform the work.

2.3 Bolt holes shall be reamed or drilled normal to the member and shall be truly cylindrical throughout. Cutting bolt holes with a torch will not be permitted without the prior written approval of the Contracting Officer.

3. MATERIALS.

3.1 General. Materials indicated on the drawings or required in the work and not covered elsewhere by detailed requirements shall conform to the requirements of this section. In all cases where materials are not specifically covered in these specifications, the Contractor shall furnish approved highest grade commercial materials or products.

3.2 Steel pipe shall be zinc-coated (galvanized) steel pipe conforming to the requirements of ASTM A 120, Standard Weight, Schedule 40.

3.3 Steel Shapes and Plates.

3.3.1 Steel bars and plates shall conform to ASTM A 36. Galvanized coating, where required, shall conform to ASTM A 123.

3.3.2 Steel tubing shall conform to ASTM A 500, Grade A for posts, and ASTM A 513 for picket rails.

3.4 Concrete, mortar and grout shall conform to the requirements of SECTION: CONCRETE.

3.5 Formwork shall conform to SECTION: FORMWORK FOR CONCRETE.

3.6 Chain shall be galvanized and shall conform to the requirements of Fed. Spec. RR-C-271, Type 1, Grade C, Class 4. The chain shall be attached with a galvanized connecting link and shall accommodate a 5/16-inch diameter padlock shackle.

3.7 Bolts and anchor bolts shall conform to Fed. Spec. QQ-S-763, Class 304, Condition A, or the applicable requirements of ASTM A 320, Grade B8. Nuts shall be galvanized.

3.8 Expansion bolts shall conform to Fed. Spec. FF-S-325.

3.9 Grease fittings shall conform to Mil. Spec. MIL-F-3541.

3.10 Signs. Reflective material on picket fence gate reflectors and unauthorized vehicles prohibited signs on pipe gates shall conform to the State Specifications of the Department of Transportation, Highway Division of the State of Arizona. Unauthorized vehicles prohibited signs on pipe gates shall be constructed as indicated on the drawings. Letters are to be black reflective material, standard 2 inch. Sign background shall be silver white. The reflectors and signs shall be constructed of heavy galvanized bonderized steel sheets having a minimum thickness of 16 gauge. Sign markings shall be baked enamel.

3.11 Pipe caps shall conform to ANSI B 16.3.

4. FABRICATION.

4.1 Picket Fence Panels. Pickets shall be steel tubing with caps welded at the top of the pickets. Fence panels shall be fabricated in the shop. Pickets, rails, and brackets shall be finished to provide smooth, straight edges free of burrs. All surfaces of the fence panels and brackets shall be cleaned in the shop to remove all rust, scale, dirt, and other foreign matter. "Tight" mill scale that cannot be lifted by applying a sharp knife to any edge will be permitted. The cleaning shall be accomplished by scraping, wire brushing, and wiping or other approved methods. The cleaning and painting operations shall be carried out in such a manner that the time between cleaning and the application of paint will not exceed 24 hours. Pickets, rails, and brackets shall be shop painted with 1 coat of zinc chromate primer and 2 coats of flat black exterior oil paint conforming to Fed. Spec. TT-E-489, Class A. Any damage of the picket fence panels during transportation and/or installation will be cause for rejection of the fence panels. Any chipping of original color during transportation and/or installation shall be repainted with original color.

4.2 Concrete Fence Posts. Steel base plates for posts need not be galvanized. Any cracking of the fence posts during installation of fence panel brackets will be cause for rejection of the post, and the damaged post shall be replaced at no additional cost to the Government (the Contractor will not be permitted to repair damaged posts).

4.3 Pipe Gate. Pipe gates shall be fabricated with steel pipe and shall be fabricated in the shop. Care shall be taken to deform pipe without "breaking" the steel. Any pipe deformations that demonstrate visible cracking or weakening may be cause for rejection the pipe gate or shall be repaired at no additional cost to the Government. All metal gate components (except grease fittings) shall be galvanized. Welded, cut, damaged, and deformed areas of galvanizing metal shall

be neatly coated with Grade 50B solder conforming to ASTM B 32. A minimum of two bolts, each not less than 1/4-inch in diameter, shall be used to fasten panels and signs to the pipe gates.

4.4 Gratings. Gratings shall be fabricated from steel bars. Steel grating and mounting bars shall be galvanized after fabrication.

4.5 Ladders. Ladders shall be steel fixed-rail conforming to ANSI A 14.3. Ladders and accessories shall be galvanized. Rungs shall be solid-section rods, fitted into punch holes in rails, welded and ground smooth. All splices and connections shall have a smooth transition with original members without projections that are sharp or more extensive than required for joint strength. Rails shall be fitted with rackets at the spacing indicated for anchorage to structure.

5. INSTALLATION.

5.1 General. Fence posts, both concrete and steel, and pipe gate posts shall be installed plumb. Fence posts shall be installed to provide a straight and even alignment. Fence panels shall be installed level and in a straight alignment from one side of the post to the other. All bolts and nuts shall be tight. Expansion anchors shall be snug and shall not permit movement when tested by hand. Surfaces of galvanized metals that are abraded, cut, or welded during installation shall be neatly covered with grade 50B solder conforming to ASTM B 32.

5.2 Excavation for concrete-embedded items shall be of the dimensions indicated on the drawings. Holes shall be cleared of loose materials prior to placement of concrete.

5.3 After fence panels are fastened to the posts, the heads of anchoring bolts and any painted areas that are damaged during installation shall be painted with paint conforming to the requirements for shop painting above. Paint shall be applied with a brush (spray methods shall not be used). Any such paint that gets on other than the surfaces specified to be painted shall be removed by the Contractor at no additional cost to the Government.

5.4 The Contractor shall use non-shrink grout conforming to the requirements of SECTION: CONCRETE to fill the voids under and above the base plates for fence posts.

5.5 The Contractor shall grease pipe gates thoroughly with grease conforming to Fed. Spec. VV-G-632 immediately after installation of gate leaves. The gates shall be installed in such a fashion that they work freely. The Contractor shall examine the operation of all pipe gates not sooner than 30 days after installation for ease of operation. Any gates that cannot be operated by one person will be repaired (including any required structural modifications) by the Contractor at no additional cost to the Government, and requirements for repair shall conform to the requirement for installation above.

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SECTION 11A

STATION MARKING

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

1.1 Federal Specification (Fed. Spec.).

TT-P-115E

Paint, Traffic, Highway, White and Yellow

2. MATERIALS.

2.1 Paint.

2.1.1 Exterior Paint on Concrete shall conform to Fed. Spec. TT-P-115, except the color shall be non-fading black.

3. STATION MARKING.

3.1 Preparation of Surfaces. Concrete surfaces shall be thoroughly cleaned of all curing compound, efflorescence, dirt, oil or other deleterious material by approved methods. The surface preparation shall be accomplished in such manner that paint will satisfactorily adhere to the surface.

3.2 Application. Painting shall be done in a neat and workmanlike manner and may be applied by brush, spray, roller or any combination of these methods. Painting of numbers and letters shall be accomplished with stencils and brush or spray application. Color for letters and numbers shall be black. All markings on concrete shall be in uniform capital block letters and numbers, 6 inches high, 3 inches wide, and 3/4-inch width of line. Markings on concrete walls shall be horizontal with the bottom of the marking 5 feet above the bottom (invert at walls) of the wall.

4. TABULATION OF STATION MARKING LOCATIONS.

ARIZONA CANAL WALL DIVERSION CHANNEL	WALL	STATION	TEXT OF MARKING	
L (left)	L (LEFT)	400+00	550+00	40 55
	L	410+00	560+00	41 56
	L	420+00	570+00	42 57
	L	430+00	580+00	43 58
	L	440+00	590+00	44 59
		450+00		45
		460+00		46
		470+00		47
		480+00	10+00	48 1
		490+00	20+00	49 2
		500+00		50
		510+00		51
		520+00		52
		530+00		53
	540+00		54	

CAVE CREEK CHANNEL

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SECTION 16A

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

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| 1. Applicable Publications | 8. Duct Lines |
| 2. General Requirements | 9. Lighting |
| 3. Submittals | 10. Concrete Pullboxes |
| 4. Materials and Components | 11. Grounding |
| 5. General Installation Requirements | 12. Meter Pedestals |
| 6. Cables, General Requirements | 13. Tests |
| 7. Low-Voltage Cables | |

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

1.1 Federal Specifications (Fed. Spec.).

W-S-610C
& Am-1

Splice Conductor

FF-P-101F

Padlocks

W-C-375

Circuit Breakers, Molded Case; Branch
Circuit and Service

W-F-1814

Fuse, Cartridge, High Interrupting
Capacity

1.2 American Association of State Highway and Transportation Officials (AASHTO) Publications.

Standard Specifications for Highway Bridges (1983, 13th Ed.; Interim
Specifications - Bridges 1984)

LTS-1

Structural Supports for Highway Signs,
Luminaires, and Traffic Signals
(1975, 1st Ed.; with Revisions
contained in HB-12 Interim Specs
1978 & 1979)

1.3 American National Standards Institute, Inc. (ANSI) Standards.

C2-1984

National Electrical Safety Code

C78.380-1984

Method for the Designation of
High-Intensity Discharge Lamps

C80.1-1983

Rigid Steel Conduit - Zinc Coated

C82.4-1985

Ballasts for High-Intensity-Discharge
and Low-Pressure Sodium Lamps
(Multiple Supply Type)

C119.1-1974	Sealed Insulated Underground Connector Systems Rated 600 Volts
C136.2-1985	Voltage Classification of Luminaires Used in Roadway Lighting Equipment
C136.3-1984	Luminaire Attachments Used in Roadway Lighting Equipment
C136.6-1984	Interchangeability of Metal Heads and Reflector Assemblies Used in Roadway Lighting Equipment
C136.9-1984	Mechanical Interchangeability of Socket Support Assemblies for Use in Metal Heads Used in Roadway Lighting Equipment
C136.10-1979	Physical and Electrical Interchangeability of Photocontrol Devices, Plugs, and Mating Receptacles Used in Roadway Lighting Equipment
C136.11-1979	Multiple Sockets Used in Roadway Lighting Equipment
C136.14-1980	Enclosed Side-Mounted Luminaires for Horizontal-Burning High-Intensity Discharge Lamps Used in Roadway Lighting Equipment
C136.15-1980	Field Identification of High-Intensity Discharge and Low-Pressure Sodium Lamps in Luminaires Used in Roadway Lighting Equipment

1.4 American Society for Testing and Materials (ASTM) Publications.

A 36-84a	Structural Steel
A 48-83	Gray Iron Castings
A 123-84	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153-82	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
B 8-81	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

1.5 Illumination Engineering Society (IES) Publication.

RP-8-1983	Roadway Lighting
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1.6 Institute of Electrical and Electronics Engineers (IEEE) Standards.

No. 142-1982

Recommended Practice for Grounding of
Industrial and Commercial Power
Systems

1.7 National Electrical Manufacturers Association (NEMA) Standards.

AB 1-1975
(R 1981)
Incl Rev 1 thru 3

Molded Case Circuit Breakers

FB 1-1983
(R 1984)

Fittings, Cast Metal Boxes, and
Conduit Bodies for Conduit and Cable
Assemblies

PB 1-1984

Panelboards

SH 5-1969
(R 1979)

Tubular Steel, Aluminum and
Prestressed Concrete Roadway
Lighting Poles

TC 6

Plastic Conduit Fitting

SG 3

Low Voltage Circuit Breaker

1.8 National Fire Protection Association (NFPA) Standard.

70-1987

National Electrical Code

1.9 Underwriters Laboratories Inc. (UL) Publications.

Electrical Construction Materials Directory (May 1986 with Quarterly
Supplements)

UL 6

Rigid Metal Conduit (Oct 23, 1981, 9th
Ed.; Rev Oct 10, 1983; Errata
Aug 29, 1986)

UL 198E

Class R Fuses (Apr 22, 1982, 3rd Ed.;
Rev thru Feb 19, 1985)

UL 467

Grounding and Bonding Equipment
(Nov 22, 1984, 6th Ed.; Rev thru
Apr 30, 1985)

UL 486A

Wire Connectors and Soldering Lugs for
Use with Copper Conductors (Nov 24,
1980, 7th Ed.; Rev thru Feb 6, 1986)

UL 486B

Wire Connectors for Use with Aluminum
Conductors (Apr 13, 1982, 2nd Ed.;
Rev thru Feb 18, 1986)

UL 489	Molded-Case Circuit Breakers and Circuit-Breaker Enclosures (Oct 15, 1980, 6th Ed.; Rev thru Jan 2, 1986)
UL 514	Outlet Boxes and Fittings (May 14, 1979, 6th Ed.; Rev thru Jun 1, 1982)
UL 854	Service-Entrance Cables (Jun 15, 1979, 6th Ed.; Rev thru Jan 13, 1986)
UL 1242	Intermediate Metal Conduit (Oct 10, 1983, 1st Ed.; Rev Apr 10, 1986)
UL 1571	Incandescent Lighting Fixtures (Feb 7, 1984, 2nd Ed.; Rev thru May 3, 1985)
UL 1572	High Intensity Discharge Lighting Fixtures (Dec 10, 1984, 2nd Ed.; Rev thru Sep 17, 1985)

2. GENERAL REQUIREMENTS. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.1 Code Compliance. The installation shall comply with the requirements and recommendations of NFPA No. 70 and ANSI C2.

2.2 Standard Product. 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.

2.3 Nameplates. Each major component of equipment shall have as a minimum the manufacturer's name, address, and catalog or style number on a nameplate securely attached to the item of equipment. Nameplates for individual items of electrical equipment shall be as specified in referenced publications and shall be provided on each item of equipment.

2.4 Prevention of Corrosion.

2.4.1 Metallic materials shall be protected against corrosion as specified. Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.

2.4.2 Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 123 and A 153.

2.4.3 Luminaires fabricated from ferrous metals, unless hot-dip galvanized or of porcelain enamel finish, shall be factory finished with a weather-resistant finish in accordance with paragraph PAINTING AND FINISHING, except exposure shall be 200 hours. Finish color shall be the manufacturer's standard, unless otherwise indicated.

2.5 Unusual Service Conditions. Items furnished under this section shall be specifically suitable for the following unusual service conditions.

2.6 Verification of Dimensions. The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

3. SUBMITTALS.

3.1 Proof of Compliance. Where materials or equipment are specified to conform to the standards or publications, and requirements of AASHTO, ANSI, ASTM, AEIC, FM, IEEE, IES, NEMA, NFPA, or UL, or to conform to a Fed. Spec., the Contractor shall submit proof that the items furnished under this section of the specifications conform to the specified requirements. The label of, or listing in the Electrical Construction Materials Directory of UL or listing in the Approval Guide of FM or the manufacturer's certification or published catalog specification data statement that the items comply with applicable specifications, standards, or publications and with the manufacturer's standards will be acceptable evidence of such compliance.

3.2 Shop Drawings. After receiving complete material lists and before installation of any of these items, the Contractor shall submit complete shop drawings and such other descriptive data as the Contracting Officer may require to demonstrate compliance with the contract documents as required by the CONTRACT CLAUSES and the SPECIAL CLAUSES. Shop drawings shall be submitted for the following items and such other items as the Contracting Officer may direct.

- a. Street-lighting luminaires, and mounting brackets.
- b. Weatherproof pedestal with meter socket.
- c. Lighting pole.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons therefore, shall be submitted with the shop drawings. Approved departures shall be made at no additional cost to the Government.

3.3 List of Equipment and Materials. A complete itemized listing of equipment and materials proposed for incorporation into the work shall be submitted. Each such itemization shall include an item number, the quantity of items proposed, the name of the manufacturer of each such item.

3.4 Instruction Manuals. Six copies of instruction manuals shall be furnished within 7 calendar days following the completion of factory tests and shall include assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked and all documents previously submitted and approved. Manuals shall also include data outlining step-by-step procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment and their basic operating features shall also be included. Documents shall be bound in a suitable binder adequately marked or identified on the spine and front cover. A table of contents page shall be

included and marked with pertinent contract information contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers. Three additional copies of the instruction manuals shall be submitted within 30 calendar days following the approval of the manuals.

3.5 Manufacturer's Certifications.

3.5.1 Certificates of Compliance. Certificates shall be prepared by the manufacturers when the manufacturer's published data or drawings do not indicate conformance with other requirements of these specifications.

3.5.2 Certified Factory Test Reports. Certified factory test reports shall be submitted when manufacturers perform routine factory tests normally performed by the manufacturer, including tests required by standards listed in paragraph: APPLICABLE PUBLICATIONS. Additional certification is required to verify each transformer has passed a production line impulse test consisting of one reduced-wave and one full-wave lightning impulse test on each fully-insulated high-voltage terminal.

3.6 Contractor's Data. The Contractor shall submit the following types of data to supplement the manufacturer's data and drawings and Contractor's drawings.

3.6.1 Certifications. Certifications shall be submitted when specified or required, including Certification of the Qualifications of Medium-Voltage Cable Installers, Certified Factory and Field Test Reports, and Certificates of Compliance submitted in lieu of other proofs of compliance with these contract provisions.

3.6.2 Certified Field Test Reports. Field tests shall be made and test reports shall be written and certified by the Contractor to the Contracting Officer. Field tests shall include cable, operational, and resistance-to-ground tests.

3.7 Contractor's Drawings. The Contractor shall submit drawings as required to supplement contract drawings, manufacturer's data and drawings, and Contractor's data to demonstrate compliance with applicable contract requirements. Drawings shall be dimensioned or scaled to show the relative arrangement and mounting details of the equipment or equipment assemblies.

4. MATERIALS AND COMPONENTS. Materials and equipment shall conform to the following requirements.

4.1 Cables. Cables shall be of annealed copper, except that 1350 alloy aluminum conductors may be used as an equivalent for copper conductors of No. 6 AWC and larger. Intermixing of copper and aluminum conductors in these sizes is not permitted, except at connections to conductors not provided under this contract. Design is based on copper conductors and aluminum conductors shall have an ampacity not less than that of the indicated copper conductors. Cables shall be single-conductor type, unless otherwise indicated.

4.1.1 Low-Voltage Cables. Low-voltage cables shall conform to UL 854 for Type USE service entrance cable and shall utilize either cross-linked, thermosetting-polyethylene or ethylene-propylene-rubber insulation.

4.1.2 Grounding Cables. Grounding cables shall be bare, except where installed in conduit with associated phase conductors. Insulated cable shall be of the same material, green color-coded, and shall be insulated to match associated phase conductors, except that cable need be rated no more than 600 volt. Bare cables shall be ASTM B 8 soft-drawn unless otherwise indicated; aluminum is not acceptable.

4.2 Cable Joints, Terminations, and Connectors.

4.2.1 Connectors for Low-Voltage Cables. Fed. Spec. W-S-610; UL 486A for copper conductors and UL 486B for aluminum conductors; and ANSI C119.1 for sealed insulated connectors.

4.3 Cast Iron. ASTM A 48, Class 30B, minimum.

4.4 Concrete. Concrete shall be 2500 psi at 28 days as specified in SECTION: CONCRETE. Duct liner shall be of monolithic construction. Where a connection is made to an existing duct line, the concrete encasement shall be well bonded or doweled to the existing encasement.

4.5 Conduit and Fittings, Steel.

4.5.1 Conduit, Intermediate Metal. UL 1242.

4.5.2 Conduit, Rigid. ANSI C80.1 and UL 6.

4.5.3 Conduit Outlets and Fittings. NEMA FB 1, and UL 514.

4.6 Duct and Conduit Calking Compound. Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F., shall not slump at a temperature of 300 degrees F., and shall not harden materially when exposed to the air. Compounds shall readily calk or adhere to clean surfaces of asbestos-cement, fiber, or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

4.7 Duct and Fittings, Nonmetallic Type for Installation Underground. Wall thicknesses and fittings shall be suitable for the application. Ducts shall be single, round-bore type. Ducts shall be of the same material when used for applications requiring the same type of wall thickness.

4.7.1 Plastic. NEMA TC 6. Conduit fittings shall conform to the applicable NEMA standards, except that where NEMA standards for conduit fittings do not exist for the type of plastic installed, fittings shall be as recommended by the conduit manufacturer.

4.8 Grounding and Bonding. Equipment, UL 467. Wire, ASTM B 8, softdrawn copper.

4.9 Lamps and Ballasts, High-Intensity-Discharge Type. Lamps shall be suitable for the burning position utilized. Ballasts shall conform to ANSI C82.4; shall be coordinated to the lamp the ballast supplies; shall be rated for the voltage indicated; and shall have a power factor of not less than 90 percent, a crest factor of 2.0 or less, and a voltage range of not less than plus or minus 10 percent. Ballasts shall be suitable for operating at 5 degrees F. and above.

4.9.1 High-Pressure Sodium Lamps. ANSI C78.380, designations S50VA-250, S55SC-150, or S545SB-100, installed where indicated.

4.10 Luminaire Components, Roadway Lighting.

4.10.1 Luminaires. Attachments, ANSI C136.3. Classification, ANSI C136.2. Field identification marking, ANSI C136.15. Interchangeability, ANSI C136.6 for metal heads and reflectors, and ANSI C136.9 for sockets. Luminaires, side-mounted, ANSI C136.14. Sockets, ANSI C136.11.

4.10.2 Photo-Control Devices. ANSI C136.10.

4.11 Luminaires, Floodlighting. UL 1571 and UL 1572.

4.12 Nameplates. Nameplates shall be made of corrosion-resistant metal with not less than 1/4-inch tall raised or engraved characters. The nameplate shall be mounted on the front of the enclosure.

4.13 Padlocks. Padlocks shall conform to Fed. Spec. FF-P-101, type and size determined by the Contracting Officer.

4.14 Poles. NEMA SH 5.

4.14.1 Metal. Poles shall be steel or aluminum.

4.15 Protective Apparatus and Metering Devices.

4.15.1 Circuit Breakers, Low-Voltage. Power, NEMA SG 3; molded-case, NEMA AB 1 and UL 489.

4.15.2 Fuses, Low-Voltage, Current-Limiting Types. Fed. Spec. W-F-1814, Class L or UL 198E, Class R.

4.15.3 Panelboards. NEMA PB 1.

5. GENERAL INSTALLATION REQUIREMENTS. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of SECTION: IRRIGATION SYSTEM. Concrete work shall conform to the requirements of SECTION: CONCRETE.

6. CABLES, GENERAL REQUIREMENTS. The type of installation, sizes, and number of cables shall be as indicated. Conductors larger than No. 8 AWG shall be stranded. Each circuit shall be identified by means of fiber, laminated plastic, or nonferrous-metal tags, or approved equal, in each manhole, each handhole, each junction box, and at each terminal. Loads shall be divided as evenly as practicable on the various phases of the system. Manufacturer's written recommendations shall be furnished for each type of splice, and for fireproofing

application methods, and shall be approved before any work is done. Compounds and tapes shall be electrical grade suitable for the cable insulation provided and shall use design materials and techniques recommended by the manufacturer. Maximum length of cable pull and cable pulling tensions shall not exceed the cable manufacturer's recommendations.

6.1 Duct Line Installation. Cables shall be installed in duct lines where indicated. Cable splices in low-voltage cables shall be made in manholes and handholes only, except as otherwise noted. Neutral and ground conductors shall be installed in the same duct with their associated phase conductors.

7. LOW-VOLTAGE CABLES. Cable shall be rated 600 volts. Other parts of cable systems such as splices and terminations shall be rated at not less than 600 Volts. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of Fed. Spec. W-S-610 and conforming to the applicable requirements of UL 486A. Splices in wires No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, Type II, Class 2 of Fed. Spec. W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. All splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

8. DUCT LINES. Low-voltage lines run elsewhere may be nonencased direct-burial, thick-wall type or as indicated.

8.1 Requirements. Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3-inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends as required, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes. Duct line markers shall be provided as indicated at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures. In lieu of markers, a 5-mil brightly colored plastic tape not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion resistant 1-mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

8.2 Treatment. Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. After a duct line is completed, a standard flexible mandrel shall be used for cleaning followed by a brush with stiff bristles. Mandrels shall be at least 12 inches long and have diameters 1/4 inch less than the inside diameter of the duct being cleaned. Pneumatic rodding may be used to draw in lead wires. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

8.3 Concrete Encasement. Each single duct shall be completely encased in concrete with a minimum of 3 inches of concrete around each duct, except that only 2 inches of concrete are required between adjacent electric power or adjacent communication ducts and 4 inches of concrete shall be provided between adjacent electric power and communication ducts. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. At any point, except railroad crossings, tops of concrete encasements shall be not less than 18 inches below finished grade or paving. At railroad crossings, duct lines shall be encased with concrete, reinforced as indicated, and tops of concrete encasements shall be not less than 5 feet below tops of rails, unless otherwise indicated. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not further apart than 4 feet on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 6 inches vertically.

8.4 Nonencased Direct-Burial. Top of duct lines shall be below frost line but not less than 24 inches below finished grade. Ducts shall be buried below frost line but in the earth and shall be installed with a minimum of 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 12 inches of earth is required. Bottoms of trenches shall be graded toward manholes or handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand or stone-free earth, 3-inch layers of sand or stone-free earth shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts in direct-contact tiered fashion. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 4-inch layer of backfill cover shall be sand or stone-free earth compacted as previously specified. Duct banks may be held in alinement with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alinement prior to backfilling. Selected earth at duct banks shall be thoroughly tamped in 4- to 6-inch layers.

8.5 Installation of Couplings. Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved. In the absence of specific recommendations, various types of duct joint couplings shall be made watertight as specified.

8.5.1 Plastic Duct. Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick one-quarter-turn twist to set the joint tightly.

9. LIGHTING.

9.1 Roadway Lighting Luminaires. Roadway luminaires shall be of the enclosed type each consisting of a cast aluminum housing, a finished aluminum reflector for corrosion protection, an enclosing glass refractor or globe providing the indicated IES RP-8 type light distributions, and a slip-fitter capable of adapting to 1-1/4 inch through 2-inch mounting brackets. Luminaire heads shall have standard dimensions suitable for interchangeable, standard optical assemblies. Heads shall be internally wired and rated 600 volts. Where indicated, luminaires shall be equipped with weatherproof plug-in or twist-lock receptacles to receive photo-control elements. Lamps shall be of the sizes and types indicated and provided with appropriate ballasts.

9.2 Vandal-Resistant Construction. Where indicated, luminaires shall be provided with vandal-resistant construction. Exposed diffusers, reflectors, or refractors shall be of a polycarbonate resin, except that other material may be used if protected by a polycarbonate resin shield or cast metal guard. Luminaires mounted 15 feet and less above grade shall have exposed screws of the tamper-resistant type.

9.3 Photo-Control. Where indicated, luminaires shall be individually controlled by a photo-control element mounted on the luminaire. Each photo-control element shall have an adjustable operating range of approximately 0.5 to 5.0 foot candles and shall be mounted in a replaceable, weatherproof, plug-in or twist-lock assembly.

9.4 Time-Control. Where indicated, luminaires shall be group controlled by astronomic, electrically wound time switches having 20-minute carry-over features and automatic adjustment provisions to allow for seasonal changes of sunset and sunrise. Adjustable settings shall allow turning on either 20 or 40 minutes before or after sunset, in addition to sunset, and adjustable off positions shall allow turning off from 8.30 p.m. to 2.30 a.m., in addition to sunrise. Three-position key-operated control switches marked ON, OFF, and AUTOMATIC shall be provided for override of time-control systems. Time switches may directly control opening and closing of lighting circuits if switches provided have an adequate rating. Where switches do not have such a rating, contactors of adequate rating and of the required number of poles shall be provided. Each time-control equipment assembly shall be mounted integrally in an enclosure suitable for outdoor operation.

9.5 Poles. Lighting poles shall be a nominal 20 feet in length of aluminum. Poles shall be suitable for use with underground supply conductors. Poles shall be designed for a wind velocity of 100 mph at the base of the pole, for a wind gust factor of 1.3, and for the height and drag factors recommended by AASHTO LTS-1. The effective projected area of luminaires and other pole-mounted devices shall be taken into account in pole design. Poles shall have grounding provisions. Bases shall be of the anchor-bolt-mounted type. The type of pole shaft material provided shall not be mixed on any project.

9.5.1 Brackets. Brackets for area lighting shall be of the indicated types. Brackets for floodlights shall have the number of tenons indicated. Slip-fitter brackets shall be coordinated with the luminaires provided, and brackets used with one type of luminaire shall be identical. Brackets shall be not less than 2-inch galvanized steel pipe or equivalent aluminum. On metal poles, brackets shall be of the same metal.

9.5.2 Aluminum Poles. Aluminum poles and aluminum brackets shall have a uniform satin finish.

9.5.3 Pole Setting. Poles shall be mounted on cast-in-place or power-installed screw foundations. Where indicated, concrete poles shall be embedded in accordance with the details shown. Conduit ells shall be provided for cable entrances into pole interiors.

9.5.3.1 Cast-In-Place Foundations. Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. After the concrete has cured, pole anchor bases shall be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles shall be set plumb. Anchor bolts shall be the manufacturers' standard, but not less than required by NEMA SH 5, and not less than necessary to meet the pole wind loading specified herein and other design requirements.

9.5.3.2 Power-Installed Screw Foundations. Power-installed screw foundations having the required strength and mounting-bolt, top plate dimensions may be utilized. Screw foundations shall be of at least 1/4-inch thick structural steel conforming to ASTM A 36 and hot-dip galvanized in accordance with ASTM A 123. Conduit slots in screw foundation shafts shall be approximately 18 inches below tops of shafts on opposite sides and top plates shall be marked to indicate orientation. Design calculations indicating adequate strength shall be approved before installation of any screw foundation is permitted.

10. CONCRETE PULLBOXES. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers. Concrete reinforcing shall be that which is regularly used in the standard products of the manufacturer. Pullbox tops shall be flush with sidewalks or curbs or placed 1/2-inch above surrounding grades when remote from curbed roadways or sidewalks. Covers shall be marked Low-Voltage and provided with two lifting eyes and two hold-down bolts. Each box shall have a suitable opening for a ground rod. Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar.

11. GROUNDING. Neutral conductors, cable shields, metallic cable sheaths and armor, metallic conduits, cable terminations, junction boxes, poles, surge arresters, fencing enclosing electrical equipment, and other noncurrent-carrying metallic parts of equipment shall be grounded.

11.1 General Requirements. A resistance of not greater than 25 ohms shall be provided, unless otherwise specified. Ground resistances shall be measured in normally dry conditions not less than 48 hours after rainfall. Resistances of systems requiring separate ground rods, rather than a counterpoise, shall be measured separately before bonding below grade. The combined ground resistance of

separate systems bonded together below grade may be used to meet the specified ground resistance, but the minimum number of rods indicated must still be provided.

11.1.1 Ground Rods. Ground rods shall be copper-clad steel, and shall be not less than 3/4 inch in diameter by 8 feet in length. Unless otherwise indicated, ground rods shall be driven into the ground until tops of rods are approximately 1 foot below finished grade. In counterpoise systems, tops of ground rods shall be approximately at elevations of counterpoises. Where the specified ground resistance cannot be met with the indicated number of ground rods, additional ground rods, longer ground rods, or deep-driven sectional rods shall be installed and connected until the specified resistance is obtained, except that not more than three additional 8-foot ground rods shall be required at any one installation. Ground rods shall be spaced as evenly as possible at least 6 feet apart and connected 2 feet below grade.

11.1.2 Connections. Connections above grade shall be made with bolted solderless connectors and those below grade shall be made by a fusion-welding process. In lieu of a fusion-welding process, a compression ground grid connector of a type which uses a hydraulic compression tool to provide the correct circumferential pressure may be used. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire. Where ground wires are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be utilized.

11.2 Neutral Grounding. Neutral conductors shall be grounded where indicated. Ground wires shall be not less than No. 1/0 AWG, except that where the rated phase current exceeds 400 amperes, the size of neutral ground wires shall be increased to not less than one-half the size of the cross-sectional area of the individual phase conductors. Neutral ground wires shall be protected by conduit where such wires run exposed above grade in nonfence-enclosed areas or are run through concrete construction. Where concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground wire and the opening shall be sealed with a suitable compound after installation of the ground wire. Bends greater than 45 degrees in ground wire connections to the ground rods or counterpoises are not permitted.

11.3 Equipment Grounding. Equipment frames of metal-enclosed equipment, medium-voltage cable shields at cable joints and terminations, metal splice boxes, chain-link fencing, and other noncurrent-carrying metal items, shall be grounded unless otherwise indicated. Connections to earth shall be made in the same manner as required for neutral grounding. Equipment or devices operating at less than 750 volts may be connected to secondary neutral grounds. Equipment operating at more than 750 volts to ground shall be provided with grounds separate from secondary neutral grounds, but both grounds shall be bonded together below grade at the ground rods or may utilize a common counterpoise.

11.4 Lighting Pole Grounding. Bases of lighting poles shall be connected to an adjacent ground rod by means of a No. 8 AWG wire. A ground connection from poles back to neutral ground points shall also be provided utilizing either metal raceways or ground wires.

11.5 Manhole, Handhole, or Concrete Pullbox Grounding. Ground rods installed in electrical-distribution-system manholes, handholes, or concrete pullboxes shall be properly connected to the cable shielding, metallic sheath, and armor at each cable joint or splice by means of No. 4 AWG or equivalent braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Ground wires shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.

11.7 Metal Splice Box Grounding. Metal splice boxes for medium-voltage direct-burial cable shall be grounded by connection to a ground rod located within 2 feet of each splice box using a ground wire having a current-carrying capacity of at least 20 percent of the individual phase conductors in the associated splice box, but not less than No. 6 AWG.

12. METER PEDESTALS.

12.1 General. Meter pedestals shall be NEMA 3R raintight and suitable for service equipment. Meter pedestals shall be of the concrete-base-mounted type, consisting of a meter section and panelboard section, assembled as a single integral unit in a substantial weatherproof and tamperproof metal enclosure. The metal enclosure shall have locking provisions and shall be provided with a 2-inch padlock. Exterior shall have rust inhibiting primer and two coats of dark green enamel. Interior finish shall be white enamel. Arrangement shall be as shown. Meter installation shall meet APS requirement. Panelboard shall be circuit breaker equipped, Type I. Circuit breaker interrupting capacities shall conform to Fed. Spec W-C-375 unless otherwise indicated. Single-pole breakers shall be full module size; two poles shall not be installed in a single module. Plug-in type circuit breakers are not acceptable. Directories shall be typed to indicate load served by each circuit and mounted in holder behind protective covering.

12.2 Installation. Meter pedestals shall be mounted on a concrete base, reinforced as indicated. The top of the concrete base shall be approximately 3 inches above the finished grade. The base shall be of adequate size to project beyond the equipment and sloped to drain. Concrete shall be 3000 psi minimum at 28 days. The metal enclosure shall be secured to the concrete base by a minimum of 4-1/2 inch galvanized anchor bolts.

13. TESTS.

13.1 Operating Test. After the installation is completed, the Contractor shall conduct an operating test for approval. Equipment shall be demonstrated to operate in accordance with the requirements herein. Tests shall be performed in the presence of the Contracting Officer. The Contractor shall furnish instruments and personnel required for the test and the Government will furnish the necessary electric power.

13.2 Ground-Resistance Measurements. Ground-resistance measurements of each ground rod shall be taken and certified by the Contractor to the Contracting Officer. No part of the electrical distribution system shall be energized prior to the resistance testing of that system's ground rods and grounding system and

submission of test results to the Contracting Officer. Test reports shall indicate the location of the ground rod and grounding system and the resistance and the soil conditions at the time the test was performed. When the building water service is used as a ground or part of the grounding system, ground-resistance measurements shall also be made of this connection. Ground-resistance measurements shall be made in normally dry weather, not less than 48 hours after rainfall, and with the ground under test isolated from other grounds. The resistance to ground shall be measured using the fall-of-potential method described in IEEE No. 142.

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ELEC. DIST. SYS. AMENDMENTS

21. SECTION 16A, ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

21.1 Page 16A-1, paragraph 1.1. To the list of Federal Specifications add:

CC-M-180

Motors, AC Fractional

W-P-115

Panel Boards

21.2 Pages 16A-1 and 16A-2, paragraph 1.3. Delete standards C78.380-1984 through C136.15-1980, inclusively.

21.3 Page 16A-2.

21.3.1 Paragraph 1.4. Delete the publication entirely: B8-81

21.3.2 Delete paragraph 1.5, entirely.

21.4 Page 16A-4, paragraph 1.9.

21.4.1 Delete the publications: UL 1571, UL 1572

21.4.2 To the list of Underwriters Laboratories publications add:

UL 508 & 845

Motor Control and Motor Control Centers

UL 943

Ground Fault Circuit Interruptor

21.5 Page 16A-5, paragraph 3.2. Delete subparagraphs a. through c. inclusive: and insert:

a. Electrical Panel.

b. GFI Outlet, 20A.

c. Motor Starter.

21.6 Pages 16A-6 and 16A-7. Delete paragraphs 4.1 to 4.2.1, inclusive and insert:

4.1 Panel Board. Dead Front Construction Fed. Spec. W-P-115, NEMA PB-1.

4.1.1 Load Center Panel Board, Type I, Class 2.

4.2 Receptables.

4.2.1 Ground Fault Circuit Interrupter UL 943.

21.7 Page 16A-8.

21.7.1 Delete paragraphs 4.9 to 4.14.1, inclusive and insert:

4.9 Motors, AC Fractional and Integral Horsepower, Fed. Spec. CC-M-180.

4.10 Motor Controls and Motor Control Centers, NEMA ICS 1, ICS 2, ICS 4 and ICS 6, and UL 508 and 845.

21.7.2 Delete paragraph 4.15.3.

21.7.3 Paragraph 6.

21.7.3.1 Line 1. Delete "CABLES" and insert: WIRES AND CABLES

21.7.3.2 Line 2. Delete "cables" and insert: wires and cables

21.8 Page 16A-7. Delete paragraph 7, entirely.

21.9 Pages 16A-11 and 16A-12. Delete paragraphs 9 through 11, inclusive and insert:

9. DELETED.

10. DELETED.

11. GROUNDING. Neutral conductors, metallic conduits, junctions boxes, fencing enclosing electrical equipment, and other noncurrent-carrying metallic parts of equipment shall be grounded.

21.10 Page 16A-13, paragraph 11.1.1, line 2. Delete "8 feet" and insert: 10 feet

21.11 Page 16A-13 and 16A-14. Delete paragraphs 11.4 through 12.2, inclusively.

16A-16