90312R02
Part 2
2ND COPY

SPECIFICATIONS
(FOR FINAL REVIEW)

CUTOFF WALLS AND CAP FOR LIME AND M-1 SETTLING BASINS

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JUN 2 7 1995
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ROCKY MOUNTAIN ARSENAL
COLORADO

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OCTOBER 1990

Rocky Mountain Arsenal
Information Center
Commerce City, Colorado

US Army Corps
of Engineers
Omaha District

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SPECNET EDITED SPECIFICATIONS

The specifications included in this volume are edited for 90% final design using the Omaha District's SpecNet computerized specifications system. Changes to the master guide specifications have been specially marked to indicate portions intended for deletion and those intended to be inserted to the master guide specifications. This gives the reviewer the ability to clearly see the proposed changes to the master guide specification.

The following is the key to the symbology used in the "edited" specifications:

This symbol indicates text that the designer intends to delete from the guide specification for the final contract specifications.

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After the designers review and incorporate all of the valid 90% review comments in the specifications, the latest changes are automatically made by the SpecNet specifications system to produce an advertised set of specifications in the same format as previous specifications.

INDEXES will not be updated until the document is in its advertised form. The macro program that creates the index only works on the specifications when the titles of all the paragraphs are in there advertised form.

FOR QUALITY ASSURANCE REVIEWS - ATTACHMENTS WILL NOT BE PROVIDED. (ATTACHMENTS WILL BE PROVIDED WITH THE FINAL REVIEW DOCUMENT.)

BIDDING SCHEDULE

BASIC

Item No.	Description	Estimated Quantity	Unit	Unit Price	Amount
1.	Entire work, complete, excluding Items listed below	Job	L.S.	---	$_____
	M-1 BASINS				
2.	Site Work	Job	L.S.	---	$_____
3.	Steel Sheet Pile	20,200	S.F.	$_____	$_____
	LIME SETTLING BASINS				
4.	Site Work	Job	L.S.	---	$_____
5.	Slurry Trench	72,500	S.F.	$_____	$_____
6.	Ground-Water Extraction Trench	8,800	S.F.	$_____	$_____
7.	Contaminated Excavations, not including slurry trenches, utilities, removals.	32,300	C.Y.	$_____	$_____
8.	Fill material under Vegetative Cover				
	a) Random Fill	7,900	C.Y.	$_____	$_____
	b) Clay	820	C.Y.	$_____	$_____
9.	Vegetative Cover	14,260	S.Y.	$_____	$_____
10.	Lift Station and Force Main	Job	L.S.	---	$_____
11.	Electrical	Job	L.S.	---	$_____
12.	Seeding	Job	L.S.	---	$_____
13.	Instrumentation	Job	L.S.	---	$_____

TOTAL AMOUNT (Item 1 thru Item 13) $_____

odes
Dist | and / or Special
A-1

Notes:

1. Quantity for unit priced item is estimated only and the respective unit price will prevail in the event of an overrun or underrun subject to Contract Clause "Variation in Estimated Quantities."

2. Bid prices must be entered for all items of the schedule. Total amount bids submitted without bid prices being entered on individual items will be rejected. Extensions will be subject to verification by the Government. In case of variation between the unit price and the extension, the unit price will be considered the bid. In case of variation between the individual bid item prices and the total amount, the individual bid prices will be considered the bid.

3. A modification to a bid which provides for a single adjustment to the total amount bid should state the application of the adjustment to each respective unit price and lump sum price affected. If the modification is not so apportioned, the single adjustment will be applied to Item No. 1 in the Bidding Schedule.

SPECIFICATIONS FOR CONSTRUCTION OF

CUTOFF WALLS AND CAP FOR LIME AND M-1 SETTLING BASINS
ROCKY MOUNTAIN ARSENAL, COLORADO

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#(4)#
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Transmittal Form (ENG Form 4025)
Construction Quality Control Daily Report Form
Project Sign Std. Details OD15-9A12 and [OD15-9A22] [OD15-9A23]

[ALTERNATE 1]
#(2,3,4A,5)#

1. **COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK.** The Contractor shall commence work under this contract within ten (10) calendar days after the date of receipt by him of Notice to Proceed, prosecute said work diligently, and complete the entire work [except seeding] ready for use not later than [_____ calendar days after receipt of Notice to Proceed.] [the number of calendar days after receipt of Notice to Proceed, as set out on page SF-1 of Standard Form 1442 and page SF-2a of the BIDDING SCHEDULE.] The time stated for completion shall include final cleanup of the premises.

1.1. **START WORK.** Evidence that the Contractor has started procurement of materials, preparation and submission of shop drawings, preparation of subcontracts, and other preparatory work will satisfy the requirement that work commence within ten (10) calendar days after receipt of Notice to Proceed. Therefore, work need not be commenced at the construction site within ten (10) calendar days. (based on FAR 52.212-3)

[ALTERNATE 2]
#(2,5,8)#

1. **COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK.** The Contractor shall commence work under this contract within ten (10) calendar days after the date of receipt by him of Notice to Proceed, prosecute said work diligently, and complete the entire work ready for use not later than the number of calendar days after receipt of Notice to Proceed as set out in completion Schedule below. The time stated for completion shall include final cleanup of the premises.

Completion Schedule

	Description of Work	Calendar Days
1.1.	All work except installation of (List extra-long lead items)	(300 or less)

#(6)#

1.2.	Install new (List extra-long lead items)	(360)

1.3. **START WORK.** Evidence that the Contractor has started procurement of materials, preparation and submission of shop drawings, preparation of subcontracts, and other preparatory work will satisfy the requirement that work commence within ten (10) calendar days after receipt of Notice to Proceed. Therefore, work need not be commenced at the construction site within ten (10) calendar days.

[ALTERNATE 1]
#(2,3,4A,5)#

2. **LIQUIDATED DAMAGES-CONSTRUCTION.**

2.1. **FAILURE TO COMPLY.** If the Contractor fails to complete the work [within the time specified in the contract, or any extension, the Contractor shall pay to the Government as liquidated damages, the sum of _____ for each day of delay.] [within the time inserted on the BIDDING SCHEDULE and in Item 11 on page SF-1 of Standard Form 1442, or any extension, the Contractor shall pay to the Government as liquidated damages, the sum of _____ for each day of delay.]

2.2. **CONTRACT TERMINATED.** If the Government terminates the Contractor's right to proceed, the resulting damage will consist of liquidated damages until such reasonable time as may be required for final completion of the work together with any increased costs occasioned the Government in completing the work.

2.3. **CONTRACT NOT TERMINATED.** If the Government does not terminate the Contractor's right to proceed, the resulting damage will consist of liquidated damages until the work is completed or accepted. (based on FAR 52.212-5)

[ALTERNATE 2]
#(2.5)#
2. LIQUIDATED DAMAGES-CONSTRUCTION.

2.1. **FAILURE TO COMPLY.** If the Contractor fails to complete the work within the time specified in the contract, or any extension, the Contractor shall pay to the Government as liquidated damages, the applicable sum as set out in the schedule below for each calendar day of delay.

2.2. **CONTRACT TERMINATED.** If the Government terminates the Contractor's right to proceed, the resulting damage will consist of liquidated damages until such reasonable time as may be required for final completion of the work together with any increased costs occasioned the Government in completing the work.

2.3. **CONTRACT NOT TERMINATED.** If the Government does not terminate the Contractor's right to proceed, the resulting damage will consist of liquidated damages until the work is completed or accepted. (based on FAR 52.212-5)

#(3)#

Liquidated Damages Schedule

#(2.7)#

2.4. NOT USED. EXCEPTION TO COMPLETION [TIME] AND LIQUIDATED DAMAGES [SCHEDULES]. In case the Contracting Officer determines that [seeding,] [sodding,] [and/or planting] and/or the specified maintenance thereof is not feasible during the construction period, such work will be excepted from the [completion time and liquidated damages] [completion and liquidated damages schedules]. This work shall be accomplished during the first [seeding], [sodding,] [and/or planting] period and the specified maintenance period following the completion date.

#(3)#

2.5. **COMPUTING COMPLETION DATES FOR NON-WORK PERIOD.** No work will be required at the construction site during the period _____ through _____ inclusive. The days in this period will not be counted when computing the calendar days for completion of the work. The Contractor may perform work at the site during all or any part of this period upon giving prior written notice to the Contracting Officer. No time extensions will be granted for delays during this period.

#(8)#

2A. ORDER OF WORK. The Contractor shall schedule all work at the M-1 Basins to be completed by 01 October 1991.

#(8A)#

[2B. SAG AIR SHOW/OPEN HOUSE. Work shall be scheduled so that there will be no construction during the 3 days (Friday, Saturday, and Sunday) of the annual air show and open house at Offutt AFB. Construction sites shall be in safe and orderly condition with no open holes, materials neatly and safely stored, equipment properly secured, and all debris removed. The open house usually occurs during the month of August.]

3. CONTRACT DRAWINGS AND SPECIFICATIONS.

#(9)#

3.1. SETS FURNISHED. [Twenty-five (25)] [Seven (7)] sets of half-size bid drawings and specifications including amendments (except applicable publications incorporated into the Technical Provisions by reference) will be mailed to the Contractor when the Notice To Proceed is issued. The bid drawings as amended shall be utilized in the performance of the work until contract drawings (i.e., bid drawings that have been posted with all amendment changes) are mailed to the Contractor. [Thirty (30)] [Eleven (11)] sets of contract drawings [(5 sets full size and 25 sets half-size)] [(4 sets full size and 7 sets half-size)] will be mailed to the Contractor as soon as possible, but no later than sixty (60) days after Notice to Proceed. The work shall conform to the contract drawings, set out in the drawing index, all of which form a part of these specifications. The work shall also conform to the standard details bound or referenced herein.

3.2. NOTIFICATION OF DISCREPANCIES. The Contractor shall check all drawings furnished him immediately upon their receipt and shall promptly notify the Contracting Officer of any discrepancies. Dimensions marked on drawings shall be followed in lieu of scale measurements. Enlarged plans and details shall govern where the same work is shown at smaller scales. The Contractor shall compare all drawings and verify the figures before laying out the work and will be responsible for any errors which might have been avoided thereby.

#(10)#

4. SUBMITTALS.

#(10A)#

4.1. SUBMITTAL REGISTER (ENG FORM 4288). The Contractor will be furnished one (1) set of ENG Forms 4288 at the preconstruction conference on which will be listed each item of equipment and material of each type for which fabricators drawings, and/or related descriptive data, test reports, samples, spare parts lists, O&M manuals, or other types of submittals are required by the specifications. Columns c thru o of ENG Form 4288 will be completed by the Government. A copy of the ENG Form 4288 may be obtained by written request to CEMRO-ED-DI, 215 N. 17th Street, Omaha, NE 68102-4978. The Contractor shall complete columns p, q, and r within twenty (20) calendar days after the preconstruction conference and return six (6) completed copies to the Contracting Officer's Representative for approval. Dates entered in columns p and q shall not include mail or delivery time. The ENG Forms 4288 will become a part of the contract after approval. [Six (6) additional copies of a revised ENG Form 4288 with column a, NAS ACTIVITY CODE, filled in shall be submitted with the completed network analysis system when a network analysis system is a contract requirement.] Column b shall be left blank for use later to record the respective transmittal and item number indicated for the submittal items(s) listed on the transmittal form entitled: "TRANSMITTAL OF SHOP DRAWINGS,

EQUIPMENT DATA, MATERIAL SAMPLES, OR MANUFACTURER'S CERTIFICATES OF COMPLIANCE" (ENG Form 4025).

#(2,11)#

4.1.1. **Scheduling.** Drawings on component items forming a system or that are interrelated shall be scheduled to be correlated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of 20 calendar days exclusive of mailing time) will be allowed on the register for review and approval. No delay damages or time extensions will be allowed for time lost in late submittals or resubmittals for such items. [An additional 20 calendar days shall be allowed on the register for review and approval and possible resubmittal of material and equipment lists for food service equipment [and shop drawings and equipment material submittals for refrigeration and HVAC control systems.]]

4.1.2. **Application to Contract.** The approved submittal register will become a part of the contract and Contractor will be subject to requirements thereof. This register and the progress schedules shall be coordinated.

4.2. **SUBMITTAL PROCESS.** The Contractor shall submit all items listed on the contract drawings and listed or specified in the other sections of these specifications. The Contracting Officer may request submittals in addition to those listed when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same used in the contract drawings. Submittals shall be made in the respective number of copies and to the respective addresses set forth below. Each submittal shall be complete and in sufficient detail for ready determination of compliance with the contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor's Quality Control (CQC) Engineer and each respective transmittal form (ENG Form 4025) shall be stamped, initialed, and dated by the CQC Engineer certifying that the accompanying submittal complies with the contract requirements. Submittals shall include such items as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operation charts or curves; test reports; test cylinders; samples, O&M manuals including parts lists; certifications; warranties and other such required submittals. Submittals pertinent to materials and equipment which are subject to advance approval shall be scheduled and made prior to the acquisition or the delivery thereof.

4.2.1. **Categories of Submittals.** The categories of items specified to be submitted shall be submitted as follows:

4.2.1.1. **Category I.** All items listed as Category I submittals in the various sections shall be mailed directly to the addressee shown below as directed. For each submittal, a completed information copy of the attached transmittal form shall also be mailed to the Area Engineer and to the Construction Division of the Omaha District.

#(2,12)# [ALTERNATE 1]

[An additional copy of Category I submittals (for information only) related to fire protection/detection systems shall be submitted to the Base Civil Engineering Office. The mailing address for these submittals shall be obtained at the preconstruction conference.]

#(2,12)# [ALTERNATE 2]

[Three (3) additional copies of Category I submittals (for information only) related to fire protection/detection systems shall be submitted as follows:

Two (2) copies to: HQ USAFA/DEER

One (1) copy to: AFRCE-CR
The mailing address for these submittals shall be obtained from the Contracting Officers Representative at the preconstruction conference.]

Technical Reviewer
#(2)#
[Engineering Division
Attn: CEMRO-ED-DI
U.S. Army Engineer District, Omaha
215 North 17th Street
Omaha, NE 68102-4978]

#(2,12)#
[Mailing address of Architect-Engineer Firm]

Each required submittal which is in the form of a drawing shall be submitted as one (1) reproducible and one (1) print of the drawing. Drawing prints shall be either blue or black line permanent-type prints on a white background or blueprint. Reproducibles shall be brownline diazo or sepia and shall be of such quality that prints made therefrom are sufficiently clear for microfilm copying.
#(12A)#
All catalog and descriptive data shall be submitted in eight (8) copies. Catalog cuts and other descriptive data which have more than one model, size, or type or which shows optional equipment shall be clearly marked to show the model, size, or type and all optional equipment which is proposed for approval. Submittals on component items forming a system or that are interrelated shall be submitted at one time as a single submittal in order to demonstrate that the items have been properly coordinated and will function as a unit.
#(12A)#

4.2.1.2. **Category II.** Except as noted below, data for all items listed as Category II Submittals in the various sections shall be submitted in five (5) copies to the Area Engineer using the transmittal form. Items not to be submitted in quintuplicate, such as samples and test cylinders, shall be submitted to the Area Engineer accompanied by five (5) copies of the transmittal form.

4.2.2. **Control of Submittals.** The Contractor shall carefully control his procurement operations to assure that each individual submittal is made on or before the corresponding date scheduled on his approved "SUBMITTAL REGISTER."

4.2.3. **Transmittal Form (ENG Form 4025).** The sample transmittal form attached to this section shall be used for submitting both the Category I and Category II submittals, in strict accordance with the instructions on the reverse side thereof. These forms will be furnished to the Contractor. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care should be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item. A separate transmittal form shall be attached to each copy of the data being submitted.

4.2.4. **Approval Action.**

4.2.4.1. **Category I.** All Category I submittals are subject to advance approval. Upon completion of review of Category I submittals, the drawing reproducible and print and other pertinent data will be identified

as having received approval by being so stamped and dated. The drawing print #(12A)# and six (6) sets of all catalog data and descriptive literature will be retained by the Contracting Officer and the drawing reproducible and two (2) sets of catalog data and descriptive literature will be returned to the Contractor.

4.2.4.2. **Category II.** Submittals may be required for "Approval" or for "Information Only." Within the terms of the CONTRACT CLAUSES clause entitled "Specifications and Drawings for Construction," Category II submittals "for approval" are considered to be "shop drawings" and Category II submittals "for information only" are not considered to be "shop drawings." Two (2) copies of Category II submittals for approval will be returned to the Contractor except for samples, test cylinders, and O&M manuals for which two (2) copies of the transmittal form only will be returned to the Contractor. Submittals for "Information Only" will not be returned to the Contractor. No Corps of Engineers' approval action will be required prior to incorporating these "Information Only" items into the work. These Contractor approved "Information Only" submittals will be used to verify that material received and used in the job is the same as that described in the plans and specifications and will be used as record copies. Delegation of this approval authority to the CQC Engineer does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications and will not prevent the Contracting Officer from requiring removal and replacement if nonconforming material is incorporated in the work. This obligation does not relieve the Contractor from the requirement to furnish samples for testing by the Government laboratory or check testing by the Government in those instances where the technical specifications so prescribe.

4.2.5. **Meaning of Approvals.** The approval of the submittals by the Contracting Officer or his authorized representative shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist as the Contractor, under the CQC requirements of this contract, is responsible for the dimensions and design of adequate connections, details and satisfactory construction of all work. After submittals have been approved by the Contracting Officer or his authorized representative, no resubmittal for the purpose of substituting materials or equipment will be given consideration unless accompanied by an acceptable explanation as to why a substitution is necessary.

4.2.6. **When Not Approved.** The Contractor shall make all corrections required by the Contracting Officer or his authorized representative and promptly furnish a corrected submittal in the form and number of copies as specified for initial submittals. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, notice as required under the CONTRACT CLAUSES clause entitled "Changes" should promptly be given to the Contracting Officer.

4.2.7. **Withholding of Payment.** Payment for materials incorporated into the work will not be made if required approvals have not been obtained.

4.3. **CERTIFICATES OF COMPLIANCE.** Any certificates required for demonstrating proof of compliance of materials with specification requirements shall be executed in three copies. Each certificate shall be signed by an official authorized to certify in behalf of the manufacturing company and shall contain the name and address of the Contractor, the project name and location, and the quantity and date or dates of shipment or delivery to which the certificates

apply. Copies of laboratory test reports submitted with certificates shall contain the name and address of the testing laboratory and the date or dates of the tests to which the report applies. Certification shall not be construed as relieving the Contractor from furnishing satisfactory material, if, after tests are performed on selected samples, the material is found not to meet the specific requirements. (EFARS 52.2/9108(c))

4.4. **PURCHASE ORDERS.** Each purchase order issued by the Contractor or his subcontractors for materials and equipment to be incorporated into the project shall (1) be clearly identified with the applicable DA contract number, (2) carry an identifying number, (3) be in sufficient detail to identify the material being purchased, (4) indicate a definite delivery date, and (5) display the DMS priority rating. Copies of purchase orders shall be furnished to the Contracting Officer when the Contractor requests assistance for expediting deliveries of equipment or materials, or when requested by the Contracting Officer for the purpose of quality assurance review.

#(2,13)#

[4.5. **EQUIPMENT ROOM DRAWINGS.** The Contractor shall prepare and submit room plans for all mechanical, electrical, and communication rooms or similar areas.

4.5.1. **Assembled Submittal.** Submittals describing the various mechanical and electrical equipment items which are to be installed in the above described area(s) shall be assembled and submitted under Category I concurrently and accompanied by the room plans.

4.5.2. **Scaled Details.** Plans, consolidated for all trades shall be to scale and shall show all pertinent structural features and other items such as doors, windows, and cabinets required for installation and which will affect the available space. All mechanical and electrical equipment and accessories shall be shown to scale in plan and elevation and/or section in their installed positions. All duct work and piping shall be shown.]

#(2,14)#

[4.6. **OPERATION AND MAINTENANCE INSTRUCTIONS AND/OR MANUALS.** Where required by various technical sections, operations and maintenance instructions and/or manuals with parts lists included shall be provided by the Contractor in quintuplicate, unless otherwise specified, and shall be assembled in book form having a cover indicating the contents by equipment or system name and project title and shall be submitted for approval to the Contracting Officer 30 days prior to final tests of mechanical and electrical systems. Each operation and maintenance manual shall contain a copy of all warranties and a list of local service representatives required by SECTION: WARRANTY OF CONSTRUCTION. If field testing requires these copies to be revised, they shall be updated and resubmitted for approval within 10 calendar days after completion of tests. The Operations and Maintenance Instructions and/or Manuals shall be shown as a separate activity on the Contractor prepared construction schedule bar chart or network analysis system.] [In addition one reproducible unfolded copy of all wiring and control diagrams and approved system layout drawings shall be submitted with the O&M Manuals.]

5. **PHYSICAL DATA.** Pursuant to CONTRACT CLAUSES clause: "Site Investigation and Conditions Affecting the Work," information and data furnished or referred to below are furnished for general information only and the Government may not be held liable for any interpretation or conclusions drawn therefrom by the Contractor.

#(2,15)#

5.1. **SOURCE OF DATA.** The physical conditions indicated on the drawings and in the specifications are the result of site investigations by [surveys] [auger borings] [core borings] [test pits] [probings] [test tunnels] [etc.]. [The data shown graphically and by symbol for each respective boring represents the actual geologic features observed and logged at the location given on the drawings. While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local minor variations characteristic of the subsurface materials of this region could occur.]

5.2. **WEATHER.** Weather conditions shall have been investigated by the Contractor to satisfy himself as to the hazards likely to arise therefrom. Complete weather records and reports may be obtained from the local U.S. Weather Bureau.

5.3. **ACCESS ROUTES.** Transportation facilities shall have been investigated by the Contractor to satisfy himself as to the existence of access highways and railroad facilities. (based on FAR 52.236-4)

#(16)#

5.4. **CONCURRENT CONSTRUCTION.** Construction work closely related to and/or located at the site of the work under this contract, including In-Situ Vitrification at the M-1 Basins, will be in progress simultaneously with work under this contract. The location[s] of this concurrent work is shown on the drawings or described in these specifications. The Contractor shall cooperate with others as necessary in the interest of timely completion of all work. In the event of interference, the Contracting Officer shall be notified immediately for resolution and his decision shall be final.

#(16A)#

5.5. NOT USED. TELEPHONE SERVICE. Telephone service for Contractor facilities at Falcon AFB will be furnished to the Contractor at no cost except that all long distance calls shall be placed with the Contractor's credit card.

6. **PAYMENT.**

6.1. **PROMPT PAYMENT ACT.** Pay requests authorized in CONTRACT CLAUSES clause: "Payments Under Fixed-Price Construction Contracts", will be paid pursuant to the clause, "Prompt Payment for Construction Contracts". Pay requests will be submitted on ENG Form 93 and 93a, "Payment Estimate-Contract Performance" and "Continuation". All information and substantiation required by the identified contract clauses will be submitted with the ENG Form 93, and the required certification will be included on the last page of the ENG Form 93a, signed by an authorized contractor official and dated when signed. The designated billing office is the Office of the Area Engineer.

6.2. **PAYMENTS FOR MODIFICATIONS.** Payments may be made for cost bearing change orders within the scope of the contract only to the extent funds are authorized in the order on a two-part modification. Contractor pricing proposed must be submitted at the earliest possible time after the change order is issued, or at a specific time as directed by the Contracting Officer. At the discretion of the Contracting Officer, any and all payments may be withheld on the modification until the Contractor has submitted a qualifying price proposal, in as much detail as required by the Contracting Officer, and the final price has been agreed.

6.3. **PAYMENT FOR MATERIALS DELIVERED OFFSITE.** In accordance with CONTRACT CLAUSES clause: "Payments Under Fixed-Price Construction Contracts,"

the Contracting Officer, at his discretion, may authorize material delivered to the Contractor at locations other than the site be taken into consideration in the preparation of payment estimates. Such materials delivered to the Contractor offsite will only be considered if the Contractor furnishes satisfactory evidence that he has acquired title to such material and that it will be utilized in the work covered under this contract.

[ALTERNATE 1]
#(2.17)#

7. **AVAILABILITY OF UTILITY SERVICES.** All reasonably required amounts of domestic water and electricity will be made available to the Contractor by the Government from existing system outlets and supplies. The Contractor shall, at his own expense, make all temporary connections and install distribution lines. The Contractor shall furnish to the Contracting Officer a complete system layout drawing showing type of materials to be used and method of installation for all temporary electrical systems. [The Contractor shall make arrangements with the Using Service, through the Contracting Officer, as to the method of determining the amount of water and electricity to be used by him and the method of payment therefor.] [Meters shall be installed by the Contractor to determine the amount of [water and] electricity used by him, and such utilities will be paid for by or charged to the Contractor]. All temporary lines shall be maintained by the Contractor in a workmanlike manner satisfactory to the Contracting Officer and shall be removed by the Contractor in like manner prior to final acceptance of the construction. Normal quantities of electricity and water used to make final tests of completely installed systems will be furnished by the Government. (based on FAR 52.236-14)

[ALTERNATE 2]
#(2.18)#

7. **AVAILABILITY OF UTILITY SERVICES.** The Contractor shall arrange with the local utility company for electricity required by him for construction under this project and shall pay all costs in connection therewith. Reasonable amounts of domestic water will be made available to the Contractor by the Government from existing system outlets and supplies. [The Contractor shall meter the amount of water used by him, and such amount of water will be paid for by or charged to the Contractor.] The Contractor shall, at his own expense, make all temporary connections and install distribution lines. The Contractor shall furnish to the Contracting Officer a complete system layout drawing showing type of materials to be used and method of installation for all temporary electrical systems. All temporary lines shall be maintained by the Contractor in a workmanlike manner satisfactory to the Contracting Officer and shall be removed by the Contractor in like manner prior to final acceptance of the construction. Normal quantities of electricity and water used to make final tests of completely installed systems shall be furnished by the Government.

[ALTERNATE 1]
#(2.19)#

8. **UTILITY SERVICE INTERRUPTIONS.** The Contractor shall submit written notification not less than 15 calendar days in advance of each interruption of each utility [and communication] service to or within existing buildings and facilities being used by others. No single outage will exceed 4 hours unless

approved in writing. The time and duration of all outages will be coordinated with the Using Agency by the Contracting Officer.

[ALTERNATE 2]
#(2,20)#
8. UTILITY SERVICE INTERRUPTIONS.

8.1. ADVANCE NOTICE. The Contractor shall submit written notification not less than 5 working days in advance of each interruption of each utility [and communication] service to or within existing buildings and facilities being used by others. No single outage will exceed 4 hours unless approved in writing. The time and duration of all outages will be coordinated with the Using Agency by the Contracting Officer.

8.2. OVERTIME WORK BY BASE OPERATING AND MAINTENANCE (O&M) PERSONNEL. The normal working hours for Government O&M personnel whose services may be required for utility outages or similar services are from 7:30 a.m. to 4:00 p.m. Overtime work by Government O&M personnel due to Contractor delays in scheduled outages, interruptions of known utility services, or other negligent acts, shall be the responsibility of the Contractor. The Contractor shall pay the Government for such additional overtime costs at the existing overtime wage rates established for the Government personnel involved.

8.3. BURIED UTILITIES. The Contractor shall coordinate all excavation work including excavation for sign posts, fence posts, and utility poles with the Using Service Facilities Engineer and the telephone company prior to beginning work.

#(20A)#
8A. DIGGING PERMITS AND ROAD CLOSINGS. The Contractor shall allow 14 calendar days from date of written application to receive permission to dig and to close roads. Roads shall only be closed one lane at a time and vehicular traffic shall be allowed to pass through the construction area. Work on or near roadways shall be flagged in accordance with the safety requirements in Safety and Health Requirements Manual EM 385-1-1, which forms a part of these specifications. Work located along the alert force route shall not cause blockage and the Contractor shall maintain unobstructed access for alert force traffic at all times.

#(2,21)#
9. LAYOUT OF WORK. The Contractor shall lay out his work from Government established [base] lines and [bench] marks indicated on the drawings and shall make all measurements in connection therewith. The Contractor shall furnish all stakes, templates, platforms, equipment, tools, and materials and labor as may be required in laying out any part of the work from the base lines and marks established by the Government. The Contractor shall execute the work to the lines and grades established or indicated and shall maintain and preserve all stakes and other control points established by the Contracting Officer until authorized to remove them. If such marks are destroyed by or through negligence of the Contractor, prior to their authorized removal, they may be replaced by the Contracting Officer at his discretion and the expense of replacement will be deducted from any amounts due or to become due the Contractor. (based on FAR 52.236-17)

[ALTERNATE 1]
#(2,22)#
10. NOT USED.QUANTITY SURVEYS.

10.1. The Government will make original and final surveys and make computations to determine the quantities of work performed or finally in place.

10.2. The Contractor shall make such surveys and computations as are necessary to determine the quantities of work performed or placed during each period for which a progress payment is to be made. All original field notes, computations, and other records for the purpose of layout and progress surveys shall be recorded in duplicating field books, the original pages of which shall be furnished promptly in ring binders to the representatives of the Contracting Officer at the site of the work and shall be used by the Contracting Officer to the extent necessary in determining the proper amounts of progress and final payments. (based on FAR 52.236-16)

[ALTERNATE 2]
#(2,23)#
10. QUANTITY SURVEYS.

10.1. The Contractor shall make such surveys and computations as are necessary to determine the quantities of work performed or placed during each period for which a progress payment is to be made. The Contractor shall also make original and final surveys. The Government will make such computations as are necessary to verify the quantities of work performed or finally in place. Unless waived by the Contracting Officer in each specific case, quantity surveys made by the Contractor shall be made under the direction of a representative of the Contracting Officer.

10.2. All original field notes, computations, and other records of the Contractor for the purposes of layout, original, progress, and final surveys shall be recorded in duplicating field books, the original pages of which shall be furnished promptly in ring binders to the representative of the Contracting Officer at the site of the work and shall be used by the Contracting Officer to the extent necessary in determining the proper amounts of progress and final payments. (based on FAR 52.236-16)

#(24)#
10A. VARIATIONS IN ESTIMATED QUANTITIES. Significant variations from the contract unit priced quantities shall be covered in accordance with the CONTRACT CLAUSES clause: "Variation in Estimated Quantity."

#(24A)#
10B. VARIATIONS IN ESTIMATED QUANTITIES - SUBDIVIDED ITEMS. The Variation in Estimated Quantities clause is applicable only to Items Nos. _____.

10B.1. In order to permit the Contractor to distribute his indirect costs properly to Item(s) No.(s.) _____ these [this] item(s) have [has] been subdivided into two or more subitems. All the Contractor's indirect costs for [each of these] [this] item(s) will be included in the bid price for the first subitem listed under the respective item. Variation from the estimated quantity in the actual work performed under any second or subsequent sub-item or elimination of all work under such a second or subsequent sub-item will not be the basis for an adjustment in contract unit price.

10B.2. Where the actual quantity of work performed for Items Nos. _____ is less than 85 percent of the quantity of the first sub-item listed under such

item, the Contractor will be paid at the contract unit price for that sub-item for the actual quantity of work performed and, in addition, an equitable adjustment shall be made in accordance with the clause FAR 52.212-11, Variation in Estimated Quantities.

10B.3. If the quantity of work performed under Items Nos. _____ exceeds 115 percent or is less than 85 percent of the total estimated quantity of the sub-items under that item,

[ALTERNATE]

10B.3. [If the quantity of work performed under the second sub-item or any subsequent sub-item under Items Nos. _____ exceeds 115 percent or is less than 85 percent of the estimated quantity of any such sub item,] and if such variation causes an increase or a decrease in the time required for performance of this contract the contract completion time will be adjusted in accordance with the clause FAR 52.212-11, Variation in Estimated Quantities.

11. TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER.

#(25)#

11.1. **ANTICIPATED WEATHER DELAYS.** This clause specifies the procedure for the determination of time extensions for unusually severe weather under the authority of the contract clause entitled "Default (Fixed-Price Construction)." The listing below defines monthly anticipated adverse weather for the contract period and is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the geographic location of the project.

MONTHLY ANTICIPATED ADVERSE WEATHER WORK DAYS

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
(07)	(04)	(04)	(04)	(06)	(03)	(04)	(02)	(03)	(03)	(02)	(05)

11.2. **WEATHER TIME EXTENSIONS.**

11.2.1. **Evaluation.** The above schedule of anticipated adverse weather will constitute the base line for monthly (or portion thereof) weather time evaluations. Upon acknowledgement of the Notice to Proceed and continuing throughout the contract on a monthly basis, actual adverse weather days will be recorded on a work day basis (including weekends and holidays) and compared to the monthly anticipated adverse weather schedule above. For purposes of this paragraph, the term "actual adverse weather days" shall be scheduled work days impacted by adverse weather.

11.2.2. **Determination.** The number of actual adverse weather days shall be recorded monthly during the construction period. Once the number of actual adverse weather days anticipated in the schedule above have been exceeded, the Contracting Officer will examine the actual adverse weather days to determine whether the Contractor is entitled to a time extension. These actual adverse weather days must prevent work for 50 percent or more of the Contractor's workday, delay scheduled work critical to the timely completion of the project, and be documented in the Contractor Quality Control reports. The Contracting Officer will convert any delays meeting the above requirements to calendar days and issue a modification under the authority of the contract clause entitled "Default (Fixed-Price Construction.)"

11.3. **THE CONTRACTOR'S SCHEDULE** must reflect the above anticipated adverse weather delays on all weather dependent activities.

#(26)#
12. NOT USED. IOWA SALES AND USE TAX.

12.1. In the event goods, wares or merchandise on which the Contractor has paid Iowa sales or use tax become an integral part of the project, the Contractor shall obtain appropriate forms from the Iowa State Tax Commission for recording the amount of purchases of such goods, wares, or merchandise, and shall complete, execute, and deliver them to the Contracting Officer prior to final settlement of the contract. The Contractor shall provide and report all data and information which may be necessary or required to enable the Contracting Officer to obtain all refunds from the Iowa Tax Commission to which the Federal Government may be entitled.

12.2. The Contractor shall insert a clause containing the substance of the foregoing paragraph 12.1 in every first tier subcontractor or vendor to include such a clause in any subcontract or purchase order which he places. The Contractor shall obtain completed forms from his subcontractor and suppliers for submission to the Contracting Officer before final settlement of the contract.

#(26A)#
13. **INSURANCE REQUIRED.** In accordance with CONTRACT CLAUSES clause: "Insurance Work on a Government Installation," the Contractor shall procure the following minimum insurance:

Type	Amount
Workmen's Compensation and Employer's Liability Insurance	$100,000
General Liability Insurance	$500,000 per occurrence
Automobile Liability Insurance	
Bodily injury	$200,000 per person and $500,000 per occurrence
Property damage	$ 20,000 per occurrence

(Coverages per FAR 28.307-2)

#(26B)#
13A. INSURANCE - LIABILITY TO THIRD PERSON - COMMERCIAL ORGANIZATIONS. See CONTRACT CLAUSES "EPA INDEMNIFICATION UNDER CERCLA - FIXED PRICE CONTRACT."

#(27)#
14. **IDENTIFICATION OF EMPLOYEES.** The Contractor shall furnish to each employee and require each employee engaged on the work to display, such identification as may be approved and directed by the Contracting Officer. All prescribed identification shall immediately be delivered to the Contracting Officer, for cancellation upon release of any employees. When the contract involves work in restricted security areas, only employees who are U.S. citizens will be permitted to enter. Proof of U.S. citizenship is required prior to entry. When required by the Contracting Officer, the Contractor shall obtain and submit fingerprints of all persons employed or to be employed on the project. (based on FAR 52.236-7007)

#(28)#
14A. **VEHICLE IDENTIFICATION.** All privately owned vehicles (including Contractor pickups, but not heavy equipment or trailer towed equipment) shall be registered while working on post. Contractor personnel shall register their vehicles at the M.P. Vehicle Registration Trailer any work day between the hours of 0700-1115 and 1300 to 1600. A safety inspection will be required and each vehicle owner will need to show (1) a valid driver's license, (2) a current vehicle registration, and (3) proof of automobile liability insurance.

15. **CONTRACTOR QUALITY CONTROL (CQC).** In conformance with the requirements of CONTRACT CLAUSES clause: "Inspection of Construction," the Contractor shall establish and maintain an effective Quality Control Program.

15.1. **GENERAL.** Except for isolated tests or other items of work specified to be performed by the Government, the quality of all work shall be the responsibility of the Contractor. Sufficient inspections and tests of all items of work, including that of subcontractors, to ensure conformance to applicable specifications and drawings with respect to the quality of materials, workmanship, construction, finish, functional performance, and identification shall be performed on a continuing basis. The Contractor shall furnish qualified personnel, appropriate facilities, instruments and testing devices necessary for the performance of the quality control function. The controls shall be adequate to cover all construction operations both on and offsite, shall be keyed to the proposed construction sequence and shall be correlated by the Contractor's quality control personnel.

15.2. **PRECONSTRUCTION PLANNING.** The Government will consider an interim CQC plan for the first days of operation. However, within ten (10) calendar days after the date of receipt by him of Notice to Proceed, and prior to starting on-site construction, the Contractor shall meet with the Contracting Officer and discuss the quality control requirements. During this meeting the Contractor shall submit for approval his proposed written QC plan which shall include all features outlined below. The proposed plan will be reviewed and the meeting shall develop mutual understanding relative to details of the system, including the personnel, facilities, forms, etc., to be used for the inspections, tests and the administration of the system. Minutes of the meeting shall be prepared by the Area Office Resident Engineer or Contractor as agreed to at the mutual understanding meeting and shall be signed by both the Contractor and the Contracting Officer or Contracting Officer's Representative. The minutes shall become a part of the contract. No change in the approved plan shall be implemented without written concurrence by the Contracting Officer.

15.3. **ACCEPTANCE OF CQC PLAN.** Acceptance of the Contractor's quality control plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes in his CQC plan and operations as necessary to obtain the quality specified.

15.4. **CONTRACTOR'S PROPOSED (QC) PLAN.** The Contractor's proposed written quality control plan (for submittal at the mutual understanding meeting) shall include as a minimum:

15.4.1. The quality control organization.

15.4.2. Names, number, and qualification of personnel to be used for this purpose.

15.4.3. Authority and responsibilities of all quality control personnel.

15.4.4. Schedule of Use of inspection personnel by types and phase of work.

15.4.5. A list of preparatory and initial inspections to be performed shall be included as part of the Quality Control Program.

15.4.6. A list of tests specified to be performed with proposed test methods including specification paragraph number and names of technicians or qualified testing laboratory to be used.

15.4.7. Location and availability of test facilities and equipment.

15.4.8. Procedures for advance notice and coordination of special inspections and tests where required.

15.4.9. Procedures for reviewing all shop drawings, samples, certificates, or other submittals for contract compliance and certifying them for submission to the Government.

15.4.10. Method of performing, documenting, and enforcing quality control operations of both prime and subcontract work including inspection and testing both onsite and offsite. Include proposed forms for approval, and indicate who will prepare, sign, and submit the reports.

15.4.11. Responsibilities and procedures for correcting deficiencies.

15.4.12. A copy of a letter of direction to the Contractor's representative responsible for quality control, outlining his duties and responsibilities, and signed by a responsible officer of the firm.

15.4.13. Method of documenting and tracking deficiencies and corrective actions.

15.5. CONTROL OF ON-SITE CONSTRUCTION. The Contractor's quality control program shall include four phases of inspection and tests. The Contracting Officer's representative shall be notified at least 24 hours in advance of each such test.

15.5.1. Preparatory Inspections shall be performed prior to beginning each feature of work on any on-site construction work. Preparatory inspections for the applicable feature of work shall include (i) review of submittal requirements and all other contract requirements with the foremen or supervisors directly responsible for the performance of the work; (ii) check to assure that provisions have been made to provide required field control testing; (iii) examine the work area to ascertain that all preliminary work has been completed; (iiii) verify all field dimensions and advise the Contracting Officer of any discrepancies; and (iiiii) perform a physical examination of materials and equipment to assure that they conform to approved shop drawings or submittal data and that all materials and/or equipment are on hand.

15.5.2. Initial Inspection shall be performed as soon as work begins on a representative portion of the particular feature of work and shall include examination of the quality of workmanship as well as a review of control testing for compliance with contract requirements.

15.5.3. Follow-up Inspections shall be performed continuously as any particular feature of work progresses, to assure compliance with contract requirements including control testing, until completion of that feature of the work.

15.5.4. Safety Inspections. The Contractor shall perform daily safety inspections of the jobsite and the work in progress to assure compliance with EM 385-1-1 and other occupational health and safety requirements of the contract. Daily Quality Control reports as required under paragraph: REPORTING

shall be used to document the inspection and shall include a notation of the safety deficiencies observed and the corrective actions taken. The Contractor shall use his designated Quality Control Staff to perform the required inspections and shall supplement the staff with additional personnel as required. Additional personnel shall be provided at no additional cost to the Government.

15.5.5. Recording Inspection Results. The results of all inspections shall be made a matter of record in the Contractor's Quality Control documentation as required by paragraph DOCUMENTATION below.

#(2.29)#

[15.6. QUALITY CONTROL STAFF. The Contractor's job supervisory staff may be used for quality control supplemented as necessary by additional personnel including special technicians for surveillance or testing to provide capability for the controls required by the specifications. A Certified Industrial Hygienist and an Industrial Hygiene Technician shall be part of the Contractor's quality control staff on projects involving asbestos removal per SECTION: ASBESTOS REMOVAL AND DISPOSAL. The Contractor's staff member designated as the Q.C. Supervisory Engineer for the contract must be a qualified engineer or technician and be able to demonstrate ability to perform correctly the duties required to the satisfaction of the Contracting Officer and must be employed full time at the project site whenever contract work is in progress.]

[ALTERNATE]

#(2.30)#

[15.6. QUALITY CONTROL STAFF. In addition to the Contractor's job supervisory staff, a separate quality control group shall be provided. This group shall report to the Contractor's management at a level no lower than an executive of the company. As a minimum, the overall strength of the quality control group for this contract shall be as follows:

15.6.1. The Quality Control Supervisory Engineer shall be an approved, qualified engineer or technician whose sole responsibility is to ensure compliance with the contract plans and specifications. This person shall demonstrate ability to perform correctly the duties required to the satisfaction of the Contracting Officer and shall be physically at the project site whenever work is in progress and will be in charge of the Contractor's Quality Control program for this project. All the Contractor's submittals for approval shall be reviewed and modified or corrected as needed by the Quality Control Supervisory Engineer (or authorized assistants) and approved correct prior to forwarding of such submittals to the Contracting Officer.

15.6.2. A Mechanical Technician, who is experienced in the construction of industrial air-conditioning, steam and sewer systems, plumbing, heating, mechanical tests, and other components of mechanical devices equipment and/or systems in the work, shall assist the QC Supervisory Engineer in the performance of his duties. The Mechanical Technician may have other duties but shall be on the project site at the times when work performed under specification Division 15 Mechanical is in progress.

15.6.3. An Electrical Technician, experienced in the construction of industrial electrical systems, overhead and underground high voltage systems, instrumentation and control systems, and the required electrical tests shall assist QC Supervisory Engineer in the performance of his duties. The Electrical Technician may have other duties but shall be on the project site at the times when work performed under specification Division 16 Electrical is in progress.

15.6.4. A Certified Industrial Hygienist and an Industrial Hygiene Technician shall assist in the performance of the QC Supervisory Engineer's duties. See SECTION: ASBESTOS REMOVAL AND DISPOSAL for duties required.

15.7. TESTS.

15.7.1. **Testing Procedure.** The Contractor shall perform tests specified or required to verify that control measures are adequate to provide a product which conforms to contract requirements. The Contractor shall procure the services of an industry recognized testing laboratory approved by the Contracting Officer, or may establish an approved testing laboratory at the project site. The Contractor shall perform the following activities and record and provide the following data:

15.7.1.1. Verify that testing procedures comply with contract requirements.

15.7.1.2. Verify that facilities and testing equipment are available and comply with testing standards.

15.7.1.3. Check test instrument calibration data against certified standards.

15.7.1.4. Verify that recording forms, including all of the test documentation requirements, have been prepared.

15.7.2. **Testing.**

15.7.2.1. **Capability Check.** The Contracting Officer's Representative (COR) will have the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques.

15.7.2.2. **Capability Re-Check.** If the selected laboratory fails the capability check, the Contractor will be assessed the actual cost for the re-check as reimbursement to the Government for each succeeding re-check of the laboratory or the checking of a subsequently-selected laboratory. Such costs will be deducted from the contract amount due the Contractor.

15.7.2.3. **Project Laboratory.** The COR will have the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

15.8. REPORTING. All inspections and test results shall be recorded daily.

15.8.1. **Daily Submittals.** The attached sample "Quality Control Daily Report" form or other approved form shall be reproduced and fully executed to show all inspections and tests and submitted in duplicate to the Contracting Officer's representative on the first work day following the date covered by the report.

15.8.2. **Results of Tests.** Triplicate copies of complete results of tests shall be submitted not later than 3 calendar days after performing the test.

15.9. COMPLETION INSPECTIONS.

15.9.1. **Contractor's Quality Control Completion Inspection.** Based upon the Contracting Officer's concurrence that the work is nearing substantial completion, and at least 14 days prior to pre-final inspection, the Contractor's Quality Control Inspection personnel shall conduct a detailed inspection. The Contracting Officer's Representative shall be notified of the inspection date in order that he may participate, if he so elects. The work shall be inspected for conformance to plans, specifications, quality, workmanship, and completeness. The Contractor shall prepare an itemized list of work not properly completed,

inferior workmanship, or not conforming to plans and specifications. The list shall also include outstanding administrative items such as as-built drawings, O&M Manuals, and spare parts. The list shall be included in the Quality Control documentation and submitted to the Contracting Officer with an estimated date for correction of each deficiency within five (5) working days after conducting this inspection.

15.9.2. **Pre-Final Inspection.** The Contractor's Quality Control Inspection personnel, his superintendent, or other primary management person and the Contracting Officer's representatives will be in attendance at this inspection. Additional Government personnel, including but not limited to those from Base/Post Civil/Facility Engineer, user groups and major commands may be in attendance. The prefinal inspection will be formally scheduled by the Contracting Officer based upon notice from the Contractor. This notice will be given to the Contracting Officer at least 14 days prior to the pre-final inspection and must include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining contract work, will be complete and acceptable by the date scheduled for the prefinal inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection costs in accordance with the contract clause entitled, "Inspection of Construction." At this inspection the Contracting Officer will develop a specific list of incomplete and/or unacceptable work performed under the contract and will subsequently furnish this list to the Contractor. Failure of the Contracting Officer to detect and list all incomplete and/or unacceptable work during this inspection will not relieve the Contractor from acceptably performing all work required by the contract documents.

15.9.3. **Final Acceptance Inspection.** The Contractor's Quality Control Inspection personnel, his superintendent or other primary management person and the Contracting Officer's representative will be in attendance at this inspection. Additional Government personnel including, but not limited to, those from Base/Post Civil/Facility Engineer, user groups, and major commands may also be in attendance. The final acceptance inspection will be formally scheduled by the Contracting Officer based upon notice from the Contractor. This notice will be given to the Contracting Officer at least 14 days prior to the final acceptance inspection and must include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract will be complete and acceptable by the date scheduled for the final acceptance inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection costs in accordance with the contract clause entitled "Inspection of Construction".

15.10. DOCUMENTATION.

15.10.1. The Contractor shall maintain current records of quality control operations, activities, and tests performed including the work of suppliers and subcontractors. These records shall be on an acceptable form and indicate a description of trades working on the project, the number of personnel working, the weather conditions encountered, any delays encountered, and acknowledgment of deficiencies noted along with the corrective actions taken on current and previous deficiencies. These records shall include factual evidence

that required activities or tests have been performed, including but not limited to the following:

15.10.1.1. Type, number, and results of control activities and tests involved.

15.10.1.2. Nature of defects and causes of rejection.

15.10.1.3. Proposed remedial action.

15.10.1.4. Corrective actions taken.

15.10.2. These records shall cover both conforming and defective or deficient features and shall include a statement that supplies and materials incorporated in the work comply with the contract. Legible copies of these records shall be furnished to the COR daily.

15.11. **ENFORCEMENT.** The Contractor shall stop work on any item or feature, pending satisfactory correction of any deficiency noted by his quality control staff or by the Contracting Officer's representative. Construction shall not proceed upon any feature of work containing uncorrected work. Notations on quality control reports will not be acceptable as a substitution for other written reports by the Contractor if required under CONTRACT CLAUSES clause: "Changes," "Differing Site Conditions," or "Default (Fixed-Price Construction)."

15.12. **NOTIFICATION OF NONCOMPLIANCE.** The Contracting Officer will notify the Contractor of any noncompliance with the foregoing requirements. The Contractor shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the Contractor or his representative at the site of the work, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses 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 part of the time lost due to any such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

15.13. **PAYMENT.** At the election of the Contracting Officer, no payment estimate will be processed under this contract until the entire Quality Control Plan has been approved or until overdue daily QC reports are properly executed and furnished.

16. **NONDOMESTIC CONSTRUCTION MATERIALS.** The requirements of this contract entitled Buy American Act Construction Materials do not apply to construction materials or their components included in the list set forth in paragraph 25.108 of the Federal Acquisition Regulation.

#(31)#

17. **NOTICE OF PRIORITY RATING FOR NATIONAL DEFENSE USE (MAY 1986).** Any contract awarded as a result of this solicitation will be a DO rated order certified for national defense use under the Defense Priorities and Allocations System (DPAS) (15 CFR 350), and the Contractor will be required to follow all of the requirements of this regulation. (based on FAR 52.212-7)

#(32)#

18. **DAILY WORK SCHEDULES.** In order to closely coordinate work under this contract, the Contractor shall prepare for and attend a weekly coordination meeting with the Contracting Officer and Using Service at which time the Contractor shall submit for coordination and approval, his proposed daily work schedule for the next two week period. Required temporary utility services, time and duration of interruptions, and protection of adjoining areas shall be

included with the Contractor's proposed 2-week work schedule. At this meeting, the Contractor shall also submit his schedule of proposed dates and times of all preparatory inspections to be performed during the next 2 weeks. The items of work listed on the proposed 2-week schedule are to be keyed to the NAS by activity number and description for each activity anticipated to be performed during the next 2-week period. Coordination action by the Contracting Officer relative to these schedules will be accomplished during these weekly meetings.

19. **EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE.** (1985 JAN HQ USACE.)

19.1. Allowable cost for construction and marine plant and equipment in sound workable condition owned or controlled and furnished by a Contractor or subcontractor at any tier shall be based on actual cost data when the Government can determine both ownership and operating costs for each piece of equipment or equipment groups of similar serial and series from the Contractor's accounting records. When both ownership and operating costs cannot be determined from the Contractor's accounting records, equipment costs shall be based upon the applicable provisions of EP 1110-1-8, "Construction Equipment Ownership and #(33)#
Operating Expense Schedule," S/N-008-022-0258-8, Vol. 5, Region V. Copies of each regional schedule may be obtained from the U.S. Government Printing Office (301-953-7974) at a cost of $11.00 per schedule. Working conditions shall be considered to be average for determining equipment rates using the schedule unless specified otherwise by the Contracting Officer. For equipment not included in the schedule, rates for comparable pieces of equipment may be used or a rate may be developed using the formula provided in the schedule. For forward pricing, the Schedule in effect at the time of negotiations shall apply. For retrospective pricing, the Schedule in effect at the time the work was performed shall apply.

19.2. Equipment rental costs are allowable, subject to the provisions of FAR 31.105(d)(ii) and FAR 31.205-36, substantiated by certified copies of paid invoices. Rates for equipment rented from an organization under common control, lease-purchase, or sale-leaseback arrangements will be determined using the schedule except that rental costs leased from an organization under common control that has an established practice of leasing the same or similar equipment to unaffiliated lessees are allowable. Costs for major repairs and overhaul are unallowable.

19.3. When actual equipment costs are proposed and the total amount of the pricing action is over $25,000, cost or pricing data shall be submitted on Standard Form 1411, "Contract Pricing Proposal Cover Sheet." By submitting cost or pricing data, the Contractor grants to the Contracting Officer or an authorizing representative the right to examine those books, records, documents, and other supporting data that will permit evaluation of the proposed equipment costs. After price agreement, the Contractor shall certify that the equipment costs or pricing data submitted are accurate, complete, and current. (EFARS 52.2/9108(f).)

#(34)#

20. **AS-BUILT DRAWINGS.** The Contractor shall maintain two separate sets of red-lined full scale, as-built construction drawings marked-up to fully indicate as-built conditions. These drawings shall be maintained in a current condition at all times until completion of the work and shall be available for review by Government personnel at all times. The location, general description,

approximate depth below finished grade of all underground utilities encountered, and all variations from the contract drawings, for whatever reason, including those occasioned by optional materials and the required coordination between trades, shall be indicated. These variations shall be shown in the same general detail utilized in the initial contract drawings. Both sets of as-built construction drawings shall be furnished to the Contracting Officer on the date of final inspection. The submittal requirement for as-built construction drawings shall be shown as a separate activity on the Contractor prepared progress bar chart or network analysis system, whichever is applicable.

#(2,4,35)#
21. **SIGN.** On commencement of work on this project, the Contractor shall furnish and erect the temporary sign in the location selected by the Contracting Officer near the project site. The Contractor shall maintain the sign in good condition through the project construction period and on completion of the project shall remove the sign from the premises. The project sign shall conform to Standard Drawing OD15-9A12 and [OD15-9A22] [OD15-9A23] bound herein. A decal of the "Engineer Castle" [and the U. S. Air Force Engineering and Services emblem] will be furnished the Contractor upon request.

#(2,36)#
22. NOT USED. GOVERNMENT-FURNISHED PROPERTY. Pursuant to [CONTRACT CLAUSES clause: "Government-Furnished Property (Short Form)"] [CONTRACT CLAUSES clause: "Government Property (Fixed Price Contracts)"] the Government will furnish to the Contractor the following property to be incorporated or installed in the work. Such property will be furnished f.o.b. [rail or] truck at the project site and the Contractor shall accept delivery when made, [pay all demurrage incurred,] and unload [and transport the property to the jobsite] at his own expense. All such property will be installed or incorporated into the work at the expense of the Contractor. The Contractor shall verify the quantity and condition of such Government-furnished property when delivered to him, acknowledge receipt thereof in writing to the Contracting Officer, and in case of damage to or shortage of such property, shall within 24 hours report in writing such damage or shortage to the Contracting Officer.

#(37)#
Quantity	Item	Description	[Dollar Value]

#(38)#
23. NOT USED. SUPERINTENDENCE OF SUBCONTRACTORS.

23.1. **ADDED SUPERINTENDENTS.** The Contractor shall furnish the following, in addition to the superintendence required by the CONTRACT CLAUSES clause entitled "Superintendence by the Contractor."

23.1.1. If more than 50 percent and less than 70 percent of the value of the contract work is subcontracted, one superintendent shall be provided at the site and on the Contractor's payroll to be responsible for coordinating, directing, inspecting and expediting the subcontract work.

23.1.2. If 70 percent or more of the value of the work is subcontracted, the Contractor shall be required to furnish two such superintendents

to be responsible for coordinating, directing, inspecting and expediting the subcontract work.

23.2. **WAIVER OF ADDED SUPERINTENDENTS.** If the Contracting Officer, at any time after 50 percent of the subcontracted work has been completed, finds that satisfactory progress is being made, he may waive all or part of the above requirement for additional superintendence subject to the right of the Contracting Officer to reinstate such requirement if at any time during the progress of the remaining work he finds that satisfactory progress is not being made. (based on FAR 52.236-7008)

#(39)#

24. **CONTRACTOR FURNISHED EQUIPMENT DATA.** At or before 30 days prior to final inspection and acceptance of the work, the Contractor shall submit the data mentioned in the following subclauses.

24.1. **EQUIPMENT LIST.** An itemized equipment list showing unit retail value and nameplate data including serial number, model number, size, manufacturer, etc., for all Contractor-furnished items of plumbing fixtures, laboratory counters and cabinets, kitchen equipment, mechanical equipment, electrical equipment, and fire protection systems installed under this contract.

24.2. **GUARANTEES.** A list of all equipment items which are specified to be guaranteed accompanied by a copy of each specific guarantee therefor. For each specific guaranteed item the name, address, and telephone number shall be shown on the list for subcontractor who installed equipment, equipment supplier or distributor, and equipment manufacturer. Completion date of the guarantee period shall correspond to the applicable specification requirements for each guaranteed item.

#(2,40)#

25. NOT USED. ACCOMMODATIONS FOR GOVERNMENT INSPECTORS. The Contractor shall furnish a temporary office facility approximately 10 feet x 20 feet with a minimum of 200 square feet of floor space. It shall be located where directed and shall be reserved for Government personnel only. Drinking water facilities, adequate lighting, [local commercial telephone service,] air-conditioning, heating equipment, and a partition enclosed chemical toilet shall be furnished and maintained by the Contractor. The office shall be furnished with one legal size filing cabinet with four drawers, one drafting table with stool, one plan rack, one desk, and three chairs. Used furniture, in good condition, will be acceptable. Entrance doors shall be equipped with a substantial lock. The Contractor shall provide janitor service, fuel for the heating facilities, electricity, [telephone] and water, all at no cost to the Government, except the Contractor will not be liable for Government long-distance calls. [Building shall be constructed so as to be easily moved and the Contractor shall relocate the building twice during the contract, if so directed.] The entire facility, including furniture, will remain the property of the Contractor and shall be removed from the site after completion of the work.

#(41)#

26. NOT USED. LABORATORY BUILDING. The Contractor shall provide and maintain an approved weatherproof building, at a location in the work area as directed by the Contracting Officer, for the exclusive use of the Government in making field tests. The building shall have not less than 100 square feet of floor space, shall be approximately 8 feet high, and shall have a framed floor, two

windows, and one door. The door shall be provided with a lock and the windows shall be equipped with conventional hardware. One workbench, approximately 8 feet long and 3 feet wide shall be provided. The building shall be wired for 110-120 volt, 60 cycle alternating current with adequate lighting and at least one duplex-service receptacle provided. The building and facilities shall be ready for use within 10 days after Notice to Proceed and shall remain so for the duration of this contract. The building shall be removed from Government premises by the Contractor upon completion of the work.

#(2.42)#

27. CONTRACTOR PREPARED NETWORK ANALYSIS SYSTEM (NAS).

27.1. The progress chart to be prepared by the Contractor pursuant to the CONTRACT CLAUSE entitled "SCHEDULE FOR CONSTRUCTION CONTRACTS" shall employ a network analysis system as described below. Implementing this system for the planning and scheduling of construction shall be the responsibility of the Contractor.

#(2.43)#

27.1.1. The Contractor prepared management system shall employ a computerized Network Analysis system (Critical Path Method (CPM)) [which shall be operated by on-site personnel at terminals located in the Contractor's on-site office.] The Contractor may elect to use either the network analysis software identical to that used by the Contracting Officer, or other IBM compatible CPM scheduling software. The Contracting Officer uses the Primavera Project Planner Software and Primavision Graphics Software by Primavera Systems, Inc., Two Bala Plaza, Bala Cynwyd, PA 19004, telephone (215) 667-8600. Should the Contractor elect to use IBM compatible scheduling software other than Primavera Project Planner and Primavision, the Contractor will be required to provide software that can export network analysis data in a format directly readable by the Contracting Officer's software in compliance with SECTION: SCHEDULING DATA EXCHANGE FORMAT. The operating system and memory of the computer selected shall be capable of supporting the number of activities required for the project. The computer and its peripherals must have [on-site] capability for report writing, allowing flexible formatting and summarization and graphical output using a dot matrix printer or other similar type plotter/printer(s). The Contractor is required to provide to the Contracting Officer one set of IBM compatible data diskettes (5.25" double sided, double density floppy disks formatted to 360k) of all required network analysis submissions and updates in addition to the specified number of hard copies of reports and network diagrams.

#(2.43)#

27.1.2. [On-site] [S]cheduling personnel shall have the expertise to operate the CPM network analysis system software to address all project activities and resources on a real time or interactive basis and be capable of rapidly evaluating alternative scenarios to optimize project management. Evidence of technical expertise of the [on-site] personnel with the system selected shall be submitted for the Contracting Officer's approval within ten (10) calendar days after issuance of Notice to Proceed (NTP).

27.1.3. The Contractors CPM and activity schedules shall be based on a 7 day week, with no weekends or holidays. The diagram shall show the order and interdependence of activities and the sequence in which the work is to be accomplished as planned by the Contractor in coordination with the subcontractors. The basic concept of an arrow or node diagram shall be followed to show how the start of a given activity is dependent on the completion of

preceding activities and its completion restricts the start of following activities. A narrative shall be provided that explains the logic used to determine the interdependence of activities and their duration.

27.2. The arrow or node diagram shall include, in addition to construction activities, the submittal and approval of samples of materials and shop drawings, the procurement of critical materials and equipment, and their installation and testing. All activities of the Government that affect progress, and contract required dates for completion of all or part of the work shall be shown. The diagram shall show early completion of certain portions of the project as specified herein. The schedule shall provide 20 calendar days for the Government to review, approve, and dispatch each shop drawing or submittal after its receipt by the Contracting Officer.

27.3. The selection and number of activities shall be subject to the Contracting Officer's approval. Detailed networks shall be drafted to show a continuous flow from left to right. The following information shall be shown on the diagrams for each activity: Preceding and following event number, description of the activity, and activity duration in calendar days. The total monetary value of all activities shall equal the amount of the contract. The number of activities and features shall be determined by the Contractor subject to the approval of the Contracting Officer. The detail of information shall be such that duration of each activity will normally range from 1 to 30 days. (The scheduled interval shall extend from Notice to Proceed to the contract completion date that is specified in paragraph "COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK." The schedule shall start no earlier than the date that the Notice to Proceed was acknowledged. Completion of the last activity in the schedule shall be constrained by the contract completion date. This constraint shall be such that if late finish of the last activity falls beyond the contract completion date, then the float calculation shall reflect a negative float on the critical path. Contractually specified interim dates shall also constrain the schedule.)

27.4. The mathematical analysis of the network diagram shall be accomplished by a computer base and have the following minimum characteristics:

27.4.1. The capability of ingesting and tabulating all data required in the diagram and as stated above.

27.4.2. Must be able to accept and tabulate input data as follows:

27.4.2.1. Percent completed for any activities as reported.

27.4.2.2. Actual start date for any activity (by calendar date).

27.4.2.3. Actual finish date for any activity (by calendar date).

27.4.3. Compute and tabulate:

27.4.3.1. Preceding and following event numbers.

27.4.3.2. Activity description.

27.4.3.3. Estimated duration of activities (by calendar days).

27.4.3.4. Earliest start date (by calendar date).

27.4.3.5. Earliest finish date (by calendar date).

27.4.3.6. Latest start date (by calendar date).

27.4.3.7. Latest finish date (by calendar date).

27.4.3.8. Float (by calendar days).

27.4.3.9. Monetary value of activity.

27.4.3.10. Contractor's earnings based on percentage of activity completed.

27.5. The monthly program used in making the sort or schedule shall be capable of compiling the total value of completed and partially completed activities and subtotals from separate buildings or features listed above. The program shall also be capable of accepting revised completion dates as modified by approved time adjustments and recomputations of all tabulation dates and float accordingly.

27.6. The program shall list and the Contractor shall provide the activities in sorts or schedules as follows:

27.6.1. I.J. or node sort, by the activity or event number lowest to highest.

27.6.2. Float sort, by the amount of float then in order of event number.

27.6.3. Early start sort, in order of earliest allowable start dates, then in order of event numbers.

27.6.4. Late start sort, in order of latest allowable start dates, then in order of event numbers.

27.6.5. Cash flow projection as required by a scheduled earnings curve.

27.6.6. Predecessor/Successor sort, I.J. node sort including all preceding and succeeding activities or events.

27.7. Cover sheet, a monitor of the input data for each periodic report listing: contract number, contractor, project name, reporting period, scheduled completion date and actual completion date.

27.8. Cover sheet to summarize the following data: Progress in the reporting period by dollar value, days worked and percent progress. Total project progress by dollar value, days worked, and percent progress.

27.9. Submission and approval of the network analysis system shall be as follows:

27.9.1. A preliminary network defining the Contractor's planned operation during the first sixty (60) calendar days after Notice to Proceed shall be submitted within ten (10) calendar days. The Contractor's general approach for the balance of the project shall be indicated. Cost of the activities expected to be completed or partially completed before submission and approval of the whole schedule should be included.

27.9.2. The complete network analysis system consisting of the detailed schedules and arrow or node diagram shall be submitted within forty-five (45) calendar days after receipt of Notice to Proceed.

27.9.3. Each updated copy shall show a date of the latest revision.

27.9.4. Initial submittal of the CPM diagram and partial revisions shall be submitted in five (5) copies.

27.9.5. Initial submittal of the computer schedules shall be in five (5) copies.

27.9.6. All sorts shall be submitted monthly in five (5) copies.

27.9.7. The required initial and monthly updated copies may be provided as two hard copies and three copies on IBM compatible data diskettes in a format directly readable by the Contracting Officer's software as specified in SECTION: SCHEDULING DATA EXCHANGE FORMAT. The diskettes shall be labeled with cover sheet information.

27.10. The first updating after review and approval by the Contracting Officer shall include a scheduled earnings curve. The curve (time versus scheduled earnings) shall be developed for the total contract to reflect the scheduled earnings in percentages using both the early and late finish of the

activities. The curve shall be updated concurrently with the computer schedule to reflect actual earnings.

27.11. The Contractor shall participate in a review and evaluation of the proposed arrow or node diagram and schedules by the Contracting Officer. Any revisions necessary as a result of this review shall be resubmitted for approval of the Contracting Officer within three (3) calendar days after the conference. The approved schedule shall then be the schedule to be used by the Contractor for planning, organizing, and directing the work and for reporting progress and requesting payment for work accomplished. If the Contractor thereafter desires to make changes in his method of operating and scheduling, he shall request approval by the Contracting Officer in writing specifically identifying every change and stating the reasons for the change. The Contracting Officer may require the Contractor to revise and submit for approval, without additional cost to the Government, all of the affected portions of the CPM diagram and schedules to show the effect on the entire project.

27.12. Prior to requesting payment for work accomplished, the Contractor shall prepare a report of the actual construction progress by updating the previous schedule. Entering of updating information into the program will be subject to the approval of the Contracting Officer. The report shall show the activities or portions of activities completed during the reporting period and their total value shall be the basis for the Contractor's periodic request for payment.

27.13. Payments made pursuant to the CONTRACT CLAUSE entitled "PAYMENTS UNDER FIXED-PRICE CONSTRUCTION CONTRACTS" will be based on the total value of such activities completed after verification by the Contracting Officer, as reflected by the updated schedules. The report will state the percent of the work actually completed and scheduled as of the report date and the progress along the critical path in terms of days ahead of or behind the allowable dates. If the progress is behind schedule, progress along other less critical paths shall also be reported. The Contractor shall also submit a narrative report with the update which shall include but not limited to a description of the problem areas, current and anticipated, delaying factors and their impact, in an explanation of corrective actions taken or proposed.

27.14. When Notice to Proceed for changes in the work or time extensions is issued, the Contractor shall revise the network logic and/or duration time estimates of all activities affected by the modification or time on the next succeeding updating report after the Notice to Proceed. These revisions shall be submitted for concurrence of the Contracting Officer prior to the inclusion in the network. If the Contractor fails or refuses to submit or include such revisions within ten (10) days after date of Notice to Proceed, the Contracting Officer may furnish to the Contractor the suggested logic and/or duration time changes to be entered into the network and be used in all subsequent updating reports until such time that the time has been settled or until actual dates supersede the estimated data. Inclusion in the network and use of revised logic and/or duration time estimates for updating, whether furnished by the Contractor or by the Contracting Officer, will not be construed as extensions of time to the dates required in the contract. If it becomes necessary for the Contracting Officer to furnish the suggested logic and/or duration time revisions because of the Contractor's failure to furnish acceptable data on time, and if the Contractor has any objections to the data furnished by the Contracting Officer, the Contractor shall advise the Contracting Officer promptly, in writing, of such objections fully supported by a counterplan; however, the Contractor shall

continue to use the revisions suggested by the Contracting Officer for all updating reports until such time as the Contracting Officer may approve alternate data. If the Contractor fails to submit, in writing, his objections to the revisions along with supporting data and counterplan within twenty (20) days after receipt, the Contractor will be deemed to have concurred in the Contracting Officer's suggested logic/duration time changes, which changes then will be the basis for equitable adjustment of the time for performance of the work.

27.15. Float or slack is defined as the amount of time between the early start date and the late start date, or the early finish date and the late finish date, for all the activities in the NAS schedule. Float or slack is not time for the exclusive use or benefit of either the Government or the Contractor. Extensions of time for performance required under the CONTRACT CLAUSES entitled "CHANGES," "DIFFERING SITE CONDITIONS," "DEFAULT (FIXED PRICE CONSTRUCTION)," or "SUSPENSION OF WORK" shall be granted only to the extent that the completion of the contract is actually delayed and equitable time adjustment for the activity or activities affected exceeds the total float or slack along the path involved.

[ALTERNATE]
#(2,42)#
27. **PROGRESS CHARTS** submitted in accordance with the CONTRACT CLAUSES clause entitled "Schedule for Construction Contracts" shall indicate the required data for each of the principal features of the work.

#(2,44)#
28. NOT USED. TIME EXTENSIONS. Notwithstanding any other provisions of this contract, the time extensions for changes in the work will depend upon the extent, if any, by which the changes cause delay in the completion of the various elements of construction. The change order granting the time extension may provide that the contract completion date will be extended only for those specific elements so delayed and that the remaining contract completion dates for all other portions of the work will not be altered and may further provide for an equitable readjustment of liquidated damages pursuant to the new completion schedule. (based on FAR 52.212-6)

#(45)#
29. **PERFORMANCE EVALUATION OF CONTRACTOR.** The Contractor's performance will be evaluated upon final acceptance of the work. However, interim evaluation may be prepared at any time during contract performance when determined to be in the best interest of the Government. The format for the evaluation will be SF 1420, and the Contractor will be rated either outstanding, satisfactory, or unsatisfactory in the areas of Contractor Quality Control, Timely Performance, Effectiveness of Management, Compliance with Labor Standards, and Compliance with Safety Standards. The Contractor will be advised of any unsatisfactory rating, either in an individual element or in the overall rating, prior to completing the evaluation, and all Contractor comments will be made a part of the official record. The final report will be supplemented or amended as necessary through the warranty period of the contract to reflect changes in the evaluation of performance elements based on compliance with warranty requirements. Performance Evaluation Reports will be available to all DOD Contracting offices for their future use in determining Contractor

responsibility, in compliance with DFARS 36.201(c)(1). (based on EFARS 52.2/9006.)

#(2,46)#

30. **PERFORMANCE OF WORK BY CONTRACTOR (1984 APR).** The Contractor shall perform on the site, and with its own organization, work equivalent to at least [twenty (20) percent] of the total amount of work to be performed under the contract. This percentage may be reduced by a supplemental agreement to this contract if, during performing the work, the Contractor requests a reduction and the Contracting Officer determines that the reduction would be to the advantage of the Government. (FAR 52.236-1)

#(2,47)#

31. NOT USED.ASBESTOS (OCCUPATIONAL HEALTH AND ENVIRONMENT).

31.1. **THE CONTRACTOR IS WARNED THAT EXPOSURE TO AIRBORNE ASBESTOS HAS BEEN ASSOCIATED WITH FOUR DISEASES: LUNG CANCER, CERTAIN GASTROINTESTINAL CANCERS, PLEURAL OR PERITONEAL MESOTHELIOMA, AND ASBESTOSIS.** Studies indicate there are significantly increased health dangers to persons exposed to asbestos who smoke and further, to family members and other persons who become indirectly exposed as a result of the exposed worker bringing asbestos laden work clothing home to be laundered.

31.2. The Contractor is advised that friable and/or nonfriable asbestos containing material has been identified in area(s) where contract work is to be performed. Friable asbestos containing material means any material that contains more than 1 percent asbestos by weight that hand pressure can crumble, pulverize, or reduce to powder when dry. Nonfriable asbestos containing materials do not release airborne asbestos fiber during routine handling and end-use. However, excessive fiber concentrations may be produced during uncontrolled abrading, sanding, drilling, cutting, machining, removal, demolition, or other similar activities.

31.3. Care must be taken to avoid releasing, or causing to be released, asbestos fibers into the atmosphere where they may be inhaled or ingested. The Occupational Safety and Health Administration (OSHA) has set standards at 29 CFR 1926.58 for occupational exposure to airborne concentrations of asbestos fibers in the construction industry. These standards define permissible exposure limits, methods of compliance, personal protective equipment including clothing and respiratory protection, hygiene facilities and practices, establishment of regulated removal areas, employee information and training, exposure monitoring of airborne asbestos, signs and labels warning of asbestos hazard, housekeeping methods for fiber control and waste disposal, and medical surveillance programs and recordkeeping of medical and exposure monitoring data. The Environmental Protection Agency (EPA) has established standards at 40 CFR 61.140-156 for the control of asbestos emissions to the environment and the handling and disposal of asbestos wastes. These standards define procedures for stripping and removing friable asbestos materials and require EPA notification that such removal is to take place. The required work practices and procedures include wetting, containment, container labeling, and disposal of removed materials in an approved sanitary landfill.

31.4. When contract work activities are carried out in locations where the potential exists for exposure to airborne asbestos fibers as described above or where asbestos waste will be generated, the Contractor shall assure that all measures necessary to provide effective protection to persons from exposure to

asbestos fibers and prevention of contamination to property, materials, supplies, equipment, and the internal and external environment are effectively instituted.

31.5. As a minimum, the Contractor shall comply with the provisions of OSHA (29 CFR 1926.58), EPA (40 CFR 61.140-156), DOT (49 CFR 172.101, 172.200-204, 173.1090), and any state or local regulations applicable to safety and health, emission control, transportation, and disposal requirements for asbestos.

31.6. In addition to complying with the above regulations, the Contractor shall perform all asbestos removal and disposal operations in accordance with the requirements as set forth in SECTION: ASBESTOS REMOVAL AND DISPOSAL.

#(2,48)#

32. NOT USED. OPERATIONS AND MAINTENANCE DATA AND TRAINING REQUIREMENTS.

32.1. The Operations and Maintenance Data required by this paragraph is in addition to Operations and Maintenance Instructions and/or Manuals required in paragraph: OPERATIONS AND MAINTENANCE INSTRUCTIONS AND/OR MANUALS above. The Operations and Maintenance Data required by this paragraph shall be shown as a separate activity on the construction schedule bar chart or network analysis system.

32.2. Operations and Maintenance Data shall consist of one (1) corrected copy of all Categories I and II submittals including one (1) updated copy of all Operations and Maintenance Instructions and/or Manuals. The Operations and Maintenance Data shall be checked for completeness, indexed, packaged, and shall be submitted to the Contracting Officer at time of contract completion and shall be addressed to: Engineering Division CEMRO-ED-DI U.S. Army Engineer District, Omaha, 215 North 17th Street, 1612 U.S. Post Office and Courthouse, Omaha, NE 68102-4978.

32.3. TRAINING. The Contractor shall provide training for Air Force personnel on the systems and system's components listed below. Where a minimum number of training hours are not specified, the instruction period shall be of sufficient length to explain the operation, maintenance, repair, and checkout procedures of the system. Where training required by technical sections of these specifications is longer than the training required below, the longer training period shall be used. Following training and initial system startup and testing, the Contractor shall supervise Base personnel in performing system startup and testing. Base personnel will follow the Contractor's operation instructions provided.

a. Hoists and Trolleys.
b. Energy Monitoring and Control System Interface.
(1) Operation (Min 4 hrs).
(2) Maintenance and Repair (Min 8 hrs).
c. Plumbing, Backflow Preventive Devices (Testing and Maintenance).
d. Compressed Air System.
e. Alarm Testing Procedures (Fire Protection).
f. Heating, Ventilating, and Air-Conditioning Systems.
(1) Converters, Operations and Troubleshooting (Min 4 hrs).
(2) Air-Conditioning, Operation and Maintenance (Min 8 hrs).
(3) Local Controls Operation and Maintenance (Min 2 hrs).
g. Exterior Electrical.

(1) Operating and Troubleshooting (2 hrs).
(2) Maintenance (Min 2 hrs).

h. Interior Electrical.
(1) Startup Procedures (Motor Control Center) (Min 2 hrs).
(2) Maintenance of Controllers including Elec-Watt/Demand Meter (Min 2 hrs).

i. Cathodic Protection, Review of Manual.

j. Overhead Doors (electrical), Operation and Maintenance.

k. Battery Inverters.

l. Intercom System.

33. **INTERIM CHANGE TO CONTRACT CLAUSE FAR 52.236-13 ACCIDENT PREVENTION.** Delete subparagraph (b) and substitute the following:

(b) If this contract is for construction or dismantling, demolition, or removal of improvements with any Department of Defense agency or component, the Contractor shall comply with all pertinent provisions of the latest version of U.S. Army Corps of Engineers Safety and Health Requirements Manual, EM 385-1-1, in effect on the date of the solicitation.

#(49)#

34. **PROFIT.**

34.1. Weighted guidelines method of determining profit shall be used on any equitable adjustment change order or modification issued under this contract. The profit factors shall be as follows:

Factor	Rate	Weight	Value
Degree of Risk	20		
Relative difficulty of work	15		
Size of Job	15		
Period of performance	15		
Contractor's investment	5		
Assistance by Government	5		
Subcontracting	25		
	100		

34.2. Based on the circumstances of each procurement action, each of the above factors shall be weighted from .03 to .12 as indicated below. The value shall be obtained by multiplying the rate by the weight. The value column when totalled indicates the fair and reasonable profit percentage under the circumstances of the particular procurement.

34.2.1. **Degree of Risk.** Where the work involves no risk or the degree of risk is very small, the weighting should be .03; as the degree of risk increases, the weighting should be increased up to a maximum of .12. Lump sum items will have, generally, a higher weighted value than the unit price items for which quantities are provided. Other things to consider: the portion of the work to be done by subcontractors, nature of work, where work is to be

performed, reasonableness of negotiated costs, amount of labor included in costs, and whether the negotiation is before or after performance of work.

34.2.2. **Relative Difficulty of Work.** If the work is most difficult and complex, the weighting should be .12 and should be proportionately reduced to .03 on the simplest of jobs. This factor is tied in to some extent with the degree of risk. Some things to consider: the nature of the work, by whom it is to be done, where, and what is the time schedule.

34.2.3. **Size of Job.** All work not in excess of $100,000 shall be weighted at .12. Work estimated between $100,000 and $5,000,000 shall be proportionately weighted from .12 to .05.

34.2.4. **Periods of Performance.** Jobs in excess of 24 months are to be weighted at .12. Jobs of lesser duration are to be proportionately weighted to a minimum of .03 for jobs not to exceed 30 days. No weight where additional time not required.

34.2.5. **Contractor's Investment.** To be weighted from .03 to .12 on the basis of below average, average, and above average. Things to consider: amount of subcontracting, mobilization payment item, Government furnished property, equipment and facilities, and expediting assistance.

34.2.6. **Assistance by Government.** To be weighted from .12 to .03 on the basis of average to above average. Things to consider: use of Government-owned property, equipment and facilities, and expediting assistance.

34.2.7. **Subcontracting.** To be weighted inversely proportional to the amount of subcontracting. Where 80 percent or more of the work is to be subcontracted, the weighting is to be .03 and such weighting proportionately increased to .12 where all the work is performed by the Contractor's own forces.

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35. **EXTENDED OVERHEAD.** Extended overhead is defined as and shall include field office costs for personnel, to include but not be limited to, the project superintendent and clerical persons, all plant, all utilities, and all supplies which are related to and incurred on a time basis. The unit price inserted in the Bidding Schedule shall be used in determining the amount to be applied to change orders or modifications for field overhead. Personnel, plant, utilities, and supplies referenced above shall not be bid or charged as direct costs on change orders and modifications. Further, the unit price stated shall be applied for each day the contract is extended, excluding time extensions granted under the contract clause entitled: "Default (Fixed-Price Construction)" and that this unit price represents the total amount to be applied for all field overhead including all subcontractors. The percentage used in Item No. 4 of the Bidding Schedule is for evaluation purposes only and shall not be construed as a limitation or a guarantee of the number of days that may be granted under the contract.

36. **OVERHEAD.** Overhead is defined as all overhead costs other than extended overhead costs. Examples include but are not limited to general and administrative home office costs and non-time related field office costs. The percentage for overhead inserted in the Bidding Schedule shall be used in determining the amount to be applied to all change orders or modifications. Further, the stated percentage, when applied to direct costs, represents the total amount of overhead payable including any and all subcontractors. The percentage used in Item No. 3 of the Bidding Schedule is for evaluation purposes only and shall not

be construed as a limitation or a guarantee of the amount of change orders or modifications that may be issued under the contract.

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37. NOT USED. INCENTIVE PROGRAM FOR SUBCONTRACTING WITH SMALL AND SMALL DISADVANTAGED BUSINESS CONCERNS, HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY INSTITUTIONS (FEB 1988).

37.1. Of the total dollars it plans to spend under subcontracts, the Contractor has committed itself in its subcontracting plan to try to award a certain percentage to small business concerns and a certain percentage to small disadvantaged business (SDB) concerns, Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs).

37.2. To encourage placement of subcontracts with SDBs/HBCUs/MIs, the Contractor will be entitled to receive an incentive award under this clause, as follows:

37.2.1. Where the SDB/HBCU/MI goal in this contract is less than five percent (5%) of the contract price and the Contractor both exceeds its SDB/HBCU/MI goal and awards more than five percent (5%) of the contract price (see FAR 15.801) to SDBs/HBCUs/MIs in performing this contract, the Contractor will receive ten percent (10%) of the difference between the actual dollar amount of subcontracts awarded to SDBs/HBCUs/MIs and five percent (5%) of the contract price.

37.2.2. Where the SDB/HBCU/MI goal in this contract is equal to or greater than five percent (5%) of the contract price and the Contractor both exceeds its SDB/HBCU/MI goal and awards more than five percent (5%) of the contract price (see FAR 15.801) to SDBs/HBCUs/MIs in performing this contract, the Contractor will receive ten percent (10%) of the difference between the actual dollar amount of subcontracts awarded to SDBs/HBCUs/MIs and the SDB/HBCU/MI goal.

37.3. The Contractor will not be entitled to receive an incentive award under this clause if the Contracting Officer determines that the amount by which the Contractor exceeded its goal was not due to the Contractor's efforts (e.g., a subcontractor cost overrun, or the award of subcontracts that had been planned but had not been disclosed in the subcontracting plan during contract negotiations, caused the actual subcontract amount to exceed that estimated in the subcontracting plan). Determinations made under this paragraph are not subject to the Disputes clause.

37.4. If this is a cost contract, the limitations of FAR Subpart 15.9 may not be exceeded. (DFARS 52.219-7009)

38. **APPLICABILITY OF DAVIS-BACON ACT.** It is the position of the Department of Defense that the Davis-Bacon Act, 40 U.S.C. 276a is applicable to temporary facilities such as batch plants, sandpits, rock quarries, and similar operations, located off the immediate site of the construction but set up exclusively to furnish required materials for a construction project on the site of the work. Clause "Payrolls and Basic Records" of the CONTRACT CLAUSES is applicable to such operations.

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39. NOT USED.SOLID WASTE DISPOSAL REQUIREMENTS.

39.1. TYPE II AND TYPE III SOLID WASTE.

39.1.1. All non-hazardous, non-toxic (Type II and Type III) generated at K. I. Sawyer AFB must be disposed of in Marquette County. The Contractor is responsible for arranging with a licensed waste hauler, or becoming a licensed waste hauler, to dispose of refuse generated in performance of this contract. The Contractor is responsible for segregation of refuse as necessary to meet landfill criteria. If the Contractor utilizes the Marquette Regional Landfill, the landfill authority will bill the Government for tipping fees, and the Government will bill the Contractor for all refuse generated on this contract, at a rate of [_____] per ton, payable NLT 30 days after billing.

39.1.2. Asbestos and asbestos related wastes must be disposed of in the Marquette County Regional Landfill. The Contractor shall coordinate the disposal of asbestos waste in accordance with the requirements of the Regional Landfill. The landfill authority will bill the Government for tipping fees, and the Government will bill the Contractor on a monthly basis for all refuse generated on this contract, at a rate of [_____] per ton plus [_____] for special waste charges, payable NLT 30 days after billing.

39.1.3. Notify Construction Management (DEEC) daily of each load sent to the landfill. A copy of the weight ticket from the landfill must be provided to the Project Inspector at the end of the next regular workday. The weight ticket must include the tare weight, the final weight, date, time, contract number, and driver's signature.

39.2. TYPE I SOLID WASTE. All hazardous waste (Type 1) generated at K. I. Sawyer AFB must be handled, stored, and disposed of in accordance with "Michigan Hazardous Waste Management Rules" (Act 64). Hazardous waste shipped off base must be properly manifested using K. I. Sawyer's EPA identification number. A copy of the manifest must be submitted to Contract Management when the waste is shipped. In addition, a copy of the manifest signed by the Treatment, Storage, or Disposal Facility that accepts the waste must be submitted to Contract Management. The Contractor is responsible for disposal cost.

39.3. DEFINITIONS.

39.3.1. Type 1 Solid Waste. Hazardous or toxic materials regulated by "Michigan Hazardous Waste Management Rules" (Act 64). Examples of wastes covered by these rules include non-latex paint wastes and spent solvents and thinners.

39.3.2. Type II and III Waste. Non-hazardous, non-toxic waste material regulated by "Michigan Solid Waste Management Regulations" (Act 64).

ZERO ACCIDENTS

SECTION 01200
WARRANTY OF CONSTRUCTION

INDEX

1. Warranty of Construction (Apr 1984)
2. Warranty Service Calls

1. **WARRANTY OF CONSTRUCTION (APR 1984).**

1.1. In addition to any other warranties in this contract, the Contractor warrants, except as provided in paragraph 1.10 below, that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, or design furnished, or workmanship performed by the Contractor or any subcontractor or supplier at any tier.

1.2. This warranty shall continue for a period of 1 year from the date of final acceptance of the work. If the Government takes possession of any part of the work before final acceptance, this warranty shall continue for a period of 1 year from the date the Government takes possession.

1.3. The Contractor shall remedy at the Contractor's expense any failure to conform, or any defect. In addition, the Contractor shall remedy at the Contractor's expense any damage to Government-owned or controlled real or personal property, when that damage is the result of--

1.3.1. The Contractor's failure to conform to contract requirements; or

1.3.2. Any defect of equipment, material, workmanship, or design furnished.

1.4. The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause. The Contractor's warranty with respect to work repaired or replaced will run for 1 year from the date of repair or replacement.

1.5. The Contracting Officer shall notify the Contractor, in writing, (by telephone in the case of WARRANTY SERVICE CALLS), within a reasonable time after the discovery of any failure, defect, or damage.

1.6. If the Contractor fails to remedy any failure, defect, or damage within a time as specified in paragraph: WARRANTY SERVICE CALLS after receipt of notice, the Government shall have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.

1.7. With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall--

1.7.1. Obtain all warranties that would be given in normal commercial practice;

1.7.2. Require all warranties to be executed, in writing, for the benefit of the Government, if directed by the Contracting Officer, and

1.7.3. Enforce all warranties for the benefit of the Government, if directed by the Contracting Officer.

1.8. In the event the Contractor's warranty under paragraph 1.2 above has expired, the Government may bring suit at its expense to enforce a subcontractor's, manufacturer's, or supplier's warranty.

1.9. Unless a defect is caused by the negligence of the Contractor or subcontractor or supplier at any tier, the Contractor shall not be liable for the repair of any defects of material or design furnished by the Government nor for the repair of any damage that results from any defect in Governmentfurnished material or design.

1.10. This warranty shall not limit the Government's rights under the Inspection and Acceptance clause of this contract with respect to latent defects, gross mistakes, or fraud.

1.11. Defects in design or manufacture of equipment specified by the Government on a "brand name and model" basis, shall not be included in this warranty. In this event, the Contractor shall require any subcontractors, manufacturers, or suppliers thereof to execute their warranties, in writing, directly to the Government. (Based on FAR 52.246-21)

2. **WARRANTY SERVICE CALLS.** The Contractor shall furnish to the Contracting Officer the names of local service representatives and/or Contractors that are available for warranty service calls and who will respond to a call within the time periods as follows: 4 hours for heating, air-conditioning, refrigeration, air supply and distribution, and critical electrical service systems and food service equipment, and 24 hours for all other systems. The names, addresses, and telephone numbers for day, night, weekend, and holiday service responses shall be furnished to the Contracting Officer and also posted at a conspicuous location in each mechanical and electrical room or close to the unit.

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SECTION 01300
ENVIRONMENT PROTECTION

INDEX

1. GENERAL
2. IMPLEMENTATION
3. PRECONSTRUCTION SURVEY
4. PROTECTION OF LAND AREAS
5. PROTECTION OF TREES AND SHRUBS
6. PROTECTION OF WATER RESOURCES
7. WASTE DISPOSAL
8. BURNING
9. DUST CONTROL
10. EROSION CONTROL
11. CORRECTIVE ACTION
12. POST-CONSTRUCTION CLEANUP OR OBLITERATION

1. **GENERAL.** The Contractor shall perform all work in such manner as to minimize the polluting of air, water, or land, and shall, within reasonable limits, control noise and the disposal of solid waste materials, as well as other pollutants.

2. **IMPLEMENTATION.** Within 20 calendar days after Notice to Proceed and prior to commencement of the work at the site, the Contractor shall:

2.1. Submit in writing his detailed proposal for implementing the requirements for environmental pollution control specified herein.

2.2. Meet with representatives of the Contracting Officer to review and alter his proposal as needed for compliance with the environmental pollution control program.

3. **PRECONSTRUCTION SURVEY.** Prior to start of any on-site construction activities, the Contractor and the Contracting Officer shall make a joint condition survey after which the Contractor shall prepare a brief report indicating on a layout plan the condition of trees, shrubs and grassed areas immediately adjacent to the site of the work and adjacent to his assigned storage area and access route(s) as applicable. This report will be signed by both the Contracting Officer and Contractor upon mutual agreement as to its accuracy and completeness.

4. **PROTECTION OF LAND AREAS.** Except for any work or storage area and access routes specifically assigned for the use of the Contractor under this contract, the land areas outside the limits of permanent work performed under this contract shall, in accordance with CONTRACT CLAUSES clause: "Protection of Existing Vegetation, Structures, Utilities and Improvements," be preserved in their present condition. Contractor shall confine his construction activities to areas defined for work on the plans or specifically assigned for his use. In accordance with CONTRACT CLAUSES clause: "Operations and Storage Areas," storage and related areas and access routes required temporarily by the Contractor in the performance of the work will be assigned by the Contracting Officer. No other areas on Government premises shall be used by the Contractor without written consent of the Contracting Officer.

5. **PROTECTION OF TREES AND SHRUBS.** CONTRACT CLAUSES clause: "Protection of Existing Vegetation, Structures, Utilities and Improvements," is hereby supplemented as follows: Except for trees or shrubs marked on the plans to be removed, the Contractor shall not deface, injure or destroy trees or shrubs, nor remove or cut them without special authority. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorages.

5.1. **TREE PROTECTIVE STRUCTURES.** Where, in the opinion of the Contracting Officer, trees may possibly be defaced, bruised, injured, or otherwise damaged by the Contractor's equipment or by his other operations, he may direct the Contractor to provide temporary protection of such trees by placing boards, planks, or poles around them.

5.2. **RESTORATION OF DAMAGED TREES.** Any tree scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition at the Contractor's expense. All scars made on trees not designated on the plans to be removed by construction operations shall be coated as soon as possible with an approved tree wound dressing. Trees that are to remain, either within or outside established clearing limits, that are damaged by the Contractor so as to be beyond saving in the opinion of the Contracting Officer, shall be immediately removed, if so directed, and replaced with a nursery-grown tree of the same species and size.

6. **PROTECTION OF WATER RESOURCES.** The Contractor shall control the disposal of fuels, oils, bitumens, calcium chloride, acids or harmful materials, both on and off the Government premises and shall comply with applicable Federal, State, County and Municipal laws concerning pollution of rivers and streams while performing work under this contract. Special measures shall be taken to prevent chemicals, fuels, oils, greases, bituminous materials, herbicides, and insecticides from entering public waters. Water used in on-site material processing, concrete curing, foundation and concrete cleanup, and other waste waters shall not be allowed to reenter a stream if an increase in the turbidity of the stream could result therefrom.

7. **WASTE DISPOSAL.** As part of his proposed implementation under paragraph 2, and prior to on-site construction, the Contractor shall submit a description of his scheme for disposing of waste materials resulting from the work under this contract. If any waste material is dumped in unauthorized areas, the Contractor shall remove the material and restore the area to the condition of the adjacent undisturbed areas. Where directed, contaminated ground shall be excavated, disposed of as approved, and replaced with suitable fill material, all at the expense of the Contractor.

8. **BURNING.** Air pollution restrictions applicable to this project are as follows. Material shall not be burned on the Government premises. If the Contractor elects to dispose of waste materials off the Government premises, by burning, he shall make his own arrangements for such burning area and shall, as specified in CONTRACT CLAUSES clause: "Permits and Responsibilities," conform to all local regulations.

#(2)#
9. **DUST CONTROL.** The Contractor shall maintain all excavations, [embankments,] #(2)# stockpiles, access roads, [plant sites,] waste areas, [borrow areas,] and all other work areas free from excess dust to such reasonable degree as to avoid causing a hazard or nuisance to the Using Service or to others. Approved #(2)# temporary methods consisting of sprinkling, chemical treatment as approved by the Contracting Officer, [light bituminous treatment] or similar methods will be permitted to control dust. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs.

10. **EROSION CONTROL.** Surface drainage from cuts and fills within the construction limits, whether or not completed, and from borrow and waste disposal areas, shall be graded to control erosion within acceptable limits. Temporary control measures shall be provided and maintained until permanent drainage facilities are completed and operative. The area of bare soil exposed at any one time by construction operations should be held to a minimum.

11. **CORRECTIVE ACTION.** The Contractor shall, upon receipt of a notice in writing of any noncompliance with the foregoing provisions, take immediate corrective action. If the Contractor fails or refuses 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 part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs of damages by the Contractor unless it was later determined that the Contractor was in compliance.

12. **POST-CONSTRUCTION CLEANUP OR OBLITERATION.** In accordance with CONTRACT CLAUSES clause: "Cleaning Up," the Contractor shall, unless otherwise instructed in writing by the Contracting Officer, obliterate all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the work. The disturbed areas shall be graded and filled and the entire area seeded.

#(3)#
[13. The Contractor shall notify the Contracting Officer a minimum of 7 days prior to installation of underground fuel storage tank(s).]

ZERO ACCIDENTS

SECTION 01401
SAFETY, HEALTH, AND EMERGENCY RESPONSE

INDEX

1. SCOPE
2. APPLICABLE PUBLICATIONS, REGULATIONS, GUIDELINES, AND STANDARDS
3. SUBMITTALS
4. SAFETY AND HEALTH PROGRAM
5. SITE SAFETY AND HEALTH PLAN (SSHP)
6. SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION
7. HAZARD/RISK ANALYSIS
8. ACCIDENT PREVENTION
9. STAFF ORGANIZATION, QUALIFICATION, AND RESPONSIBILITIES
10. TRAINING
11. PERSONAL PROTECTIVE EQUIPMENT
12. MEDICAL SURVEILLANCE
13. EXPOSURE MONITORING/AIR SAMPLING
14. HEAT/COLD STRESS MONITORING
15. STANDARD OPERATING SAFETY PROCEDURES, ENGINEERING CONTROLS, WORK PRACTICES
16. SITE CONTROL AND WORK ZONES
17. DECONTAMINATION
18. EMERGENCY EQUIPMENT AND FIRST AID
19. EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES
20. LOGS, REPORTS AND RECORDKEEPING
21. INSPECTIONS/AUDITS
22. RADIOLOGICAL EQUIPMENT

APPENDIX A: SITE INFORMATION

1. **SCOPE.** This section covers safety, health, and emergency response requirements to be followed during execution of this contract.

2. **APPLICABLE PUBLICATIONS, REGULATIONS, GUIDELINES, AND STANDARDS.** Work performed shall be consistent with the following guidelines and references and in compliance with all applicable regulations and standards including, but not limited to, those listed below. In the case that these requirements are conflicting, the one which offers the greatest protection shall be followed.

2.1. U.S. Army Corps of Engineers (USACE) Safety and Health Requirements Manual, EM 385-1-1. Revised October 1987

2.2. Federal Acquisition Regulation, F.A.R. Clause 52.236-13: Accident Prevention.

2.3. Occupational Safety and Health Administration (OSHA) Construction Industry Standards, 29 CFR 1926, and General Industry Standards, 29 CFR 1910, especially 29 CFR 1910.120 - "Hazardous Waste Site Operations and Emergency Response".

2.4. NIOSH/OSHA/USCG/EPA, "Occupational Safety and Health Guidance manual for Hazardous Waste Site Activities. DHHS (NIOSH) Publication No. 85-115, October 1985

2.5. U.S. Environmental Protection Agency (USEPA) Standard Operating Safety Guidelines, 1988

3. **SUBMITTALS.** In accordance with SECTION: SPECIAL CLAUSES, the Contractor shall submit data for the following items. Details for their contents are described in following paragraphs.

3.1. **CATEGORY** I. (for Approval)

3.1.1. Site Safety and Health Plan

3.2. **CATEGORY** II. (for Information)

3.2.1. Corporate Safety and Health Program covering workers engaged in hazardous waste work.

3.2.2. Weekly Safety reports.

3.2.3. Employee/visitor register.

3.2.4. Monitoring/sampling results.

3.2.5. Training Logs.

3.2.6. Accident Reports

3.2.7. Certification of Employee Fitness

3.3. **CATEGORY** II. (for Approval)

3.3.1. Phase-Out Report.

4. **SAFETY AND HEALTH PROGRAM.** All contractors performing on-site activities at hazardous waste sites are required by regulation to develop and maintain a written Safety and Health Program in compliance with OSHA standard 29 CFR 1910.120(b)(1) through (b)(4). Written certification that such a program has been prepared and implemented shall be submitted to the CO as a preface to required Site Safety and Health Plan (SSHP). The program including updates shall be submitted to the CO as required by paragraph: SUBMITTALS.

5. **SITE SAFETY AND HEALTH PLAN (SSHP).**

5.1. **GENERAL.** The Contractor shall prepare a Site Safety and Health Plan (SSHP) covering all work to be performed under this contract. The SSHP shall establish, in detail, the protocols necessary for the recognition, evaluation, and control of all hazards associated with each task performed by the Contractor and all Subcontractors. The SSHP shall be a brief document addressing only site-specific safety and health requirements and procedures based upon site-specific conditions. Duplication of the general information contained in the Safety and Health Program is unwanted. The level of detail provided in the SSHP shall be tailored to the type of work, complexity of operations to be accomplished, and hazards anticipated.

5.2. **TOPICS.** All topics required by OSHA standard 29 CFR 1910.120(b)(4) and those listed below shall be addressed in the SSHP. Where the use of a specific topic is not applicable to the project, the SSHP shall include a statement to justify its omission and establish that adequate consideration was given the topic.

5.2.1. Site description and contamination characterization.

5.2.2. Hazard/risk analysis

5.2.3. Accident prevention

5.2.4. Staff organization, qualifications, and responsibilities

5.2.5. Training

5.2.6. Personal protective equipment
5.2.7. Medical surveillance
5.2.8. Exposure Monitoring/Air sampling
5.2.9. Heat/cold stress monitoring.
5.2.10. Standard operating safety procedures, engineering controls, and work practices
5.2.11. Site control and Work Zones
5.2.12. Decontamination
5.2.13. Emergency equipment and first aid
5.2.14. Emergency Response and Contingency procedures
5.2.15. Logs, reports and recordkeeping
5.2.16. Inspections/audits

5.3. **APPROVAL AND MODIFICATIONS.** The SSHP shall be submitted to the CO for approval as described in paragraph: SUBMITTALS. The Contractor will not be allowed to perform any on-site work until this plan has been approved by the CO. Should any unforeseen hazard become evident during the performance of the work, the Site Safety and Health Officer (SSHO) shall bring such hazard to the attention of the CO, both verbally and in writing, for resolution as soon as possible. In the interim, the Contractor shall take necessary action to re-establish and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Should the Contractor seek modification of any portion or provision of the SSHP, such modification shall be requested by the CIH or SSHO in writing to the CO, and if approved, be authorized in writing. Any disregard for the provisions of these Safety, Health and Emergency Response specifications and the approved SSHP shall be deemed just and sufficient cause for ordering the stopping of all work beyond the Support Zone until the matter has been rectified to the satisfaction of the CO.

6. SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

6.1. **PLAN REQUIREMENTS.** The SSHP shall include a site description and contamination characterization that addresses the following elements, as a minimum:

6.1.1. Location and approximate size of the site.
6.1.2. Site topography and accessibility by air and roads.
6.1.3. Present status and capabilities of emergency response teams that would provide assistance to hazardous waste clean-up site employees at the time of an emergency.
6.1.4. A complete list of the contaminants found or known to be present in site areas to be impacted by the work to be performed. Chemical names, concentration ranges, media in which found, locations on-site, and estimated quantities/volumes to be impacted by site work shall be included if known.

6.2. **SITE INFORMATION.** Appendix A of the specifications provides a record of site contaminants and a description of the Lime and M-1 Settling Basins. This information is provided to assist the Contractor in preparing the SSHP. However, the contractor shall also research and use additional sources of information from past site investigation activities when preparing the "Site Description and Contamination Characterization" section of the SSHP.

7. HAZARD/RISK ANALYSIS

7.1. **PLAN REQUIREMENTS.** The SSHP shall include a hazard/risk analysis that addresses the following elements, as a minimum:

7.1.1. Description of on-site jobs/tasks to be performed.

7.1.2. Duration of planned site activities.

7.1.3. Chemical, physical, biological and safety hazards of concern for each site task and/or operation to be performed. (Activity Hazard Analysis)

7.1.4. Pathways for hazardous substance dispersion.

7.1.5. Chemical, physical, and toxicological properties of contaminants, sources and pathways of employee exposures, anticipated on and off-site exposure level potentials, and regulatory (including Federal, State, and local) or recommended protective exposure standards.

8. ACCIDENT PREVENTION. The SSHP shall serve as the Accident Prevention Plan (APP) and activity hazard analyses (Phase Plans), required by F.A.R. Clause 52.236-13, and Paragraphs 01.A.03 through 01.A.06 and Appendix Y of USACE EM 385-1-1. Thus, a separate APP is not required. For the purposes of clarification, the items from Appendix Y of EM 385-1-1 are listed below with the corresponding section(s) of the SSHP in which they are to be addressed (either as described elsewhere in these specifications or as described in EM 385-1-1).

App. Y Items	SSHP Topics
Administrative Section:	
Admin. responsibilities	Staff Organization, ...
Local requirements	As applicable, dependent on requirement
Method of controlling and coordinating subs	Staff organization, ...
Layout	Site control and work zones
Training	Training
Traffic control	Site control and work zones
Maintaining job cleanup, safe access & egress	SOPs, controls & work practices and Site control and work zones
Fire protection and emergencies	Emergency response & contingency procedures.
Inspections	Inspections/audits
Accident Investigations	Logs, reports, & recordkeeping and Inspections/ audits
Fall protection	SOPs, controls and work practices
Temporary power	SOPs, controls and work practices
Safe clearance	SOPs, controls and work practices
Trailer anchoring	SOPs, controls and work practices
Contingency plans for severe weather	Emergency response & contingency procedures
Activity Hazard Analysis Section:	
Activity hazard analysis for each activity and operation	Hazard/risk analysis

9. STAFF ORGANIZATION, QUALIFICATION, AND RESPONSIBILITIES.

9.1. **GENERAL.** The Contractor shall develop an organizational structure that sets forth lines of authority, responsibility, and communication. The SSHP

shall include a description of this organization, qualifications and responsibilities of each of the following individuals.

9.2. CERTIFIED INDUSTRIAL HYGIENIST (CIH)

9.2.1. **Qualifications.** The Contractor shall utilize the services of an Industrial Hygienist certified in Comprehensive Practice by the American board of Industrial Hygiene. The CIH shall:

9.2.1.1. Possess a minimum of three years experience in developing and implementing health and safety programs at hazardous waste sites or in the chemical industry,

9.2.1.2. Have demonstrable experience in supervising professional and technician level personnel,

9.2.1.3. Have demonstrable experience in developing worker exposure assessment programs and ambient air monitoring programs, and

9.2.1.4. Have working knowledge of State and Federal occupational safety and health regulations.

9.2.2. **Responsibilities.** The CIH shall:

9.2.2.1. Be responsible for the development, implementation, oversight, and enforcement of the SSHP,

9.2.2.2. Sign and date the SSHP prior to submittal,

9.2.2.3. Conduct initial site-specific training,

9.2.2.4. Be present on-site during the first three days of remedial activities,

9.2.2.5. Visit the site at least once per week for the duration of activities,

9.2.2.6. Be available for emergencies,

9.2.2.7. Provide on-site consultation as needed to ensure the SSHP is fully implemented,

9.2.2.8. Coordinate any necessary modifications to the SSHP with the CO, and

9.2.2.9. Serve as a member of the quality control staff.

9.3. SITE SAFETY AND HEALTH OFFICER (SSHO)

9.3.1. **Qualifications.** The Contractor shall designate an individual to be the Site Safety and Health Officer (SSHO). The SSHO shall:

9.3.1.1. Posses a minimum of two years experience in developing and implementing health and safety programs at hazardous waste sites or in the chemical industry,

9.3.1.2. Possess demonstrable experience in construction safety techniques and procedures,

9.3.1.3. Have working knowledge of State and Federal occupational safety and health regulations,

9.3.1.4. Have specific training in personal and respiratory protective equipment program implementation and in the proper use of air monitoring instruments, air sampling methods, and procedures, and

9.3.1.5. Be certified in first aid/CPR by the Red Cross, or equivalent agency.

9.3.2. **Responsibilities.** The SSHO shall:

9.3.2.1. Assist and represent the CIH in the continued on-site implementation and enforcement of the SSHP,

9.3.2.2. Be assigned to the site on a full time basis for the entire duration of field activities, and shall have no duties other than Health and Safety related duties.

9.3.2.3. Ensure that all aspects of the SSHP are complied with including preparation of records, air monitoring, use of PPE, decontamination, and site control,

9.3.2.4. Serve as a member of the quality control staff on matters relating to safety and health,

9.3.2.5. Have authority to stop work if unacceptable health or safety conditions exist, and

9.3.2.6. Consult with and coordinate any necessary modifications to the SSHP with the CIH and the CO.

9.4. **HEALTH AND SAFETY SUPPORT PERSONNEL.** For each work crew in the exclusion zone, the Contractor shall designate one person as a Health and Safety support person. These individuals shall perform activities at their location consistent with the SSHP such as air monitoring, decontamination, and safety oversight on behalf of the SSHO. They shall have appropriate training equivalent to the SSHO in the specific area(s) for which they have responsibility. They shall report to and be under the supervision of the SSHO.

9.5. **OCCUPATIONAL PHYSICIAN.** The Contractor shall utilize the services of a licensed physician who is certified in occupational medicine by the American Board of Preventative Medicine, or who, by necessary training and experience is Board eligible. The physician shall be responsible for developing a medical monitoring program in compliance with 29 CFR 1910.120(f). See paragraph: Medical Surveillance.

10. **TRAINING**

10.1. **GENERAL.** All employees working on-site with the potential for exposure to hazardous substances, health hazards, or safety hazards shall meet the minimum training requirements as specified in 29 CFR 1910.120. These employees shall have competed the required 40 hours of hazardous waste training and shall have three days of field experience in hazardous waste work. All supervisory personnel shall have received an additional eight hours of training as required for management of personnel and activities associated with hazardous waste site activities. Employees shall also receive a minimum of eight hours refresher training annually.

10.2. **SITE-SPECIFIC.**

10.2.1. An initial site-specific training session shall be conducted by the CIH prior to commencement of work or entering the site. This training shall cover site hazards, procedures, and all contents of the approved SSHP. All site employees, including those working in the support zone, shall attend this training.

10.2.2. Periodic on-site training shall be provided by the Contractor at least weekly and prior to each change in operation.

11. **PERSONAL PROTECTIVE EQUIPMENT**

11.1. **GENERAL.** In accordance with 29 CFR 1910.120(g)(5), a written Personal Protective Equipment (PPE) program which addresses all the elements listed in that regulation, and which complies with respiratory protection program requirements of 29 CFR 1910.134 is to be included in the Safety and Health Program. Therefore, the Site Safety and Health Plan (SSHP) shall detail the minimum PPE ensembles (including respirators) and specific materials from which the PPE components are constructed <u>for each site-specific task/operation to be performed</u>, based upon the hazard/risk analysis. Components of levels of protection (B,C,D and modifications) must be relevant to site-specific

conditions, including heat stress potential and safety hazards. The PPE section of the SSHP shall include site-specific procedures for on-site fit-testing, cleaning, maintenance, inspection, and storage.

11.2. **COMPONENTS OF LEVELS OF PROTECTION.**

11.2.1. Level D Protection shall consist of :

- Hard hat
- Safety glasses with side shields or safety goggles.
- Work clothing as prescribed by weather.
- Steel toe work boots.
- Hearing protection (if needed)

11.2.2. Modified Level D Protection shall consist of all elements of Level D above plus:

- disposable outer coveralls (chemically resistant)
- disposable boot covers.
- Surgical inner gloves.
- Chemically protective outer gloves (as per PPE program).

11.2.3. Level C Protection shall consist of:

- Hard hat
- Work clothing as prescribed by weather.
- Disposable outer coveralls (chemically resistant)
- Disposable boot covers
- Steel toe work boots.
- Hearing protection (if needed)
- Surgical inner gloves.
- Chemically protective outer gloves (as per PPE program).
- Full face air purifying respirator (APR) with appropriate cartridges (selected as per respiratory protection program).

11.2.4. Level B Protection shall consist of all elements of Level C above except the air purifying respirator shall be replaced by an air supplied respirator.

11.3. **INITIAL MINIMUM LEVELS OF PPE BY TASK.** The Contractor's CIH shall establish appropriate levels of protection for each work activity based on historical site information, air monitoring results, and an evaluation of the potential for dermal exposure during each task. The Contractor's CIH shall also establish upgrade/downgrade "action levels" based on air monitoring results. Protocols formally changing the level of protection and the communication network for doing so shall be described in the SSHP. Historical information and past field activities in the Lime and M-1 Settling Basins have indicated the possible presence of chemical agents and their breakdown products. Therefore, the level of PPE required during intrusive activities shall be Level B.

11.4. **PPE FOR GOVERNMENT PERSONNEL.** The contractor shall provide appropriate approved personal safety equipment and protective clothing to government representatives who require access to the exclusion zone. A minimum of two sets of appropriate PPE per day will be required to support government representatives.

12. **MEDICAL SURVEILLANCE**

12.1. **GENERAL.** The CIH, in conjunction with the Occupational Physician, shall detail, in the SSHP, the medical monitoring program that includes scheduling of examinations, certification of fitness, compliance with OSHA requirements, and information provided to the physician. The program shall, as a minimum, outline the requirements specified below.

12.2. **COMPLIANCE WITH OSHA.** The Contractor shall ensure the physician performs the medical examination prescribed in 29 CFR 1910.120 for workers performing work in areas other that the Support Zone. Accordingly, the Contractor shall furnish the physician with:

12.2.1. Information on the employee's anticipated or measured exposure;

12.2.2. PPE use;

12.2.3. A description of the employee's duties;

12.2.4. A copy of 29 CFR 1910.120

12.2.5. Information from previous examinations not readily available to the examining physician.

12.2.6. A copy of Section 5.0 of NIOSH Publication 85-115.

12.3. **PHYSICIAN'S OPINION.** The Contractor shall obtain a copy of the physician's written opinion about employees' ability to perform hazardous remediation work and furnish copies to the CIH, the CO, and the employee before work begins. The opinion shall contain:

12.3.1. The physician's recommended limitations upon the employee's assigned work;

12.3.2. The physician's opinion about increased risk to the employee's health resulting from work; and

12.3.3. A statement that the employee has been informed and advised about the results of the examination.

12.4. **FREQUENCY OF EXAMINATIONS.** The Contractor shall make medical examinations available to employees:

12.4.1. Before they start work;

12.4.2. Annually thereafter;

12.4.3. On termination of employment;

12.4.4. If the employee develops signs or symptoms of illness relating to workplace exposures;

12.4.5. If the physician determines examinations need to be conducted more often than once a year; and

12.4.6. When an employee develops a lost time injury or illness during the period of this contract. The supervisor must be provided with a written statement signed by the physician prior to allowing the employee to return to the work site after illness resulting in a lost time workday. The written statement shall be submitted to the CO as part of the weekly safety report (see also Paragraph: LOGS, REPORTS AND RECORDKEEPING of this section).

12.5. **CONTENT OF EXAMINATIONS.** The following parameters shall be included in the medical surveillance program at a minimum. The actual parameters selected shall be the responsibility of the Occupational Physician and shall meet the requirements of 29 CFR 1910.120, 1910.134 and ANSI Z88.2.

12.5.1. Complete medical and occupational history (initial exam only).

12.5.2. General physical examination including an evaluation of all major organ systems.

12.5.3. Pulmonary function testing including FVC and FEV1.0

12.5.4. CBC with differential

12.5.5. Biological blood profile (SMAC-21 or equivalent).

12.5.6. Urinalysis with microscopic examination.

12.5.7. Audiometric testing (as required by Hearing Conservation Program).

12.5.8. Visual acuity

12.5.9. Chest x-ray. (This test to be performed no more frequently than every four years, unless directed by Occupational Physician.)

12.5.10. Electrocardiogram (as directed by Occupational Physician).

13. **EXPOSURE MONITORING/AIR SAMPLING.**

13.1. **GENERAL.** The Contractor shall write and include in the SSHP an exposure monitoring/air sampling program for all construction operations. The program shall establish reporting requirements and notification procedures. Modifications of the programs shall have the concurrence of the CO or COR. The Contractor shall sample and screen air quality to establish:

13.1.1. Concentrations of air contaminants in the workers' breathing zones (BZ), and

13.1.2. Concentrations of air contaminants at the site perimeter.

13.2. **MONITORING AND SAMPLING FOR BREATHING ZONE (BZ) CONCENTRATIONS.** Breathing zone concentrations shall be determined to establish proper levels of PPE and to document employee exposure levels.

13.2.1. Real time (direct reading) monitoring. The Contractor shall utilize direct reading instruments to monitor for contaminants in workers' breathing zones. The following direct reading instruments shall be utilized, as a minimum:

13.2.1.1. Organic vapor monitor utilizing either a photoionization detector or a flame ionization detector.

13.2.1.2. Total dust monitor.

13.2.1.3. Army issued instruments for detecting military chemical agents.

13.2.1.4. Colorimetric detector tubes.

13.2.2. **Personnel exposure monitoring.** The CIH or SSHO shall perform monitoring and will be responsible for ensuring compliance with all requirements of 29 CFR 1910.120(h). Personal air sampling shall be performed at intervals designated in the approved SSHP. As a minimum, this shall be every day for the first two weeks of trenching operations in the Lime Settling Basins area, once per week thereafter and once per week during all soil intrusive activities. The individual(s) selected for personal air monitoring shall be the individual(s) expected to have the greatest exposure during the current activities. Full-shift or near-full-shift breathing zone samples shall be collected. Sampling shall utilize personal sampling pumps with sorbent tubes and filter cassettes, using NIOSH methods. Samples shall be analyzed by an American Industrial Hygiene Association accredited laboratory. The actual compounds to be sampled shall be determined by the Contractor's CIH after reviewing available data and shall be listed in the SSHP.

13.3. **MONITORING AND SAMPLING AT THE SITE PERIMETER.** The Contractor shall perform monitoring and sampling at the site perimeter as required to ensure that no unacceptable emissions are migrating beyond the site perimeter. Perimeter monitoring and sampling is performed to:

13.3.1. Assess potential worker exposure in locations where personal sampling is not practical;

13.3.2. Ensure that contaminants are not migrating into support areas;

13.3.3. Ensure that contaminants are not migrating into off-site areas at concentrations above acceptable limits; and

13.3.4. Identify sources.

14. HEAT/COLD STRESS MONITORING

14.1. GENERAL. The Contractor's CIH shall develop a heat stress/cold stress monitoring program for on-site activities. Details of the monitoring program including work/rest schedules and physiological monitoring requirements shall be described in the SSHP. Monitoring shall be performed by a person with a current first aid/CPR certification who is trained to recognize the symptoms of heat and cold stress.

14.2. HEAT STRESS. The climate at the site combined with the requirements for personal protective equipment may create heat stress. For workers who wear permeable clothing, the Contractor shall follow recommendations for monitoring requirements and suggested work/rest schedules in the current ACGIH Threshold Limit Values for Heat Stress. For workers who wear semipermeable or impermeable clothing, the Contractor shall follow the technical guidelines in "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" (see paragraph: APPLICABLE PUBLICATION, REGULATIONS, GUIDELINES, AND STANDARDS).

14.3. COLD STRESS. To guard against cold injury the Contractor shall provide appropriate clothing and warm shelter for the rest periods. Procedures to monitor and avoid cold stress shall be followed in accordance with the current TLVs for Cold Stress as recommended by the ACGIH.

15. STANDARD OPERATING SAFETY PROCEDURES, ENGINEERING CONTROLS, WORK PRACTICES. The SSHP shall address the engineering controls and safe work practices to be implemented for the work covered by these specifications. These shall include, but not be limited to the following:

15.1. Site rules/prohibitions (buddy system, eat/drink/smoking restrictions, etc.)

15.2. Protocols for operation of heavy construction equipment in accordance with 29 CFR 1926.

15.3. Protocols for working around heavy equipment.

15.4. Descriptions of safety inspection and preventative maintenance requirements for the operation of machinery or mechanized equipment, including written inspection reports.

15.5. Site "housekeeping".

15.6. Fall protection.

15.7. Safe clearance

15.8. Sanitation (In accordance with 29 CFR 1910.120(n).)

15.9. Confined Space Entry.

15.10. Electrical hazards.

15.11. Utility clearances.

15.12. Communication.

15.13. Excavation and trenching.

16. SITE CONTROL AND WORK ZONES.

16.1. GENERAL. In order to control the spread of contamination and the flow of personnel and materials into and out of the work area, the contractor shall establish a site control section in the SSHP. This section shall describe the methodology to be used by the SSHO in determining the modification of work zone designations, procedures to limit the spread of contamination and general limitations to be observed by site personnel. The Contractor shall clearly layout and identify the work zones in the field and shall limit equipment, operations, and personnel in the zones as required by these specifications and

described in the SSHP. Initial work zone boundaries are shown on the drawings. These may be changed with approval of the CO.

16.2. **SUPPORT ZONE.** The Support Zone shall be established on the site and is defined as the area outside the zone of significant contamination. The Support Zone shall be clearly delineated and shall be secured against active or passive contamination from the work site. The function of the Support Zone is to provide :

16.2.1. An entry area for personnel, material, and equipment into the Exclusion Zone of site operations.

16.2.2. An exit area for decontaminated personnel, materials and equipment from the Exclusion Zone of site operations.

16.2.3. Location for support facilities.

16.2.4. A storage area for clean safety and work equipment.

16.3. **CONTAMINATION REDUCTION ZONE (CRZ).** The CRZ shall serve as the personnel and equipment decontamination area. A decontamination pad for heavy equipment shall be located in the CRZ. The CRZ shall also contain personnel decontamination facilities. See paragraph: DECONTAMINATION, for additional details.

16.4. **EXCLUSION ZONE.** The EZ boundary shall be set by the Contractor so that it encompasses areas around all construction being performed. The Contractor shall control entry into this area and exit may only be made through the CRZ.

17. DECONTAMINATION

17.1. **GENERAL.** The Contractor shall establish decontamination procedures for "on-site" personnel who perform activities in the Exclusion Zone and for equipment utilized in the Exclusion Zone. Decontamination shall be performed in the CRZ prior to entering the Support Zone from the Exclusion Zone. The Contractor may elect to establish an area for gross decontamination in the CRZ near the M-1 area and transport personnel and equipment to the CRZ near the Lime area for final decontamination. This would eliminate the need for two complete decontamination facilities. The Contractor shall refer to Chapter 10.0 of the technical guidance publication "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" (NIOSH 85-115) when preparing decontamination procedures. Procedures shall be described in the SSHP. The Contractor shall train employees in the procedures and enforce the procedures throughout site operations.

17.2. **WASTE DISPOSAL.** Decontamination water shall be containerized and delivered as directed by the CO to a site on RMA for disposal by others. Disposable PPE shall be containerized and disposed of by the Contractor as hazardous waste.

17.3. Equipment decontamination shall be accomplished on the equipment decontamination facility in the CRZ.

17.4. The Contractor shall provide a mobile personnel decontamination trailer for personnel decontamination activities in the CRZ. This facility shall be used by both Contractor personnel and government representatives. The decontamination trailer shall be equipped with a change room and lockers, a shower stall room for showering,and a PPE doffing room which will face the Exclusion Zone.

18. **EMERGENCY EQUIPMENT AND FIRST AID.** The SSHP shall describe the emergency and first aid equipment to be utilized. The following items, as a minimum, shall be immediately available for on-site use:

18.1. First aid equipment and supplies approved by the consulting physician.

18.2. Emergency eyewashes/showers (comply with ANSI Z-358.1)

18.3. Two Self-Contained Breathing apparatus shall be dedicated for emergency use only and maintained on-site in the Contamination Reduction Zone.

18.4. Spill control materials and equipment.

18.5. Fire extinguishers with a minimum rating of 2A-10B:C shall be provided at all site facilities and at any other site locations where flammable or combustible materials present a fire risk.

19. **EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES.**

19.1. **GENERAL.** The Contractor shall prepare an Emergency Response Plan in compliance with 29 CFR 1910.120(1), which addresses the following elements, as a minimum:

19.1.1. Pre-emergency planning and procedures for reporting incidents to appropriate government agencies for potential chemical exposures, personal injuries, fires/explosions, environmental spills and releases.

19.1.2. Personnel roles, lines of authority, communications.

19.1.3. Posted instructions and a list of emergency contacts (physician, nearby medical facility, fire and police departments, ambulance service, federal/state/local environmental agencies, CIH, Contracting Officer).

19.1.4. Emergency recognition and prevention.

19.1.5. Site topography, layout, and prevailing weather conditions.

19.1.6. Criteria and procedures for site evacuation (emergency alerting procedures/employee alarm system, emergency PPE and equipment, safe distances, places of refuge, evacuation routes, site security and control).

19.1.7. Specific procedures for decontamination and medical treatment of injured personnel.

19.1.8. Route maps to nearest pre-notified medical facility.

19.1.9. Criteria for initiating community alert program, contacts, and responsibilities.

19.1.10. Procedures for critique of emergency responses and follow-up.

19.2. **RMA PROCEDURES.** The Contractor shall ensure the Emergency Response Plan also complies with all special RMA emergency response and notification procedures including but not limited to those listed below:

19.2.1. SOP SF-50-1, Emergency Response Plan for Field Activity Discovered Chemical Agents.

19.2.2. SOP GC-01, Emergency Notification Plan.

19.2.3. AMC-R 385-131, Safety Regulation for Chemical Agents H, HD, HT, GB and VX.

20. **LOGS, REPORTS AND RECORDKEEPING**

20.1. **GENERAL.** The Contractor shall maintain logs and reports covering the implementation of the SSHP. The formats shall be developed by he Contractor and submitted as part of the SSHP.

20.2. **DAILY SAFETY LOG AND INSPECTION REPORT.** The daily safety log and inspection report shall include practices and events that affect safety and

health, safety and health discrepancies encountered, and safety and health issues brought to the supervisor's attention. Each entry shall include:

20.2.1. Date
20.2.2. Work area checked
20.2.3. Employees present in work area
20.2.4. PPE and work equipment being used in each area
20.2.5. Special health and safety issues and notes
20.2.6. Signature of preparer.

20.3. **WEEKLY SAFETY REPORTS.** Weekly reports shall be submitted to the CO within 5 days of the end of the week reported. The format to be used for reporting shall be shown in the SSHP. The following information shall, at a minimum, be included:

20.3.1. Week ending date.
20.3.2. Summary sheet covering the range of work performed.
20.3.3. Any incidents of violations of the safety and health protocols set forth in the SSHP.
20.3.4. Job related injuries and illness.
20.3.5. SSHO signature
20.3.6. Copies of the daily logs and safety inspection reports.

20.4. **EMPLOYEE/VISITOR REGISTER.**

20.4.1. Date
20.4.2. Name
20.4.3. Agency or company
20.4.4. Time entering site
20.4.5. Time exiting site

20.5. **MONITORING/SAMPLING RESULTS.**

20.5.1. Date
20.5.2. Type of equipment utilized
20.5.3. Equipment I.D. number
20.5.4. Monitoring results for each work location or monitoring station with time of readings.
20.5.5. Analytical results for personal exposure or perimeter sampling
20.5.6. Personnel or location monitored/sampled with description of activity being performed.
20.5.7. Sample numbers.
20.5.8. Miscellaneous information related to monitoring/sampling performed.

20.6. **TRAINING LOGS.** Training logs shall be completed by the SSHO and submitted to the CO upon request and at the completion of the work. These logs shall be used to document all on-site training. The format to be used for reporting shall be shown in the SSHP. The following information shall, at a minimum, be included:

20.6.1. Date
20.6.2. Employees in attendance and signature
20.6.3. Visitors in attendance
20.6.4. Description of training activity and/or topics covered
20.6.5. Equipment utilized
20.6.6. Signature of instructor

20.7. **PHASE-OUT REPORT.** At the completion of the work, the Contractor shall submit a phase-out report. The report shall be submitted to the CO within

10 working days following completion of the work, prior to final acceptance of the work. The following minimum information shall be included:

20.7.1. Summary of the weekly safety reports which outlines the overall performance of Health and Safety by the contractor.

20.7.2. Documentation of medical certifications for site personnel.

20.7.3. Final decontamination documentation including procedures and techniques used to decontaminate equipment, vehicles, and on-site facilities.

20.7.4. Complete summary of air monitoring accomplished during the project.

20.7.5. Signed and dated by the Contractor and the CIH.

20.8. ACCIDENT REPORTING. All accidents shall be investigated and reported as specified in EM 385-1-1 and as prescribed by the CO.

20.9. EMPLOYER OBLIGATION. The Contractor shall be aware that Federal laws such as OSHA require chemical exposure records and/or medical records be maintained by the employer for a specified length of time after the termination of the job.

21. INSPECTIONS/AUDITS. The SSHO shall perform daily inspections of the jobsite and the work in progress to ensure compliance with the Corps of Engineers Manual EM 385-1-1, the SSHP and other occupational health and safety requirements of the contract. The inspections shall also be conducted to determine the effectiveness of the SSHP. Daily safety logs, as required under paragraph: "LOGS, REPORTS AND RECORDKEEPING" shall be used to document the inspection, noting safety deficiencies, deficiencies in the effectiveness of the SSHP, and corrective actions taken.

22. RADIOLOGICAL EQUIPMENT. In accordance with Requirement 08.F.01 of EM 385-1-1, entitled Safety and Health Requirements Manual, the Contractor is required to obtain a service permit to use, store, operate, or handle a radiation producing machine or radioactive materials on a Department of Defense (DOD) Installation. The service permit shall be obtained from the appropriate U.S. Army or U.S. Air Force Command through the Contracting Officer's representative. The Contractor should notify the Contracting Officer during the prework conference if a radiation producing device will be utilized on a DOD Installation in order to determine the permit application requirements, and allow a lead time of 45 days for obtaining a permit.

INTERIM CHANGE TO EM 385-1-1 - SAFETY AND HEALTH REQUIREMENTS MANUAL

1. Page 21, Section 07.A.03, replace with the following:

"07.A.03 - Protective footwear, such as rubber boots, protective covers, ice clamp-ons, and steel-toed safety boots, shall be worn by all persons exposed to hazards to the feet (including, but not limited to impact, puncture, slipping, electrical, or chemical hazards).

a. For all activities in which Corps or contractor personnel or official visitors are potentially exposed to foot hazards, the applicable job/activity hazard analysis, accident prevention plan, or project safety plan shall include

an analysis of, and prescribe specific protective measures to be enforced for, foot hazards.

b. Footwear providing protection against impact and compressive forces, conduction hazards, electrical hazards, and sole puncture shall meet the applicable requirements of ANSI Z41."

2. Page 143, Section 18.C.05, replace with the following:

"18.C.05 - All load drums on loading-hoisting equipment shall be equipped with at least one positive holding device. This device should be applied directly to the motor shaft or some part of the gear train. It is not necessary that the positive holding device utilize shearing of metal to meet this requirement. Friction surfaces are acceptable."

3. Page 145, add Sections 18.C.24 and 18.C.25 which will read:

"18.C.24 - During personnel handling operations load and boom hoist drum brakes, swing brakes, and locking devices such as pawls or dogs shall be engaged when the occupied platform is in a stationary working position.

"18.C.25 - During personnel handling operations the load hoist drum shall have a system or device on the power train other than the load hoist brake, which regulates the lowering rate of speed of the hoist mechanism (controlled load lowering). Free fall is prohibited."

4. Page 146, Section 18.D.09, replace with the following:

"18.D.09 - All telescopic boom cranes engaged in standard lift operations (including concrete bucket) should be equipped with a two-block warning feature(s), a two-block damage prevention feature, or an anti-two block device for all points of two-blocking (i.e., jibs, extension, etc). In addition, all new telescopic boom cranes shall be equipped with an anti-two block device or a two-block damage prevention feature for all points of two-blocking. Cranes that are used exclusively as duty cycle machines (clamshell, dragline, grapple, pile driving operations) are exempt from this requirement but will meet the requirements of ANSI/ASME-B30.5-1982 (as revised). To alleviate difficulties associated with attaining compliance, an implementation time period until 1 January 1991 is granted. In all cases where cranes are utilized without these safeguards equivalent protection shall be established, documented and approved by the designated authority."

5. Page 146, add Sections 18.D.10 and 18.D.11, which will read:

"18.D.10 - All lattice boom cranes engaged in standard lift crane operations (including concrete bucket) shall be equipped with a two-block warning feature which functions for all points of two-blocking. Cranes that are used exclusively as duty cycle machines (clamshell, dragline, grapple, pile driving operations) are exempt from this requirement but will meet the requirements of ANSI/ASME-B30.5-1982 (as revised). To alleviate difficulties associated with attaining compliance, an implementation time period until 1 January 1991 is granted. In all cases where cranes are utilized without these safeguards

equivalent protection shall be established and documented and then approved by the designated authority."

"18.D.11 - During personnel handling operations all telescopic and lattice boom cranes shall be equipped with a device which when activated disengages all functions whose movement can cause contact between the load block or overhaul ball and the boom tip (anti-two block device), or a system shall be used which deactivates the hoisting action before damage occurs in the event of a two-blocking situation (two-block damage prevention feature). The device or system must be installed for all points of two-blocking (i.e. jib or boom points) and in the case of the anti-two block device the crane must be equipped with automatic brakes on each hoist line; hoist lines not so equipped must be taken out of service while personnel lifts are being made."

ZERO ACCIDENTS

SECTION 02050
DEMOLITION

INDEX

1. GENERAL REQUIREMENTS
2. SUBMITTALS
3. DUST CONTROL
4. PROTECTION
5. USE OF EXPLOSIVES
6. EXISTING FACILITIES
7. FILLING
8. DISPOSITION OF MATERIAL
9. NOT USED

1. **GENERAL REQUIREMENTS.** The work includes demolition or removal of all construction indicated or specified. All materials resulting from demolition work, except as indicated or specified otherwise, shall become the property of the Contractor and shall be removed from the limits of Government property. Rubbish and debris shall be removed from Government property daily unless otherwise directed so as to not allow accumulation at the work site. Materials that cannot be removed daily shall be stored in areas specified by the Contracting Officer.

2. **SUBMITTALS.** In accordance with SECTION: SPECIAL CLAUSES, the Contractor shall submit for approval, data as specified herein on the following:

2.1. **CATEGORY II.**

Procedures for accomplishment of salvage and demolition work including procedures for:

Safe conduct of the work
Careful removal and disposition of materials specified to be salvaged
Protection of property which is to remain undisturbed
Coordination with other work in progress
Timely disconnection of utility services
Detailed description of the methods and equipment to be used for each operation
Sequence of operations

3. **DUST CONTROL.** The amount of dust resulting from demolition shall be controlled to prevent the spread of dust to avoid creation of a nuisance in the surrounding area. Use of water will not be permitted when it will result in, or create, hazardous or objectionable conditions such as ice, flooding, and pollution.

4. **PROTECTION.**

4.1. **PROTECTION OF EXISTING WORK.** Before beginning any cutting or demolition work, the Contractor shall carefully survey the existing work and examine the drawings and specifications to determine the extent of the work. The Contractor shall take all necessary precautions to ensure against damage to existing work to remain in place, to be reused, or to remain the property of the Government, and any damage to such work shall be repaired or replaced as approved by the Contracting Officer at no additional cost to the Government. The

Contractor shall carefully coordinate the work of this section with all other work and construct and maintain shoring, bracing, and supports, as required. The Contractor shall ensure that structural elements are not overloaded and be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under any part of this contract.

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

5. **USE OF EXPLOSIVES.** Use of explosives will not be permitted.

6. **EXISTING FACILITIES.**

6.1. **STRUCTURES, WALLS, AND PARTITIONS.** Existing structures indicated #(N)# shall be removed. [to grade] [to top of foundation walls.] [to _____ feet below #(N)# grade.] All interior walls other than retaining walls and partitions shall be removed to _____ feet below grade or to top of concrete slab on ground. Basement slabs shall be broken up to permit drainage. Sidewalks, curbs, gutters, and street light bases shall be removed as shown on the drawings.

6.2. **UTILITIES.** Existing utilities with related meters and equipment shall be disconnected and removed as indicated. When utility lines are encountered that are not indicated on the drawings, the Contracting Officer shall be notified.

7. **FILLING.** Holes, open basements, and other hazardous openings shall be #(N)# filled [in accordance with SECTION: _____] [as follows: _____] [as indicated] with the random fill material which is described in SECTION: 02210 Grading.

8. **DISPOSITION OF MATERIAL.**

8.1. **TITLE TO MATERIALS.** Title to all materials and equipment to be demolished, excepting Government salvage and historical items, is vested in the Contractor upon receipt of notice to proceed. The Government will not be responsible for the condition, loss, or damage to such property after notice to proceed.

8.2. NOT USED. MATERIAL FOR CONTRACTOR SALVAGE. Material for salvage shall be stored as approved by the Contracting Officer. Salvage materials shall be removed from Government property before completion of the contract. Material for salvage shall not be sold on the site.

8.3. **UNSALVAGEABLE MATERIALS.** Concrete, masonry, and other noncombustible materials other than concrete permitted to remain in place, shall be disposed #(N)# of by the Contractor [off the Government premises] [in the disposal areas located] as approved by the Contracting Officer. After disposal is completed, the Contractor shall grade the disposal area, uniformly, to drain. Combustible materials shall #(N)# be disposed of by the Contractor [in the sanitary fill area located _____] [off the Government premises] [by burning].

8.4. **MATERIALS FOR GOVERNMENT SALVAGE.**

8.4.1. **Property of the Government.** Salvaged items shall be removed in a manner to prevent damage and packed or crated to protect the items from damage while in storage or during shipment. Containers shall be properly identified as to contents. Salvaged items shall be delivered to the designated
#(N)#
[warehouse] [storage area] on the Government premises.

8.4.2. **Damaged Items.** Items damaged during removal or storage shall be repaired or replaced to match existing.
#(N)#

[8.5. **ASBESTOS.** It has been determined that friable or nonfriable asbestos containing material has been identified in areas where contract work is to be performed and exists on and within materials or equipment to be removed during this project. It shall be the responsibility of the Contractor to perform the asbestos removal operations in accordance with the requirements set forth in SECTION: ASBESTOS REMOVAL AND DISPOSAL.]

9. NOT USED.

ZERO ACCIDENTS

SECTION 02060
WELL ABANDONMENT

INDEX

1. APPLICABLE PUBLICATIONS
2. SCOPE
3. QUALITY CONTROL
4. DOCUMENTATION
5. SUBMITTALS
6. MATERIALS
7. WELL ABANDONMENT SCHEDULING
8. WELLS TO BE ABANDONED
9. GOVERNMENT FURNISHED DATA
10. WELL ABANDONMENT PROCEDURES
11. GROUT PLACEMENT

1. APPLICABLE PUBLICATIONS. The following publications of these 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.

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

C 150-86 Standard Specification for Portland Cement

2. SCOPE. The work provided for herein consists of furnishing all plant, labor, fuels, lubricants, electric energy, materials and equipment, and performing all operations required for the abandonment of wells as indicated on the drawings and as specified herein.

3. QUALITY CONTROL. The Contractor shall establish and maintain quality control for all well abandonments to assure compliance with contract requirements. The Contractor shall maintain records of his quality control for well abandonment, including but not limited to the items listed in paragraph: SUBMITTALS.

4. DOCUMENTATION. For each well abandonment, the documents outlined below shall be completed.

4.1. Well Abandonment Logs. Well abandonment logs shall be prepared by a qualified geologist or hydrogeologist present on-site during all well abandonment activities. Copies of the logs shall be submitted as a Category II (Approval) within 5 working days after completion of each well abandonment. Information on the logs shall include, but not be limited to the following:

4.1.1. Name of project and site.
4.1.2. Well number
4.1.3. Location (coordinates)
4.1.4. Name of driller and name and signature of geologist/geohydrologist.
4.1.5. Type of drill rig and name of drilling firm.
4.1.6. Date(s) when abandonment was performed.
4.1.7. Well Construction History.
4.1.7.1. Original depth of well
4.1.7.2. Original boring depth(s)
4.1.7.3. Casing depth(s)
4.1.7.4. Screen(s) depth(s)

4.1.8. Abandonment Drilling Log.
4.1.8.1. Depth to water and date measured
4.1.8.2. Drilling method
4.1.8.3. Depth abandonment boring drilled.
4.1.8.4. Diameter of abandonment boring.
4.1.9. Casing Removal.
4.1.9.1. Footage drilled and/or pulled.
4.1.10. Grouting Record.
4.1.10.1. Method of grouting.
4.1.10.2. Depth of tremie pipe placement(s).
4.1.10.3. Top and bottom elevations of grout.
4.1.10.4. Grout mixture (include water).
4.1.10.5. Grout weight per gallon.
4.1.11. Remarks.

4.2. Well Abandonment Diagrams. A well abandonment diagram shall be completed for each well abandonment. The scale of the diagram shall be 1-inch equals 1-foot. The diagram shall be prepared by the geologist/hydrogeologist present during well abandonment operations. Submission of the diagram shall be a Category II (Approval) submittal within 5 working days of the completion of each well abandonment. The well will not be accepted by the Contracting Officer's Representative before the geologic logs and installation diagrams are received. The diagram shall illustrate the as-built condition of the abandonment and include, but not be limited to, the following items:

4.2.1. Name of the project and site.
4.2.2. Well identification number and location (coordinates).
4.2.3. Name of driller and name and signature of hydrogeologist preparing diagram.
4.2.4. Date(s) of well abandonment.
4.2.5. Original well construction.
4.2.5.1. Description of material from which the well is constructed including casing and screen material, diameter and schedule of casing and screen, and joint type (threaded, coupled, etc.).
4.2.5.2. Total depth of well.
4.2.5.3. Nominal hole diameter.
4.2.5.4. Depth to top and bottom of screen, filter pack, and any tailpipe installed in the well.
4.2.5.5. Depth to top and bottom of any seals installed in the well boring (grout or bentonite).
4.2.5.6. Type of cement and bentonite used, mix ratios of grout, and quantities used.
4.2.5.7. Elevations of key features of the well, such as top of well casing, top and bottom of protective casing, ground surface, bottom of borehole, top and bottom of well screen, top and bottom of filter pack, and top and bottom of seal(s).
4.2.5.8. Other pertinent construction details, such as gradation and depth of filter pack, quantities of filter pack installed, slot size and percent open area of screen, and manufacturer of screen.
4.2.5.9. A brief stratigraphic log showing major changes in lithology and depths to those changes.
4.2.6. Well abandonment data.
4.2.6.1. Date(s) of abandonment operations.

4.2.6.2. Depth to water and date measured.
4.2.6.3. Diameter of abandonment boring.
4.2.6.4. Depth of abandonment boring.
4.2.6.5. Casing removal.
4.2.6.6. Method of grouting.
4.2.6.7. Top and bottom elevations of grout.
4.2.6.8. Grout mixture (include water).
4.2.6.9. Grout weight per gallon.

4.3. Field Notebook. A field notebook shall be kept by the geologist/hydrogeologist present during well abandonment operations. Information recorded in the book shall include, but not be limited to the following:

4.3.1. Identification number and location of well.

4.3.2. To the extent known or measurable, boring depth and diameter; surface and well casing interval, diameter and materials; screen interval, diameter and materials; seal interval and materials.

4.3.3. Description of abandoned well including boring diameter and depth; grout intervals.

4.3.4. Description of well abandonment methods.

4.3.5. Significant observations made during abandonment.

4.3.6. Record of materials used during abandonment operations.

4.3.7. Geologic and mechanical problems encountered during well abandonment.

4.3.8. Weather conditions.

4.3.9. Personnel present and visitors to the site.

4.3.10. Other information.

4.3.11. Daily start up and completion times.

4.3.12. Date and sign-off by geologist/geohydrologist.

5. SUBMITTALS. In accordance with Section: Special Provisions, the Contractor shall submit the following items.

5.1. Category I.

5.1.1. Well Abandonment Plan. A plan describing methods and procedures to be used for well abandonment shall be submitted. The plan must be prepared by, or approved and signed by a geologist/hydrogeologist before submittal. The plan shall include, but not be limited to the following:

5.1.1.1. Description of well abandonment procedures including drilling and placement of grout.

5.1.1.2. Description of drilling equipment.

5.1.1.3. Description of well abandonment material.

5.1.1.4. Description of quality control procedures including depth measurements, placement of grout. Also include example forms for well abandonment logs and diagrams.

5.2. Category II (Approval).

5.2.1. Well abandonment logs.

5.2.2. Well abandonment diagrams.

5.2.3. Field notebook.

6. MATERIALS.

6.1. Grout. Grout for well abandonment shall consist of a mixture of 94 pounds of Type II portland cement, 3 pounds of powdered bentonite and a maximum 8 gallons of water. Cement shall meet the requirements of ASTM C 150-86.

7. WELL ABANDONMENT SCHEDULING. Well abandonment operations must be completed before construction of the work platform for the bentonite slurry trench for the lime settling basins and before preparations are made for the sheet pile wall for the M-1 settling basins.

8. WELLS TO BE ABANDONED. Wells to be abandoned are constructed of either 2-inch or 4-inch diameter, schedule 40 PVC casing and well screen. All well casings have been grouted with neat cement grout. The locations are shown in the drawings. The following are pertinent data concerning the wells to be abandoned.

WELL NO.	APPROXIMATE DEPTH OF WELL (FT)	INSIDE DIAMETER (IN)	OVERBURDEN WELL	DENVER FORMATION BEDROCK WELL
36055A	24	2	Yes	No
36055B	?	2	?	?
36058	24	2	Yes	No
36059	85	2	No	Yes
36076	30	2	Yes	No
36167	17	4	Yes	No
36194	24	4	Yes	No
01503	20	4	Yes	No
01504	19	4	Yes	No

9. GOVERNMENT FURNISHED DATA. Well logs and/or well installation diagrams will be furnished to the Contractor for the above wells. These data shall be used by the Contractor to complete the requirements of Sections: Well Abandonment Logs and Well Abandonment Diagrams.

10. WELL ABANDONMENT PROCEDURES.

10.1. Water Levels. Water levels shall be measured in each well prior to abandonment operations.

10.2. Concrete Pad and Protective Casings. Well 36167 has an 8-inch diameter protective surface casing and well 36194 has a 6-inch square protective surface casing and concrete pad approximately 3'x3'x6" around the casing. Each protective surface casing extends no more than 3-feet below ground surface and they are cemented in place. These protective surface casings shall be pulled from the ground and turned over to the Rocky Mountain Arsenal for disposal. The concrete pad at well 36194 shall be broken and disposed of in an area designated by the Contracting Officer's Representative. This area shall be within the working area of the lime settling basins.

10.3. PVC Well Casing Stickups. The 2-inch and 4-inch PVC well casings protruding above the ground surface shall be cut off flush with the ground surface.

10.4. Drilling Method. The 2-inch and 4-inch PVC well casings and grout shall be drilled out by the hollow stem auger method. The outside diameter of the augers shall be at least 10-inches. The bit attached to the center plug shall be sized so as to serve as a pilot within the PVC well casings. The PVC well casings and screens shall be completely drilled out to the bottom of each

well. The hollow stem auger shall remain in place at the bottom of the well until grouting operations have begun.

10.5. Decontamination. The drill rig, drill rods, augers, and all other associated equipment shall be cleaned with high-pressure steam prior to drilling at each location. Decontamination shall be performed at the decontamination station.

10.6. Drill Cuttings. Drill cuttings produced during drilling operations will be considered contaminated. Cuttings will be disposed of in an area within the lime settling basins designated by the Contracting Officer's Representative.

10.7. Water Source. Water for grout and other operations shall be obtained from the same source as that specified for monitor wells.

11. GROUT PLACEMENT. The grout shall be placed by tremie pipe, submerged in the grout at all times. The tremie pipe may be raised as the grout is placed as long as the discharge end remains submerged in the grout. The tremie pipe shall be constructed so as to direct the flow of grout to the sides rather than downward. The hollow stem auger shall be withdrawn from the bottom of the well as the grout is placed. The grout shall be placed from the bottom to the top of the hole in one continuous operation.

ZERO ACCIDENTS

SECTION 02150

HANDLING AND DISPOSAL OF CONTAMINATED MATERIALS

INDEX

1. GENERAL.
2. DEFINITION.
3. SUBMITTALS.
4. HANDLING OF CONTAMINATED MATERIALS.

1. GENERAL. This section covers the Contractor's requirements for materials, equipment, and personnel associated with the handling and disposal of contaminated materials generated by construction activities. All activities conducted under this section shall be in accordance with SECTION: SAFETY, HEALTH, AND EMERGENCY RESPONSE, and the Contractor's approved Site Safety and Health Plan (SSHP).

2. DEFINITION. For this project, contaminated materials are identified as any soils, solid waste materials, debris, liquid, sludge, or any other substance which meets any of the following requirements.

2.1. The material exhibits concentrations of any of the component chemicals from EPA's Target Compound List in excess of established background levels for the area.

2.2. The material exhibits any reading above background levels when monitored with a direct reading total organics analyzing instrument.

2.3. The material exhibits gross surface contamination.

2.4. All materials excavated within the exclusion zones as indicated on the drawings.

3. SUBMITTALS.

3.1. CATEGORY I.

3.1.1. The Contractor shall submit for approval a written Materials Handling Plan. The Materials Handling Plan shall address, at a minimum:

3.1.1.1. Methods proposed for excavating contaminated material, including all methods for conducting Geophysical survey involving Unexploded Ordinance (UXO) detection techniques.

3.1.1.2. Methods proposed for removal, loading, and handling of contaminated materials..

3.1.1.3. Storage provisions for contaminated materials.

3.1.1.4. Security provisions for contaminated materials storage.

3.1.1.5. Waste identification methods (e.g., labeling, marking containers).

3.1.1.6. Location of waste staging and storage areas.

3.1.1.7. Location of onsite waste disposal areas.

3.1.1.8. Provisions for minimizing offsite contamination associated with temporary storage of contaminated materials onsite.

3.1.1.9. Special safety precautions.

3.1.1.10. Dust Control Measures.

The Materials Handling Plan shall be developed in strict adherence with other Contractor generated plans (e.g., SSHP, CQCP, Spill Control Plan) and with all relevant and appropriate Federal, State, and local regulations associated with contaminated materials handling and disposal. The Materials Handling Plan shall be submitted to the Contracting Officer concurrently with the Site Safety and Health Plan (SSHP). Sections of the Materials Handling Plan may refer directly to the SSHP.

4. HANDLING OF CONTAMINATED MATERIALS.

4.1. PREVIOUSLY IDENTIFIED CONTAMINATED AREAS. Rocky Mountain Arsenal has been the site for Army and Army Lessee operations that included: manufacturing of toxic and hazardous chemicals, military weapons testing, and waste disposal. Any past operation at Rocky Mountain Arsenal does not preclude the possibility that some Unexploded Ordinance (UXO) or Army Chemical Agent may exist in the Lime and M-1 Settling Basin Area. If these items are encountered during any excavation, the Contractor shall mark the location, immediately stop operations in the affected area, and notify the Conracting Officer or his representative. The Contractor shall excavate all waste and soil as designated in the exclusion zones shown on the drawings. All soils excavated inside the exclusion zones are considered contaminated.

4.2. SLURRY WALL AND GROUND-WATER EXTRACTION TRENCH INSTALLATION. The Contractor is expected to encounter contamination within the materials excavated from the slurry wall trench and the ground-water extraction trench alignment. The Contractor shall maintain a contaminated materials staging area within which all material excavated from the slurry trench alignment, and not used for slurry trench backfill materials, shall be deposited.

4.2.1. Provision for Reclassification of Contaminated Material. The Contractor shall have the option to request that material excavated from the slurry trench alignment as identified on the contract drawings be usable as slurry trench backfill material. The Contracting Officer will be responsible for determining if material will be allowed to be used as slurry trench backfill. In order to be determined to be usable, the material must:

a. Be natural in situ soil.

b. Exhibit no signs of visual contamination.

c. Meet with approval of the slurry wall inspector that it appears to be of a suitable soil classification for use as backfill material (e.g., ML, CL).

4.3. OTHER SITE ACTIVITIES. Contaminated materials may also be encountered in other site activities. Specifically, contaminated materials are expected to be encountered during:

a. Preliminary site grading.

b. Storm Drain Installation.

c. Removal of onsite debris.

d. Monitoring well and piezometer installation.

e. Lift Station installation.

f. Use of decontamination facilities.

g. Utility relocations or removals.

This list is not complete. It is possible that contaminated materials may be encountered in any activity associated with this project. These activities exhibit the greatest likelihood of encountering contaminated materials.

4.3.1. Soils and Solid Waste Handling. All contaminated soils and solid wastes shall be collected and stored in the contaminated materials staging area for eventual disposal within slurry wall isolation cell and under the vegetative cover.

4.3.2. Liquid Waste Handling. Liquid wastes are expected to be generated during installation of monitoring wells and piezometers. All potentially contaminated liquid associated with installation and development of wells onsite shall be containerized and transferred to RMA for disposal. Liquid wastes are also expected to be generated during use of decontamination facilities.

5. STORAGE OF CONTAMINATED MATERIALS. Shall be in accordance with all appropriate provisions of RCRA regarding storage of contaminated materials, and shall be in accordance with all other appropriate and relevant Federal, State, and local regulations pertaining to storage of contaminated materials. In addition, provisions shall be made to ensure that offsite migration of contamination from storage areas is prevented.

6. DISPOSAL OF CONTAMINATED MATERIALS.

6.1. ONSITE DISPOSAL. Wastes that have been excavated prior to placement of the vegetative cover, and all contaminated materials are to be disposed of onsite and contained within the slurry wall containment cell and under the vegetative cover. The location of waste disposal on the site shall be proposed by the Contractor as part of the Contractor's Materials Handling Plan.

6.2. INCIDENTAL WASTE DISPOSAL.

6.3.1. Waste materials generated by construction activities resulting outside the Exclusion Zone and Contamination Reduction Zone shall be considered as uncontaminated solid wastes to be disposed of offsite. The following list includes typical waste streams which shall be disposed of offsite:

a. Office waste.
b. Lunch room waste.
c. Concrete formwork.
d. Material and equipment packing.
e. Crates.
f. Steel scrap.
g. Containers.
h. Wasted concrete.

Any materials taken offsite shall be handled as per applicable RCRA regulations.

6.2.2. Waste materials generated by construction activities resulting within the Exclusion Zone and Contamination Reduction Zone shall be considered as contaminated solid wastes and shall be disposed of in accordance with paragraphs 6.1.

7. MEASUREMENT AND PAYMENT. Measurement and payment for the excavation, and handling of contaminated materials will be at the contract unit price per cubic yard of material. No separate measurement or payment will be made for the excavation and handling of the contaminated material from the slurry trench and

ground-water extraction trench excavations. Payment for these items will be included in the unit price for the slurry wall and ground-water extraction trench, and utility excavations. SECTION 2210 - GRADING, addresses the method of payment for the excavation, stockpiling, and placement of the vegetative cover and other fill operations.

SECTION 02210

GRADING

INDEX

1. APPLICABLE PUBLICATIONS
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11. PROTECTION OF EXISTING SERVICE LINES AND UTILITY STRUCTURES
12. BACKFILL ADJACENT TO STRUCTURES
13. PREPARATION OF LIME BASINS FOR FILL
14. FILL
15. COMPACTION
16. TOP SOIL PLACEMENT
17. FINISHED EXCAVATION, FILLS AND EMBANKMENTS
18. SUBGADE AND EMBANKMENT PROTECTION
19. MEASUREMENT AND PAYMENT

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 422-72	Particle-Size Analysis of Soils.
D 698-78	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in (305-mm) Drop.
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 2487-85	Classification of Soils for Engineering Purposes.
D 2922-81	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
D 3017-88	Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
D 4318-84	Liquid Limit, Plastic Limit, and Plasticity Index of Soils 2. 2.

2. **GENERAL.** The work under this section shall consist of any earthwork necessary to construct site structures in accordance with the lines, grades, and dimensions shown in the Drawings.

3. **NOT USED.**

4. **SUBMITTALS.** In accordance with SECTION: SPECIAL CLAUSES, the Contractor shall submit data for the following items required by this section.

4.1. **CATEGORY I.** None.

4.2. CATEGORY II. For information only.
4.2.1. Optimum Moisture - Density Curves.
4.2.2. Field Compaction Test Results.
4.2.3. Atterberg Limit Test Results
4.2.4. Grain Size Determinations

5. DEFINITIONS.

5.1. **SUITABLE SOIL MATERIALS** include materials that are free of debris, organic or frozen materials and stones having a maximum dimension of 4 inches in the upper 6 inches of fill or 6 inches in the remainder of soil fill. Suitable soil materials shall not be classified as OL, OH, or PT using the Unified Soil Classification System (ASTM D-2487). Free liquids, as determined from USEPA Method 9050, "Paint Filter Liquids Test," shall not be present in suitable soil materials.

5.2. **UNSUITABLE SOIL MATERIALS** include soil that is determined by the Contracting Officer as unsatisfactory for providing a stable slope, fill, or subgrade. An otherwise suitable soil which is unsuitable due to excess moisture content will not be classified as unsuitable soil material unless it cannot be dried by manipulation, aeration, or blending with other materials satisfactorily as determined by the Contracting Officer.

5.3. **SUITABLE NON-SOIL MATERIALS** for fill in landfill areas include materials that directly result from trench and waste excavation operations, clearing and grubbing activities, and demolition activities within the landfill area. These materials include but are not limited to waste, stumps, cut trees, brush, and rock.

5.4. **CLAY** is defined as material classified in ASTM 2487 as CL, CH, SC and shall be free of roots, debris, and stones having a maximimum dimension of 2 inches in any direction. The Plasticity Index (PI) as determined by ASTM D 4318 shall not be less than 15.

5.5. **RANDOM FILL** is defined as suitable soil materials free of debris obtained from the Random Fill Borrow Source indicated on the drawings.

5.6. **TOPSOIL** is defined as acceptable random fill material from the Random Fill Borrow Source that is free from lumps, stones, or debris larger than 2 inches for field seeded areas.

5.7. **DEGREE OF COMPACTION** is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557, Method D abbreviated below as a percent of laboratory maximum density.

5.8. **SUBSURFACE DATA**: Condensed subsurface soil boring logs are shown on the drawings. The subsoil investigation report, full logs, and samples of materials taken from subsurface investigations may be examined at the Omaha District Office. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

6. **EXCAVATION.** Excavation of every description, regardless of material encountered, within the grading limits of the project shall be performed to the lines and grades indicated. Excavation material shall be transported to and placed in fill areas within the limits of work. All unsuitable soil fill material which is disturbed by the Contractor's operations or softened due to exposure to the elements and water shall be disposed of in areas approved for surplus material storage by the Contracting Officer. During construction, excavation and filling shall be performed in a manner and sequence that will utilize all suitable non-soil material and suitable contaminated soil prior to

utilizing suitable soil material and will provide drainage at all times. Material required for fills in excess of that produced by excavation within the grading limits shall be obtained from off-site borrow areas.

7. **UTILIZATION OF EXCAVATED MATERIALS.** Suitable soil material removed from required excavation shall be utilized in the formation of embankments, subgrades, shoulders, slopes, bedding, backfill for culverts and other structures, and for other purposes as directed. No excavated material shall be wasted without the authorization of the Contracting Officer. Material authorized to be wasted shall be disposed of as directed and in such a manner as not to obstruct the flow characteristics of any stream or to impair the efficiency or appearance of any structure. No excavated material shall be deposited at any time in a manner that may in any other way be determined to harm the completed work.

8. **SELECTION OF BORROW MATERIAL.** Two borrow sources, one for clay materials, and one for random fill materials, are indicated on the drawings. Borrow materials from the clay borrow area may not be obtained during the period from 1 November to 1 April, as it is located in the Bald Eagle Management Area. Clay borrow materials may be stockpiled at the project site, if necessary, to comply with the excavation time restriction. Any offsite borrow materials, if used by the Contractor, shall be selected to meet requirements and conditions of the particular fill for which it is to be used. Borrow materials shall be clean, uncontaminated material when obtained from off-site borrow areas. The source of offsite borrow material shall be the Contractor's responsibility. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, shall pay all royalties and other charges involved, and shall bear all the expense of developing the sources, including rights-of-way for hauling.

9. **OPENING AND DRAINAGE OF BORROW AREAS.** Necessary clearing, grubbing, disposal of debris, and satifactory drainage of borrow areas shall be considered incidental operations to the borrow excavation and shall be performed by the Contractor at no additional cost to the Government. Except as otherwise permitted, borrow areas shall be excavated in a manner that will afford adequate drainage. Overburden and other spoil material shall be disposed of or used for special purposes, as approved. Borrow areas shall be neatly trimmed and left in such shape as will provide a neat appearance subject to approval of the Contracting Officer.

10. **EXCAVATION OF DITCHES.** Ditches shall be cut to the cross sections and grades indicated. All roots, stumps, rock, and foreign matter in the sides and bottom of ditches shall be trimmed and dressed or removed to conform to the slope, grade, and shape of the section indicated. Ditch slopes shall be constructed to a tolerance of ± 0.2 feet. All ditches excavated under this section shall be maintained until final acceptance of the work. Satisfactory soil material excavated from ditches shall be placed in fill areas. Unsatisfactory excavated soil material shall be disposed of in accordance with directions given by the Contracting Officer.

11. **PROTECTION OF EXISTING SERVICE LINES AND UTILITY STRUCTURES.** Existing utility lines, the locations of which are made known to the Contractor prior to excavation, that are to be retained as well as utility lines constructed during

construction operations, shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired by the Contractor at his expense. In the event that the Contractor damages any existing utility lines, the locations of which are not made known to the Contractor, report thereof shall be made immediately to the Contracting Officer. If determined that repairs are to be made by the Contractor, such repairs shall be made in accordance with the clause "Changes" of the CONTRACT CLAUSES.

12. **BACKFILL ADJACENT TO STRUCTURES.** Backfill adjacent to structures shall be placed and compacted uniformly in such manner as to prevent wedging action or eccentric loading upon or against the structures. Slopes bounding or within areas to be backfilled shall be stepped or serrated to prevent sliding of the fill. During backfilling operations and in the formation of embankments, equipment that will overload structures in passing over and compacting these fills shall not be used.

13. **PREPARATION OF LIME SETTLING BASINS FOR FILL.** Prior to filling in the Lime Settling Basins, the surface water in the ponds shall be removed as approved by the Contracting Officer. After the water has been removed, the Contractor shall place random fill material in the drained Lime Settling Basins up to elevation 5248.0 m.s.l. The fill material shall be compacted as specified. After random fill has been placed to elevation 5248.0 m.s.l., contaminated soils and materials may be placed to the lines and grades shown on the drawings.

14. **FILL.** Fills and embankments herein designated as fills shall be constructed at the locations and the lines and grades indicated on the Drawings. The completed fill shall correspond to the shape of the typical sections shown on the drawings and shall meet the requirements of the particular case. Suitable soil material from excavations and off-site borrow areas shall be used in forming the remainder of fill material. Suitable contaminated soil shall be used as described in Paragraph: UTILIZATION OF EXCAVATED MATERIALS. Where otherwise suitable soil or suitable contaminated soil material is too wet, it shall be aerated or dried to provide the moisture content specified for compaction. No frozen material will be permitted in the fill. The materials used for fill shall be placed in successive horizontal layers of 8 to 12 inches in loose depth for the full width of the cross section and shall be compacted as specified.

15. **COMPACTION.** Compaction shall be accomplished by means specified and to the following densities for various parts of the work. Deficiencies in construction shall be corrected by the Contractor at no additional cost to the Government.

15.1. **LIME SETTLING BASIN FILL AREAS.** Fill materials placed inside the slurry wall containment cell and under the vegetative cover shall be compacted in 12 inch lifts at a moisture content as required to facilitate compaction of at least 90 percent of the maximum density determined as specified.

15.2. **SLURRY TRENCH WORK PLATFORM.** All fills for the construction of the slurry wall work platform shall be compacted at a moisture content as required to facilitate compaction to a density of 95 percent of maximum density determined as specified. Moisture content and density requirements for the slurry trench work platform are specified in SECTION: SOIL BENTONITE SLURRY TRENCH CUTOFF.

15.3. **CONTRACTOR STAGING AREAS.** The Contractor shall place 6 inches of random fill material and 4 inches of crushed rock surfacing over all utilized areas in the Contractor's Support Zone (Contractor's Office Trailer and Staging

Area). The 6 inch fill layer shall be compacted at a moisture content as required to facilitate compaction to a density of 95 percent of maximum density determined as specified.

15.4. **VEGETATIVE COVER.** The Contractor shall construct the first 12 inch layer of the vegetative cover in 6 inch lifts at a moisture content as required to facilitate compaction of at least 90 percent of the maximum density determined as specified. The first 12 inches of the cover shall be constructed of random fill material. Placement of the topsoil is specified in Paragraph: TOP SOIL PLACEMENT.

15.5. **SPOT SUBGRADE REINFORCEMENT.** The use of spot subgrade reinforcement material shall be at the direction of and subject to the approval of the Contracting Officer. Unsuitable subgrade materials shall be removed, the bottom of the resulting excavation shaped uniformly and compacted firmly to the density specified for subgrade, and the required provisions for adequate drainage shall be made. The subgrade reinforcement material shall then be placed in the prepared excavation, in layers of not more than 5 inches, which shall be spread and rammed until level with the surrounding subgrade surface. The voids shall then be filled with necessary finer selected material and the area rolled, or tamped if inaccessible to the roller. The filling and rolling or tamping shall be continued until the entire mass is thoroughly compacted to not less than the density of the surrounding or adjacent areas. The surface shall be finished to conform accurately to the grade and cross section shown on the Drawings.

15.6. **TESTS FOR AND CONTROL OF DENSITY.** All quality control sampling shall be performed by the Contractor in accordance with Paragraph: CONTRACTOR QUALITY CONTROL of SECTION: SPECIAL CLAUSES and as specified herein. Tests for determination of maximum dry density and optimum moisture shall be the responsibility of the Contractor and shall be performed in accordance with the requirements of ASTM D 698, Standard Proctor. Samples shall be representative of the materials to be placed. One optimum moisture-density curve shall be obtained for each principal type of material or combination of material encountered or utilized. This testing shall include Atterberg limits and grain-size determinations in accordance with ASTM D 4318 and D 422. Results of these tests shall be the basis of control for compaction. Field in-place density shall be determined in accordance with ASTM D 1556 or D 2922. The Contractor shall obtain a service permit to use radiation providing machinery or radioactive materials in accordance with local, state, and federal laws if ASTM D2922 is used. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted if necessary, using the sand cone method (ASTM D 1556) as described in Paragraph: "CALIBRATION" of the ASTM publication. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. The calibration checks on both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. Field density and moisture content tests shall be performed on every 5,000 square yards of each 8 to 12-inch loose lift placed. Additional tests shall be made as deemed necessary by the Contracting Officer. Copies of the test results shall be made available to the Contracting Officer and reported in the Daily Construction Quality Control Report as soon as the tests are performed. Acceptance tests may be made by the Government for verification of compliance; however, the Contractor shall not depend on such tests for his control of

operations. Deficiencies in construction shall be corrected by the Contractor at no additional cost to the Government.

16. **TOP SOIL PLACEMENT.** All ground areas disturbed by construction under this contract and not built over, paved or otherwise surfaced shall be covered with soil and revegetated.

16.1. **CLEARING.** Prior to placing soil cover, vegetation shall be removed from the area, and the ground surface cleared of all other materials that would hinder proper grading or subsequent maintenance operations.

16.2. **GRADING.** Previously constructed grades shall be repaired if necessary so that the areas to receive soil cover shall conform to the section indicated on the Drawings upon completion of soil cover placement.

16.3. **TILLAGE.** Subsequent to grading, the areas to receive soil cover exclusive of the Vegetative Cover shall be thoroughly scarified by approved means to a depth of at least 3 inches for bonding with subsoil. The work shall be performed only during periods when beneficial results are likely to be obtained. When conditions are such, by reason of drought, excessive moisture, or other factors, that satisfactory results are not likely to be obtained, the work will be stopped by the Contracting Officer and shall be resumed only when directed. Undulations or irregularities in the surface that would interfere with further construction operations or maintenance shall be leveled before the next specified operation.

16.4. **PLACING TOP SOIL.** Soil cover shall be uniformly distributed on the designated areas and evenly spread and tracked in 4-inch loose layers on areas exclusive of the vegetative cover. Soil cover shall be uniformly distributed on the Vegetative Cover in a 6-inch loose layer. Prior to seeding, tracking shall be performed on the final soil cover slope with grousers parallel to the contours. The final surface shall meet the finish surface requirements specified in the following Paragraph: FINISHED EXCAVATION, FILLS, AND EMBANKMENTS. Soil cover shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to proper grading or the proposed planting.

17. **FINISHED EXCAVATION, FILLS, AND EMBANKMENTS.** All areas covered by the project, including excavated and filled sections and adjacent transition areas, shall be uniformly smooth graded to ±0.2 feet of the grades shown in the Drawings. The finished surface shall be reasonably smooth, compacted, and free from irregular surface changes. The degree of finish shall be that ordinarily obtainable from either blade-grader or scraper operations, except as otherwise specified. Ditches shall be finished to permit adequate drainage.

18. **SUBGRADE AND EMBANKMENT PROTECTION.** During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along the subgrade shall be maintained in such manner as to drain effectively at all times. Where ruts occur in the subgrade, the subgrade shall be brought to grade, reshaped if required, and recompacted prior to the placement of surfacing. The storage or stockpiling of materials on the subgrade will not be permitted unless approved by the Contracting Officer. No surfacing shall be laid until the subgrade has been checked and approved, and in no case shall any surfacing be placed on a muddy subgrade or on one containing frost.

19. **MEASUREMENT AND PAYMENT.** Measurement and payment for grading and fills will be at the contract unit price per cubic yard of material. Measurement and payment for the installation of the vegetative cover shall be at the contract unit price per square yard. Payment for contaminated excavations are addressed in SECTION 2150 - HANDLING AND DISPOSAL OF CONTAMINATED MATERIALS.

ZERO ACCIDENTS

SECTION 02214
SOIL-BENTONITE SLURRY TRENCH CUTOFF

1. SCOPE
2. APPLICABLE PUBLICATIONS
3. GEOTECHNICAL SITE CONDITIONS
4. DEFINITIONS
5. SUBMITTALS
6. QUALIFICATIONS FOR SLURRY TRENCH CONSTRUCTION
7. NOT USED
9. MATERIALS
10. EQUIPMENT
11. SLURRY TRENCH CONSTRUCTION
12. QUALITY CONTROL
13. QUALITY ASSURANCE
14. MEASUREMENT
15. PAYMENT

1. SCOPE. The work covered by this section of the specifications consists of furnishing all plant, labor, equipment, and materials and of performing all operations in connection with constructing the soil-bentonite slurry trench cutoff, hereinafter referred to as the slurry trench, in accordance with these specifications and applicable drawings.

2. 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 reference thereto.

2.1. American Petroleum Institute (API) Standard Specifications.

Code RP 13B-1 June 1, 1990	Recommended Practice Standard Procedures for Testing Drilling Fluids; and Supplements
Spec 13A, Sections 4,5,9,10 July 1, 1990	Specification for Oil-Well Drilling Fluid Materials

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

D 422-63	Particle-Size Analysis of Soils
D 512-88	Test Methods for Chloride Ion in Water
D 1140-54	Materials Finer than 75 uM (No. 200) Sieve in Mineral Aggregates by Washing
D 2216-80	Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
D 2487-85	Classification of Soils for Engineering Purposes
D-2217-85	Wet Preparation Method
D 2922-81	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D 3017-78	Moisture Content of Soil and Soil-Aggregate

	in Place by Nuclear Methods (Shallow Depth)
C 143-89a	Slump of Portland Cement Concrete
D 698-78	Test for Moisture Density Relations of Soils and Soil-Aggregate Mixture, Using 5.5-Pound Hammer and 12-Inch Drop
D 1586-84	Standard Penetration Test
D 1587-83	Thin Walled Tube Sampling of Soils
D 4318-84	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D 4253-83	Maximum Index Density of Soils Using a Vibratory Table

2.3. Corps of Engineers Manuals

EM 1110-2-1906 Laboratory Soils Testing
Appendix VII
(Dated 30 Nov. 1970 with change 1 dated 1 May 1980)

2.4. NOT USED. Military Standard

619B Unified Soil Classification System for Roads, Airfields, Embankments and Foundations

3. GEOTECHNICAL SITE CONDITIONS.

3.1. Exploratory Borings. Subsurface exploratory borings have been obtained by the Government to determine the character of materials to be excavated. Locations of the borings are shown on the plans and condensed logs of those borings which fall within the area of this contract are included in the drawings for the convenience of the Contractor. The Government assumes no responsibility for interpretation or deductions made by the Contractor from the logs and borings. Local minor variations in the subsurface materials are to be expected and, if encountered, will not be considered as being materially different within the purview of Paragraph PHYSICAL DATA of SECTION: SPECIAL CLAUSES. Soils classifications shown on the logs are the result of field visual classifications and laboratory classifications in accordance with the Unified Soil Classifications System. The Field Investigations Report, including the full logs and results of all laboratory testing including rock and soil, are available for review by the Contractor in the Omaha District Office. *(Attention is invited to Paragraph in the SPECIAL PROVISIONS entitled: SUBSURFACE INVESTIGATIONS, for availability of core borings and soil samples for inspection.)

3.2. Subsurface Conditions. The overburden in the Lime Settling Basins area is of Quaternary age and is the result of deposition by the ancient Platte River drainage network and eolian processes. The thickness of the overburden ranges between 13.5 and 27.5 feet in this area. The soils consist mostly of silty fine-grained sand with moderate amounts of sandy, silty clay and clay. The sand ranges from loose to dense and the clay ranges from soft to very stiff. The overburden soil ranges from dry to saturated with moisture content increasing with depth. The bedrock in the Lime Settling Basins is the Denver Formation consisting of claystone and sandstone. The claystone is generally soft to moderately hard, brown, blocky and is occasionally silty. Sandstone lenses are frequently encountered. The sandstone units are fine-grained, and vary from soft to hard, depending upon the degree of cementation and weathering. The sandstones

also contain silt. A thick, up to 15 feet, fine-grained sandstone lense occurs in the northern section of the isolation cell.

3.3. Groundwater. Ground water occurs throughout the site, at about elevation 5250 at the south wall of the slurry trench and about 5237 at the north wall. Saturated thickness of this overburden ranges from 9.5 to 21.0 feet. Permeable sandstone lenses in contact with overburden will reflect the hydraulic characteristics of the overburden.

4. DEFINITIONS. The terms used in this section are defined as follows:

4.1. Slurry Trench. The slurry trench is a 3 foot minimum width trench excavated through the existing ground or prepared working surface using the slurry method of excavation and backfilled with a specified mixture of soil and bentonite slurry hereinafter referred to as the soil-bentonite backfill material, to form an impervious cutoff wall. The completed trench will have an in-place permeability less than or equal to 1 x 10EE-7 centimeters per second.

4.2. Slurry Method of Excavation. The slurry method of excavation consists of excavating a vertical walled trench and at the same time keeping the trench filled with a bentonite slurry mixture. The purpose of the slurry is to support the walls of the trench and prevent movement of ground water.

4.3. Bentonite. Bentonite is an ultrafine natural clay whose principal mineral constituent is sodium cation montmorillonite, characterized by high adsorption and very large volume change with wetting.

4.4. Bentonite Slurry. Slurry is a colloidal mixture of bentonite and water. A viscous, fully hydrated, water-based colloidal suspension of bentonite in water.

4.5. Backfill . A homogeneous mixture of material produced by mixing soil with bentonite slurry *(and additional dry bentonite if required) which is used as the final filling of the slurry trench to construct the soil-bentonite slurry trench cutoff. Backfill Material. Soil material which will be mixed with bentonite slurry to form the soil-bentonite backfill. The soil material is a select natural soil or mixture of soils with appreciable fines and possibly additional bentonite.

4.6. Soil-Bentonite Backfill Material. A homogeneous mixture of material produced by mixing the backfill material with bentonite slurry (and additional bentonite if required) which is used as the final filling of the slurry trench to create the soil-bentonite slurry trench cutoff wall.

4.7. Cohesionless and Cohesive Materials. Cohesionless materials are defined as materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials are defined as materials classified as GC, SC, ML, CL, and CH. Materials classified as GM and SM will be identified as cohesionless when the fines are nonplastic, and cohesive when the fines are plastic.

4.8. Plastic Fines. That portion of materials passing a U.S. Standard No. 200 Sieve which has a liquid limit greater than 20 and a Plasticity Index greater than 4 when tested in conformance with ASTM D 4318.

4.9. Ground Water Level. The ground water level is the piezometric level of the ground water as determined from piezometers and wells.

4.10. Work Platform. The work Platform is the top of the stripped and/or prepared natural ground or the surface of previously compacted fill from which the slurry trench shall be constructed. The elevations and materials of the work platform shall be as shown on the drawings and/or specified hereinafter.

4.11. ~~Impervious~~Key Stratum. The ~~impermeable~~ soil or rock unit to or into which the bottom of the slurry trench is excavated.

4.12. Slurry Trench Specialist . A slurry trench specialist is an individual who has had at least 2 successful years of experience in slurry trench construction and has knowledge in all aspects of slurry trench construction which includes but is not limited to: (1) the use, testing, and control of bentonite as a slurry, (2) the mixing methods required to properly mix the slurry and backfill materials as required, (3) trench excavation and backfill procedures, and (4) a thorough knowledge of construction equipment and material testing required for slurry trench construction.

5. SUBMITTALS. In accordance with SECTION 01100: SPECIAL CLAUSES, the Contractor shall submit data for approval by the Contracting Officer for the following items required by this section.

5.1. Category I.

5.1.1. Schedule and Sequence of Operations . The schedule and sequence of operations shall include but is not limited to ~~*(drilling and sampling prior to trench excavation,)~~work platform preparation, trench excavation, use of excavated material, waste management, slurry preparation, slurry placement, slurry maintenance, method of mix constituent measurement, bottom cleaning, backfill preparation, backfilling, QA/QC drilling, sampling, and testing, and final grade closure.

5.1.2. Layout of Operations. The layout of operations shall include but is not limited to drawings depicting bentonite storage area, slurry preparation area, hydration pond(s) slurry storage area, backfill storage and mixing area, location and sizes of all stationary equipment, water storage tanks, pumps, valves, lines, hoses, and materials, and waste areas.

5.1.3. Slurry Trench Construction Method and Equipment.

5.1.4. NOT USED. ~~Blast Plan.~~

5.1.5. Gradation of all imported borrow material. Include borrow area or commercial sources, laboratory certification of the physical characteristics of the soil including grain size analysis and Atterberg limits.

5.1.6. Samples of Imported Soil from Each Source of Material: 10 pounds minimum for each sample.

5.1.7. Preconstruction Testing of Backfill Mix. Reports for soil-bentonite backfill material including trial moisture content, density, mix proportions, gradation, and laboratory permeability for 10 samples of each proposed backfill mix using the materials proposed by the Contractor for use. One backfill material is specified; . The Contractor may use the soils specified or may prove the specified mix design will provide the same permeability test results with his proposed materials.

5.1.8. Equipment and Procedure to Obtain Bedrock ~~*(Impervious Stratum)~~ Samples.

5.1.9. Quality Control Testing Equipment and Procedures.

5.1.10. Sample Test Results Forms for all Quality Control Tests.

5.1.11. Equipment and Procedure to Obtain Undisturbed Record Samples of Completed Slurry Trench.

5.2. Category II

5.2.1. Contractor's Qualifications.

5.2.2. Slurry Trench Specialist's Qualifications.

5.2.3. Bentonite Certification (from Supplier).

5.2.4. Backfill Gradation (Onsite Materials Prior to Mixing with Slurry).

5.2.5. Excavation and Backfill Soundings.

5.2.6. Results of all Contractor Quality Control (CQC) Tests and Measurements.

5.2.7. Quality Assurance Samples of Completed Slurry Trench.

5.3. At the Contractors option, the Category I submittals may be submitted in one document, called the Slurry Trench Implementation Plan. Whether submitted individually or as one document, they should be submitted approximately 2 months prior to the anticipated construction starting date to allow for full review time.

6. QUALIFICATIONS FOR SLURRY TRENCH CONSTRUCTION.

6.1. Contractor. The Contractor shall be experienced in slurry trench soil-bentonite cutoff wall construction. The Contractor and key personnel who manage the project shall submit evidence that verifies the experience and competency required to construct the slurry trench soil-bentonite cutoff wall in accordance with these specifications including methods such as backhoe and clamshell. The evidence shall be submitted with the Contractor's bid and shall include the qualifications and experience of all personnel who shall be responsible for conducting the operations contained in these specifications. A slurry trench specialist shall be employed by the Contractor.

6.2. Slurry Trench Specialist. The slurry trench specialist shall be a Geotechnical Engineer and have a minimum of 2 years successful experience in the following: controlling composition, mixing, placing, cleaning, and maintaining slurry; supervision of alignment, verticality and depth of slurry trenches; controlling blending, mixing and placement of soil-bentonite backfill methods such as clamshell operation. The slurry trench specialist's responsibility shall be solely for the construction of the slurry trench soil-bentonite cutoff wall including all testing, inspection, and records. The slurry trench specialist shall be on site at all times during trenching and backfilling operations. The name and qualifications of the slurry trench specialist shall be submitted with the Contractor's Bid.

7. NOT USED. SUBSURFACE INVESTIGATIONS.

7.1. General . Borings shall be made to locate the top of the impervious stratum as defined hereinbefore. Borings shall be drilled along the alignment of the cutoff wall prior to excavation. Borings shall be located at a maximum spacing of feet as measured along the alignment of the slurry trench. Borings shall be completed to a point at least feet in advance of the trenching operation at all times. If the elevation of the top of the impervious stratum encountered in the soil borings differs by more than feet between two adjacent borings, an additional boring shall be drilled midway between the other two. The number of additional borings is not anticipated to exceed percent of that specified.

7.2. Drilling . Drilling equipment shall be rotary type, approved by the Contracting Officer, which allows sampling of in-place native soil using bentonite slurry drilling fluid. At the time of sampling, the borehole shall be cleaned of drill cuttings and shall have maximum of inches of slough in the bottom of the borehole.

7.3. Sampling . Sampling shall be performed by the *(Standard Penetration Test in accordance with ASTM D 1586,) *(Coring,) *(Drive samples) or (other methods approved by the Contracting Officer.) Core catchers or other devices shall be used to insure all samples are retained during sampler extraction from the borehole. The samples shall be placed in suitable containers as approved by the Contracting Officer and the container shall be clearly marked to indicate boring number, location, depth of sample, and date sample was obtained. Samples shall be taken continuously from a depth of *(5) * ( ) feet above the anticipated depth of the impervious stratum to a depth of *(4) * ( ) feet below the top of the impervious stratum actually encountered or deeper if directed. Following completion of the slurry trench, all samples shall be disposed of *(in the waste disposal area) *(as directed by the Contracting Officer.)

7.4. Survey . The elevation of the ground surface at each boring location shall be determined within an accuracy of 0.1 feet. The location of each soil boring shall be determined within an accuracy of *(2.0) * ( ) feet.

8. NOT USED. INSTRUMENTATION MONITORING. The Contractor shall be responsible for monitoring instrumentation at the project as outlined herein and as shown on the contract plans. The results shall be reported to the Contracting Officer as specified herein.

8.1. Piezometers . Each piezometer to be monitored is listed in Table and shown on Drawings(s) and . The elevation of the top of each riser is also shown on Table . If any change is made in the top of the riser elevation, the Contractor shall establish the new top of riser elevation and report it in writing to the Contracting Officer. The water level in each piezometer shall be measured to the nearest tenth of a foot and shall be reported as an elevation on a standard form on the same day as they are measured. Any fluctuations noted that could be related to construction activities shall be reported immediately to the Contracting Officer. The Contractor shall begin monitoring the piezometers as soon as the site work begins and shall continue until the contract is completed. Readings on all the piezometers shall be made at least once a . Piezometers which are within feet of any slurry trench construction activities shall be monitored. These piezometers shall be monitored *(daily) * ( ) until they have stabilized from any effects of the construction activity or from the closure of the slurry trench in that area. Any piezometer which is damaged or becomes plugged as a result of the Contractor's negligence shall be repaired or washed out within five days at the Contractor's expense. If the piezometer is destroyed, it shall be replaced as directed by the Contracting Officer.

9. MATERIALS. The requirements for the materials to be utilized in the slurry trench construction are as follows:

9.1. Bentonite. The bentonite shall be sodium cation base montmorillonite powder (Premium Grade Wyoming-type bentonite) that conforms to the standards set forth in API Specification 13A, Section 3, 5, 6, 7, and 8 5, 9, and 10 as last revised. No chemically treated bentonite will be allowed. The Contractor shall furnish to the Contracting Officer a certificate of compliance and a copy of the test reports from the bentonite manufacturer for each lot of bentonite shipped to the site stating that the bentonite complies with all applicable standards. No bentonite from the bentonite manufacturer shall be used prior to acceptance

by the Contracting Officer. All bentonite will be subject to inspection, sampling, and verification of quality of testing by or under the supervision of the Government. Bentonite not meeting specifications shall be promptly removed from the site of the work and replaced with bentonite conforming to specifications requirements at the Contractor's expense. Bentonite shall be protected from moisture during transit and storage.

9.2. Water. *(The Contractor shall supply all water required for mixing with bentonite to produce slurry.) Water will be furnished by the Government. The water shall be clean, fresh, and comply with the standards specified below:

a. A pH equal to 7.0 plus or minus 2.0

b. Total dissolved solids not greater than 600 parts per million.

c. Oil, organics, acids, alkali, or other deleterious substances not greater than 50 parts per million each.

d. Hardness less than or equal to 100 ppm.

The Contractor shall submit water quality test results for water used for mixing the bentonite slurry to assure conformance with the above limits.

9.3. Bentonite Slurry. The bentonite slurry for supporting the sides of the trench and that mixed with the backfill shall consist of a stable colloidal suspension of powdered, premium-grade natural bentonite in water. It is the responsibility of the Contractor that the slurry meets the necessary properties. Mixture adjustments of the slurry within specified limits may be required by the Contracting Officer. The properties of the slurry used in all construction sequences shall be in accordance with the testing procedures described in API Code RP 13B-1 and shall conform to the following requirements:

9.3.1. Initial Bentonite Slurry Mixture. At the time of introducing bentonite slurry into the trench excavation, the slurry mixture shall consist of a minimum of 20 pounds of bentonite per 42-gallon barrel of slurry. The slurry mixture shall have a minimum apparent viscosity of 40 seconds as measured by the Marsh funnel. The slurry density shall be a minimum of 64 pounds per cubic foot. The water loss shall not be greater than 30 cubic centimeters in 30 minutes as measured by a filter press at 100 psi. The pH shall not be less than 8.0. Mixture adjustment shall conform to the requirements in subparagraph: Additional Bentonite.

9.3.2. Trench Bentonite Slurry Mixture. The minimum apparent viscosity of the bentonite slurry mixture in the trench at any time shall be 40 seconds as measured by the Marsh funnel. The density of the slurry mixture in the trench at any level shall be greater than 64 pounds per cubic foot and shall not exceed 85 pounds per cubic foot at any time. If the density of the slurry in the trench exceeds 85 pounds per cubic foot or if the slurry becomes unworkable due to excessive sand content, the excess solids shall be removed from the slurry using methods approved by the Contracting Officer or the slurry shall be replaced with fresh slurry. Mixture adjustments shall conform to the requirement in subparagraph: Additional Bentonite.

9.3.3. Additional Bentonite. If directed by the Contracting Officer, the Contractor shall thicken the slurry to a more viscous condition than the limits specified above. The Contractor shall use additional bentonite, as directed.

9.4. Additives. Admixtures of the types used in the control of oil field drilling muds such as thinners, dispersents, and flocculants may be used to control standard properties of the slurry such as apparent viscosity and filtration characteristics subject to the approval of the Contracting Officer.

Peptizing or bulking agents shall not be mixed with the slurry. Additives shall not be mixed with the slurry.

9.5. Soil-Bentonite Backfill Material. The materials to be used in backfilling the slurry trench shall consist of a mixture of soil and bentonite. The soil shall be obtained from the required excavation of the slurry trench, *(Government furnished borrow areas on site), off-site borrow areas procured and developed by the Contractor, commercial sources or a combination thereof. The selection of an off-site borrow area shall be subject to the approval of the Contracting Officer. All backfill shall be free of roots and other deleterious materials. Thirty Sixty days prior to the utilization of any off-site borrow, representative samples of each type of material shall be submitted to the Contracting Officer for testing. The materials shall be thoroughly mixed, and at the time of placement, the backfill material shall conform to the following physical property requirements.

Screen Size or Number (U.S. Standard)	Percent Passing by Dry Weight
3-inch	
No. 4	
No. 40	
No. 200	

Bentonite slurry: % by weight of bentonite/water to yield slump of 3 to 7 inches;

Dry bentonite: % (to yield total of % bentonite content in backfill;

Moisture content:

Total fines content:

Off-site clay:

Slump: 3-7 inches; and

Density: 110 lbs. per cubic foot (a minimum of 15 pounds heavier than slurry in the trench).

If the Contractor proposes to use soils other than trench excavated material and/or Government supplied borrow the Contractor's proposed testing plan must be submitted and approved prior to beginning testing. No testing shall take place prior to Government inspection and approval of the laboratory.

10. EQUIPMENT. The Contractor shall furnish all necessary plant and equipment for efficient; stripping, cutting, and/or filling and compacting to form the slurry-mixing and work platform surface; excavating the trench; mixing and placing slurry; cleaning of slurry and trench bottom; hauling, mixing and placement of backfill; disposal of undesirable and contaminated excavated material in accordance with other provisions of this contract; preparation for and placement of the final cap compacted clay trench cover on the completed trench, and for quality control testing of the materials used in such processes.

10.1. Work Platform and Trench Cover Equipment. The work platform and trench cover shall be constructed using earthmoving or grading equipment, compaction equipment, moisture control equipment, and hauling equipment to produce the specified grades and compaction.

10.2. Trench Excavation. Equipment required for excavating the trench shall be furnished by the Contractor. The trench shall be excavated by extended-reach backhoe or by a crane-mounted, slurry-trench clamshell. The buckets

utilized with such equipment may be tapered and equipped with bottom-side cutter teeth protruding no more than 6 inches on each side. The bucket shall be designed to maintain the specified width of the trench and to minimize ravelling of the trench sides during use. Regardless of the equipment used, the bucket shall be capable of excavating the minimum required width in a single pass.

10.3. Mixing and Placing Slurry. Slurry mixing and placing equipment will be approved by the Contracting Officer. The slurry mixing plant shall be equipped with a high-speed/high-shear, collodial mixer or a high-velocity/high pressure venturi jet mixer used in conjunction with a high-speed/high-shear centrifugal pump. The Contractor may, at his option, design a concrete pad of sufficient size and with sufficient berms around the edges for mixing slurry with a bulldozer. The Contractors reasons and rationale for selecting the mixing method and equipment shall be included in the Slurry Trench Construction Method and Equipment submittal (or the Slurry Trench Implementation Plan submittal). The plant shall be equipped with a mechanically or hydraulically agitated sump and shall include pumps, valves, hoses, supply lines, tools, and other equipment and materials required to prepare the slurry and deliver it in a continuous supply from the hydration pond to the slurry trench. The Contractor shall have sufficient ponds and pits for storage of hydrated bentonite slurry. The ponds and pits shall be mechanically or hydraulically agitated. No slurry is to be made in the trench.

10.4. Field Laboratory Equipment. The field laboratory shall contain as a minimum the following equipment:

a.	1	Mold for slump test
b.	2	Marsh funnel sets
c.	1	Standard filter press
d.	2	Mud balances (direct reading of density)
e.	1	Slurry sampler
f.	2	Number 200 sieves
g.	1	Set of standard sieves and sieve shaker
h.	1	Oven for moisture content
i.	1	Balance
j.	1	pH meter
k.	2	Mixers
l.	1	Direct-indicating viscometer
m.	1	Nuclear density/moisture gage

10.5. Cleaning of Slurry. Slurry cleaning equipment shall include but not be limited to a vibratory shaker screen, centrifugal sand separator, and/or stilling ponds.

10.6. Preparation of Trench Bottom. The bottom of the trench shall be prepared by using crane mounted clamshell or jet pipes, air lift pumps, vibrating shaker screens, probe pipes, and necessary pipes, hoses, and fittings or other suitable equipment.

10.7. Mixing and Placing Backfill. The equipment used for the mixing and placing of the backfill material, including but not limited to bulldozers, disks, harrows, monitor patrols, pugmills and haul trucks shall be capable of mixing backfill materials into a homogeneous mixture conforming to the contract requirements and be suitable for placement of the backfill material in the trench as specified herein. Blending backfill material with dry bentonite shall be accomplished by pugmill or similar technique. Other means such as powertooth harrow may be used when surface spreading of the bentonite is approved by the Contracting Officer. Initial placement of backfill on the trench bottom shall

be by clamshell or other approved method and shall prevent free fall, segregation, and entrapment of slurry. Excavation equipment may be needed to obtain supplemental material from borrow areas.

11. SLURRY TRENCH CONSTRUCTION.

11.1. General. The slurry trench shall be constructed to the elevations, lines, grades, and cross-sections shown on the drawings and in accordance with these specifications, unless otherwise directed by the Contracting Officer. The Government may modify the dimensions and quantities of the work as determined necessary. The Contractor shall submit a general work sequence schedule and layout plan of operations to the Contracting Officer for approval, a minimum of 8 weeks prior to the start of construction.

11.2. Work Platform. The work platform from which the slurry trench is to be constructed shall be defined in paragraph DEFINITIONS, and shall constitute the top of the slurry trench cutoff for the purpose of measurement for payment. The work platform shall be covered with one foot of random fill as defined in SECTION: GRADING. The fill will be spread and placed in one layer and compacted at a moisture content as required to obtain at least 90 percent of the maximum dry density as determined in accordance with ASTM D 698 for cohesive materials or at least 75 percent relative density as determined in accordance with ASTM D 4253 for cohesionless materials. However, the Contractor may construct, at no expense to the Government, a working surface to a level higher then the defined working surface for his own convenience providing it is approved by the Contracting Officer. There will be no payment for any additional excavation, fill, or slurry trench cutoff required as the result of constructing for the convenience to the Contractor a higher level working surface than the defined working surface. In the event that the static ground water table is encountered at a depth of *(1.0) * ( ) foot or less below the designated working surface, the Contractor shall, at the direction of the Contracting Officer, raise the working surface to a height of *(1), *(3) feet above the measured static ground water level with approved fill material. The working surface thus constructed shall be utilized as a basis for measurement for payment.

11.3. Excavation. The excavation shall be by the slurry method of excavation. Construction shall proceed in such a manner that the up-gradient section of the slurry trench is complete before the down gradient section. This will prevent "damming" of the groundwater at the site that could cause a significant rise in the water level over the site during construction. Excavation shall be conducted in a manner which provides for a continuous 3 ft minimum width trench to the required depth at all points along the centerline of the excavation. The Contractor shall excavate the slurry trench from the work platform. Excavation shall be conducted by the slurry method.The excavation shall be carried immediately to the minimum depth shown on the drawings at the point where excavation is started. The Contracting Officer may direct the Contractor to deepen the trench based on examination of bucket cuttings or drive samples taken at specified locations. The distance between the toe of the slope of the trench excavation and the toe of the backfill slope shall be kept to the minimum value which will allow both cleaning of the trench bottom and a minimum 24 hours between slurry placement and soil-bentonite backfill placement. The distance shall not be greater than 105 feet without the approval of the Contracting Officer. The toe of the slope of the trench excavations shall not precede the toe of the backfill slopes by less than *(50) * ( ) feet or more than *(105) * ( ) feet. The slurry trench shall be constructed without undue

interruption until complete. If for a reason approved by the Contracting Officer, it is necessary for a slurry trench boundary to be constructed in more than one straight line segment, reexcavation of a section of the previously constructed slurry trench backfill material will be required at points of intersection. The reexcavation of the placed backfill shall consist of the removal of 10 feet perpendicular to the slope of the backfill for the full depth of the slurry trench. That section of the slurry trench backfll material that is removed and rebackfilled shall be considered incidental to the slurry trench cutoff pay item. A minimum overlap length of 2 feet throughout the entire depth of backfill shall be constructed at any slurry trench corner to obtain continuous trench backfill through the entire length of the slurry trench.

11.3.1. Bedrock Excavation. The bedrock excavation shall be carried the full width of the trench to the depths shown on the drawings or as otherwise directed by the Contracting Officer. *(Any *(sandstone) * ( ) lenses encountered at the minimum excavation depth shall be removed for the full width of the trench and into the underlying impervious stratum.) The bedrock shall then be sampled in accordance with subparagraph Samples of Impervious StratumBedrock. Termination of excavation will be approved by the Contracting Officer.

11.4. NOT USED. Blasting. Any blasting shall be approved by the Contracting Officer. Blasting shall be conducted in accordance with an approved blasting plan. The blasting plan shall include hole spacings and depths, loading, delay sequence, type of explosives, safety program, and any other pertinent information that will be necessary for the Contracting Officer's evaluation. Explosive materials shall *(shall not) be stored on the site. *(Onsite storage shall be at .) *(A drawing showing the top and bottom elevations of the *(sandstone) * ( ) at each blasting drill hole shall be submitted to the Contracting Officer.)

11.5. Sampling. After the trench bottom has been cleaned thoroughly, the Contractor shall sample the trench bottom with a *(split-spoon sampler) * ( ) approved by the Contracting Officer. Rock surfaces that cannot be penetrated by a split-spoon sampler shall not be required to be sampled. After examining the samples, the Contracting Officer will either approve the termination of excavation at the points checked or require additional excavation. If additional excavation is required, then additional samples shall be furnished by the Contractor as specified above. Samples of Bedrock. Samples of Bedrock shall be taken at the minimum excavation depth shown on the drawings at 20-foot horizontal intervals and at additional intervals or depths as directed by the Contracting Officer's Representative. The sampler shall be a 3-inch I.D. (or larger) drive tube sampler with a minimum length of 2-feet. Samples shall be obtained by pushing the sampler a minimum of 18 inches into the bedrock. Three-inch diameter samples shall have a minimum length (recovery) of 6-inches. After examining these samples, the Contracting Officer will either approve the termination of excavation at the sample points or require additional excavation. If additional excavation is required, then additional samples will be furnished by the Contractor as specified above. All samples taken shall be properly identified and labeled, placed in sealed plastic containers and stored in a location designated by the Contracting Officer.

11.6. Placement of Slurry. Slurry shall be introduced into the trench at the time excavation begins. The level of the slurry in open trenches shall be at all times maintained a minimum of 3 feet above ground water level and no more than 1 foot below the work platform until the placement of backfill material

is complete. The Contractor shall have sufficient personnel, equipment, slurry storage areas, and stored slurry materials ready to raise the slurry level at all times in the excavated trench during construction within the limitations specified in this subparagraph. To this end, the Contractor shall have personnel on call to raise the slurry level at any time a drop occurs, weekends and/or holidays included. Dilution of slurry by surface waters shall be prevented. The Contractor shall take all precautionary measures necessary to minimize damage to the work from groundwater and surface water. The quality of the slurry shall be maintained at all times, including periods of work stoppage, in a condition which meets the requirements set forth in subparagraph Bentonite Slurry. Conditioning of the slurry may required recirculation through shaker screens or the addition of approved additives.

11.7. Excavated Material. Material excavated from the trench *(shall) *(shall not) be used in the backfill. Material to be used in the backfill shall be stockpiled for subsequent processing in areas approved by the Contracting Officer. Material not used in the backfill shall be placed inside the Lime Basins.

11.8. NOT USED. Backfilling Trench in Case of High Water. In the event the ground water rises or is expected to rise to within 3 feet of the top of the working surface, the Contracting Officer reserves the right to require the Contractor to stop excavation and to begin continuous operations to either dike around the open trenches and raise the slurry levels or to fill all or part of the open trenches with slurry trench backfill mixed and placed as specified in subparagraph Backfilling. Continuous operations shall consist of expeditiously performing the required operations twenty-four hours per day until the operations are completed or the water level falls to a depth of more than 3 feet below the top of the working surface.

11.9. Stability. The Contractor shall be responsible for insuring and maintaining the stability of the excavated trench at all times for its full length and depth and shall be responsible for maintaining slurry densities and levels within specified limits. The Contractor shall control surcharges from all excavation and backfilling equipment, waste, berm construction, backfill stockpiles, and any other loading situations that may affect trench stability. It is the Contractor's sole responsibility to ensure that the mixing of backfill and any stockpiles do not affect the open trench stability. Slopes of stockpiles and excavated material shall be no steeper than 1 Vertical to 2 Horizontal and no higher than 10 feet above the work platform. In the event of failure of the trench walls prior to completion of backfilling, the Contractor shall at his expense reexcavate the trench and remove all material displaced into the trench and take corrective action to prevent further deterioration.

11.10. Treatment of Trench Bottom.

11.10.1. NOT USED. Treatment of Rock Surface.

11.10.2. Cleaning. After the trench bottom has been accepted by the Contracting Officer based on samples of bedrock, the trench bottom shall be cleaned by an air lift pump or other suitable equipment to insure removal of all sand, gravel, sediment, and any other material left in the trench during excavation and/or which has settled out of the slurry. After the Contractor cleans the trench bottom by removing all loose rock and gravel, he shall then probe the trench bottom for possible potholes, cracks, and crevices. Such depressions shall be cleaned out by air lifting or other suitable equipment. All cleaning equipment shall be operated in such a manner to prevent removal of materials from the walls of the trench. The Contracting Officer will supervise

the cleaning and probing operations and may require additional cleaning as he deems necessary.

11.10.3. Preparation. The bottom of the trench shall be sounded in the presence of the Contracting Officer to determine the nature of material on the bottom of the trench before backfilling operations. The soil-bentonite backfill shall key into the designated stratum with removal of all loosened excavation and settled materials, such as sand. The final elevation of the bottom of the trench shall be approved by the Contracting Officer.

11.11. Backfilling.

11.11.1. Mixing Areas. Areas for mixing of backfll and other operations shall be located as approved by the Contracting Officer. All mixing areas shall be cleaned up and restored upon completion of the work in accordance with subparagraph Cleanup.

11.11.2. Mixing. Stockpiled material from excavation and/or material from borrow or commercial sources shall be mixed and blended by windrowing, disk harrowing, bulldozing, power tooth harrowing, blading, or other approved methods. Mixing and blending shall be performed as to produce the required gradation of backfill material as specified in subparagraph Soil-Bentonite Backfill Material. This material, when mixed with new bentonite slurry or slurry from the trench to attain the specified slump, shall constitute the soil-bentonite backfill material used to fill the slurry trench. The backfill material must contain at least *(2) * percent sodium bentonite of the type specified in subparagraph Bentonite. Excess slurry which may drain away from the mixing operations shall be allowed to drain back into the trench. The backfill material shall be thoroughly mixed into a homogeneous mass, free from large lumps or clods of soil or pockets of fines, sand, or gravel. Occasional lumps of up to 1 inch in their largest dimension will be permitted. All particles shall be coated with slurry. The slurry mixed with the backfill shall meet the requirements of the initial slurry introduced into the trench. The soil-bentonite backfill may be created by mixing new bentonite slurry or slurry from the trench, with approved backfill material. The soil-bentonite backfill shall be thoroughly blended to form a homogeneous mixture having a consistency of wet concrete. The soil-bentonite backfill material, just prior to placement in the trench, shall have a consistency to provide a slump of 3 to 7 inches and as approved by the Contracting Officer. The selected slump for the backfill material shall be the minimum slump within the specified range which will provide an acceptable workable backfill material. The materials may be sluiced with slurry during the blending operations. Sluicing with water will not be permitted. When mixing the backfill, heavy equipment such as bulldozers shall not operate in a back and forth fashion, paralleling the open trench, closer than 15 feet from the lip of the trench. Any sloughing of the slurry trench walls or other damages as a result of operating equipment near the trench shall be repaired or restored by the Contractor at no additional cost to the Government. If the Contracting Officer deems it necessary, a small dike 2 to 3 feet high paralleling the slurry trench shall be constructed at the Contractor's expense to keep the backfill from flowing into the trenches as a result of wave action created by the equipment mixing the backfill. Intermittent holes in the dike will be allowed so that excess slurry may flow back into the trenches.

11.11.3. Placing. The backfill material shall be placed in the excavated trench in such a manner that no pockets of slurry are trapped in the completed slurry trench. The Contractor shall backfill continuously from the beginning of the trench in the direction of the excavation to the end of the

trench. Placing operations shall proceed in such fashion that the top of the backfill below the surface of the slurry shall follow a reasonably smooth grade and shall not have hollows which may trap pockets of slurry during subsequent backfilling. To this end, the face of the backfill below the surface of the slurry may require rodding, and the Contractor shall have such equipment available at the job site. Free dropping of backfill material through the slurry will not be permitted. The method of initial soil-bentonite backfill placement shall be included in the Construction Method and Equipment submittal. Two acceptable alternatives are placing by lowering it to the bottom of the trench with crane and clamshell bucket until the surface of the backfill rises above the surface of the slurry trench at the end of the trench or by the use of clamshell bucket to begin excavation at a point outside of the limits of work which will provide a sufficient distance for the backfill face to form by dozing the backfill into the trench before the toe of the backfill reaches the point where the slurry trench is required. No payments will be made for the portions of such trenches which lie outside of the limits of work. Backfill shall then be placed in such a manner that the backfill enters the trench by sliding down the forward face of the previously placed backfill. To accomplish this, the Contractor shall backfill from the initial backfill toward the opposite end of the trench. Backfilling operations shall proceed in such a manner that the slope of the initial backfill will be maintained. The new backfill material will be allowed to slide down the slope of the previously placed backfill and shall be placed in such a manner that pockets of slurry will not be trapped during the backfilling. This remaining backfilling may be accomplished by the use of bulldozer or other approved equipment and in such a manner that the backfill below the slurry surface will be pushed along the trench.

11.11.4. Mixing and Placing During Cold Weather. No mixing or placing of the backfill shall be performed when the air temperature is below 20 degrees F. Frozen soil-bentonite backfill shall not be placed in the trench and backfill material contaning frozen lumps shall not be used to blend soil-bentonite backfill.

11.12. Treatment of Top of Slurry Trench. The slurry trench shall have backfill material placed to the lines and grades shown on the drawings. To prevent drying of the top of the slurry trench backfill, a 1 -foot thick section of impervious compacted clay material approximately 8 feet wide shall be placed on the slurry trench section, as shown on the drawings, for a minimum of 2 weeks. This material shall be placed a minimum of 2 days and a maximum of 4 days after backfilling is completed over each 100-foot reach. Placement shall be carried out in layers not exceeding 8 inches in thickness at the time of placement. The material shall be compacted with a backhoe bucket or a small hand-operated roller of no more than 2,000 pound weight to a dry density of 95 percent of maximum density at optimum moisture to +3 percent in accordance with the requirements of ASTM procedure D 698. No heavy construction equipment or machinery shall be driven over the soil-bentonite slurry trench during the minimum two-week period after backfilling. After the 2-week period, the compacted clay cover shall be recompacted with standard compaction equipment to develop and expose any possible depression in areas and to show settlement. If any sink should develop within the backfilled slurry-trench area, it shall be repaired by placing and compacting additional clay material. After the 2-week period, the Contractor shall, at locations near the access roads, excavate a maximum of two areas of the slurry trench and compacted clay trench cover to a depth of 4 feet and construct trench crossings consisting of compacted clay and geotextiles as shown on the drawings.

The width of the crossings shall be chosen by the Contractor based on the width of his equipment and machinery. The crossing boundaries shall be marked with flagging or cones. During subsequent construction heavy equipment will be allowed to cross the slurry trench at these locations only. Excess material shall be disposed of in accordance with subparagraph Cleanup. Compacted clay for the compacted clay trench cover shall be obtained from the clay borrow area on the Arsenal as shown on the drawings.

11.13. Cleanup. Removal of all excavation spoil, unused backfill, and slurry shall be accomplished following completion of final backfilling and trench site compacting and grading. These materials will be disposed of inside the Lime Settling Basins. During final disposal of the slurry, the material shall be flocculated to separate the bentonite from the water. The flocculated bentonite material shall be placed in the designated disposal areas and the water shall be disposed of in an approved manner.

12. QUALITY CONTROL. The Contractor shall be responsible for project quality control and quality control records. Observation, measurements, and tests described in these specifications shall be performed for quality control. In addition to the slurry trench specialist, the Contractor shall provide at least one inspector for each soil-bentonite slurry trench cutoff wall construction operation to carry out quality control functions. All quality control records, routine testing procedures, observations, and measurements shall be available for inspection by the Contracting Officer's Representative at any time. Quality control tests and testing frequencies of soil, bentonite, and water are summarized in Table 1.

12.1. Bentonite. Each truckload (100 sacks or less) of bentonite delivered to the site shall be sampled in accordance with Appendix F of API RP 13B-1. The samples shall be tested in accordance with the procedures of Section 5 of API Spec 13A to confirm conformance with the physical and chemical requirements listed in Table 5.1 of Section 5. For information the bentonite will also be tested for wet screen analysis and moisture content (Section 4).

12.2. Water. Prior to the start of construction, the source of water to be mixed with the bentonite shall be tested for pH, hardness, total dissolved solids and oil, organics, acids,alkali and other deleterious substances. Subsequent to the start of construction testing shall be conducted once a month. Tests shall conform with the requirements of API Code RP 13B-1. Each water supply source will also be tested for chloride in accordance with ASTM D 512.

12.3. Slurry Properties. All tests specified in this paragraph shall be conducted in accordance with API Code RP 13B-1. The initial bentonite slurry shall be tested prior to placing the slurry in the trench a minimum of 3 times each shift per batching plant. The following tests shall be performed: viscosity, pH, and density. At the time of placing soil-bentonite backfill into the slurry-filled trench, the bentonite slurry within the trench shall be tested for viscosity, density, and sand content. The bentonite slurry in the trench shall be sampled a minimum of 3 times per shift per batching plant at intervals of every 10 feet of depth and shall include one sample taken within 5 feet of the toe of the backfill slope and with 1 foot of the bottom of the trench. The sampling devices and procedures will be in accordance with Appendix G of API RP 13B-1. The Contractor shall be required to obtain additional samples for the government at any time or location requested. Personnel shall be provided by the Contractor for conducting the tests and they must have a working knowledge of test procedures for drilling fluids in accordance with applicable API standard

procedures. Equipment for bentonite slurry testing shall be furnished and maintained by the Contractor.

12.4. Excavation and Backfill Soundings. The Contractor shall make excavation and soil-bentonite backfill soundings every 20 feet along the trench centerline using a weighted tape, cable, or other devices approved by the Contracting Officer. The soundings at each 20 foot interval shall record the following:

12.4.1. Elevation of Top of ImperviousKey Stratum. The top of impervious key stratum will be confirmed by the Contracting Officer based on an examination of bucket cuttings during trench excavation. The Contractor shall determine the elevations.

12.4.2. Elevation of Bottom of Excavation. The determination of the bottom of excavation will be made by the Contracting Officer using impervious stratum bedrock samples as described under subparagraph Samples of Impervious StratumBedrock. The minimum excavation line is shown on the drawings. The Contractor shall determine the elevation.

12.4.3. Elevation of Bottom Prior to Backfilling. This sounding shall record the thickness of sediments accumulated at the trench bottom. Additional material removal from the trench bottom prior to backfilling may be required by the Contracting Officer. This sounding shall not precede the toe of the soil-bentonite backfill slope more than 50 feet.

12.4.4. Profile of Backfill Slope. The soil-bentonite backfill slope shall be sounded at horizontal intervals of 20 feet to determine the profile of the backfill slope. The soil-bentonite backfill slope shall be sounded at the beginning and end of each shift and at additional times as directed by the Contracting Officer.

12.5. Backfill Material (On or Off-Site). The backfill material shall be tested for gradation based on one representative sample for each 500 cubic yards of backfill material prior to blending with bentonite. Sampling equipment shall be subject to the Contracting Officer's approval and shall be maintained onsite for the duration of the job. Testing of gradation samples shall be by set sieving and shall conform to ASTM D 422. Off-site clay shall also be tested for Atterberg limits (ASTM D 4318) at the same time.

12.6. Soil-Bentonite Backfill Material. All sampling and testing shall be performed just prior to placing the material in the trench. Each batch of material shall be assigned a number to be included with all QA/QC test reporting. The slump of the soil-bentonite backfill shall be tested in accordance with ASTM C 143. Density testing shall be in accordance with API RP 13B-1. Slump cone and density tests shall be performed at least 3 times per shift per batching plant. If the soil-bentonite backfill will not come out of the cone without agitation then the inside of the cone may be coated with bentonite slurry. Soil-bentonite backfill material shall also be tested for grain size (ASTM D 422) once for every 2000 cubic yards of material placed. One moisture content (ASTM D 2216) and permeability (EM 1110-2-1906, Appendix VII) test each will be performed for every 100 lineal feet of soil-bentonite slurry trench. Sampling for the permeability tests will be in accordance with ASTM D 1587, except the sample tubes will be sealed with expandable packers and plastic end caps taped on.

12.7. Compacted Clay. The compacted clay material shall be tested for grain size (ASTM D 422) once for every 2,000 cubic yards of material placed. The placed and compacted material shall also be tested for density (ASTM D 2922) and moisture content (ASTM D 3017) (nuclear methods) at 5 locations per lift.

12.8. In-Situ Soil-Bentonite Slurry Trench Permeability Determinations.

12.8.1. Drilling and Sampling. A minimum of 7 days after placement into the trench, undisturbed samples shall be taken for each 300 lineal feet of slurry trench, or a minimum of 2 locations per trench boundary. The holes shall be drilled with hollow stem augers with a 4-inch minimum I.D. Sampling shall be continuous for the full depth of slurry trench cutoff wall using new three inch diameter thin wall tubes. The thin wall tube sampler shall be a stationary piston type containing a sealed piston and a locking cone in the head to prevent the piston from moving downward. The inside of the tubes may be coated with bentonite slurry or shellac to prevent corrosion of the tube.

12.8.2. Backfilling. The boreholes will be backfilled with the soil-bentonite backfill material, except the top 1 foot which shall be backfilled with clay. Backfill will be dropped into the boring with periodic rodding to break up any bridging which may occur during backfilling operations. A minimum of 14 days after backfilling, the Contractor shall add additional clay soil to any boring which exhibits settlement.

12.8.3. Survey. The elevation of the ground surface at each boring location shall be determined within an accuracy of 0.1 feet. The location of each boring shall be determined within an accuracy of 0.1 feet.

12.8.4. Testing. Samples will either be extruded in the field, Contractor permeability tested, or sent to the Missouri River Division Laboratory for Quality Assurance testing. The Contractor shall perform permeability tests on two samples from each boring: one sample from near the water table depth and one sample from near the trench bottom. For 10 percent of those locations, the sample collected either immediately above or immediately below the Contractor permeability samples will be sent to the MRD Lab. Prior to Contractor permeability testing, the samples will be X-Rayed. An engineer or technician familiar with examining sample X-Rays will determine which part of the sample will be used for permeability testing. The samples not permeability tested will be extruded in the field, photographed, and described (consistency, color, observed defects) in a logbook. All undisturbed samples to be taken offsite will be sealed with expandable packers with plastic end caps taped on to prevent loss of moisture. Samples to be tested for permeability (Contractor or Government) will be shipped vertically in boxes or in a rack, and the permeability tests must be completed within 6 weeks of field sampling. Permeability testing will be done in accordance with EM 1110-2-1906, Appendix VII, Back-Pressure Method. Draft test results shall be reported no later than 7 days after testing completion. The address of the Missouri River Division Laboratory is:

Department of the Army
Corps of Engineers, Missouri River Division
ATTN: CEMRD-ED-GL (Solsky)
420 So. 18th St.
Omaha, NE 68102-2586
Telephone: (402)444-4304

12.9. Samples of ImperviousKey Stratum. Samples of the impervious stratum shall be taken at the minimum excavation depth shown on the drawings at foot horizontal intervals and at additional intervals or depths as directed by the Contracting Officer. The sampler shall be a inch I.D., or larger, *(drive tube sampler) with a minimum length of feet. Samples shall be obtained by advancing the sampler a minimum of inches into the impervious stratum. The samples shall have a minimum length (recover) of inches. After examining these samples, the Contracting Officer will either approve the

termination of excavation at the sample points or require additional excavation. If additional excavation is required, then additional samples shall be furnished by the Contractor as specified above. All samples shall be properly identified and labeled, placed in sealed plastic containers and stored in a location designated by the Contracting Officer. Sampling of the key stratum is specified in Subparagraph Samples of Bedrock.

12.10. Records. Records shall be maintained by the Contractor for all testing, measurements, and inspections performed to ascertain that the slurry trench soil-bentonite cutoff wall construction meets the specifications. Required reports, records, and documentation shall be furnished to the Government daily. The Contractor's required records are outlined below.

12.10.1. As-Built Profile. An as-built profile of the trench bottom, backfill slopes including descriptions of materials encountered in the trench bottom shall be continuously maintained by the Contractor. This profile shall indicate extent of excavation and the soil-bentonite backfill profile at the end of each work day, as determined from soundings. The Soil-bentonite backfill batch numbers will also appear on the log so it will be known where each batch of material was placed in the trench.

12.10.2. Results. The results of all construction control testing required in these specifications, including water tests, slurry tests, backfill tests, and depth soundings shall be furnished by the Contractor. The Contractor shall furnish records of all observations, measurements, and tests performed, identified with the location and time of testing. These records shall be furnished no later than 24 hours after the tests, measurements, and/or observations were made.

12.10.3. Bentonite Slurry Mix. Bentonite slurry mix quantities, proportions of all additives utilized, and placement locations into the trench shall be recorded by the Contractor. Any adjustments in the bentonite slurry mix shall also be recorded.

12.10.4. Construction Log. The Contractor shall maintain a construction log of daily activities which shall include delays encountered during construction, causes of delays, locations of affected areas, and extent of delays. The log shall also record unusual conditions or problems encountered, and the dispositions made.

13. QUALITY ASSURANCE. The Government will perform quality assurance testing on the bentonite slurry and backfill materials using the laboratory and equipment furnished by the Contractor. The Government testing will in no way relieve the Contractor of the responsibility of performing tests necessary to meet the construction requirements. The Contractor shall provide the equipment and laboratory space to government personnel on demand and these services shall be considered a subsidiary obligation of the slurry trench soil-bentonite cutoff wall construction. All routine testing procedures being conducted by the Contractor shall be available for inspection by the Contracting Officer at any time. The quality assurance testing program is given in Table 2. Quality assurance sampling and testing of the completed trench is specified in subparagraph In-Situ Soil-Bentonite Slurry Trench Permeability Determinations.

14. MEASUREMENT.

14.1. Lines and Grades. The slurry trench cutoff shall be constructed to the elevations, lines, grades, and cross sections shown on the drawings, unless otherwise directed by the Contracting officer. The Government reserves the

right to modify the elevations, lines, grades, and/or cross sections as may be determined necessary by the Contracting Officer.

14.2. Soil-Bentonite Slurry Trench Cutoff. Measurement for Soil-Bentonite Slurry Trench shall be based on the area in square feet of slurry measured in a vertical plane through the centerline of the slurry trenches within the boundaries established by the work platform as defined in subparagraph Work Platform, the bottom of the excavated trenches as approved, and vertical lines at each end of the approved full depths of the excavated trenches. Measurement shall be based on surveys and soundings taken at the site as directed and approved by the Contracting Officer.

15. PAYMENT. Payment for Soil-Bentonite Slurry Trench measured as specified hereinbefore shall be made at the contract unit price per square foot. Such price shall include all costs of stripping, excavating by the slurry method of excavation, cleaning the trench bottom, stockpiling or spoiling excavated materials, obtaining backfill materials from commercial quarry, mixing, blending, placing and rodding the slurry trench backfill, and all other items incidental to the construction and completion of the slurry trench. No separate payment will be made for slurry materials including bentonite, additives, equipment and mixing, handling and cleaning the slurry, diking around the open trench, and overtime during continuous operations, cleanup, and assistance in the collection and maintenance of records; such items being included in the price of slurry trench.

TABLE 1
SOIL-BENTONITE SLURRY TRENCH QUALITY CONTROL TESTING

Subject	Test		
	Standard	Specific Test	Frequency
Bentonite Powder	API STD-13A	a. YP/PV Ratio b. Plastic Viscosity c. Filtrate d. Record: d1. Wet Screen Analysis d2. Moisture Content	1 per truck shipment (100 bags)
Chemical Analysis of Water	API RP 13B-1	a. pH b. Hardness c. Total Dissolved Solids d. Oil, Organics etc.	Initially and monthly thereafter
	ASTM D152	Chloride	1 per water supply source or if changes occur
Initial Soil Bentonite Slurry Properties	API RP 13B-1	a. Viscosity b. Density c. pH	3 per shift (see Note 1)
In-Trench Soil Bentonite Slurry Properties	API RP 13B-1	a. Viscosity b. Density c. Sand Content	3 per shift (see Note 1)
Backfill Material	ASTM D 422 ASTM D 4318	Grain Size Atterberg limits	1 per 500 cubic yds
Soil-Bentonite Backfill Material	ASTM C 143 API RP 13B-1	Slump Cone Density	3 per shift (see Note 1)
	ASTM D 422	Grain Size	1 per 2000 cubic yds
	ASTM D 2216 EM 1110-2-1906	Moisture Permeability	1 per 100 ft. length or per new batch (see Note 2)
Compacted Clay	ASTM D 422	Grain Size	1 per 2000 cubic yds
	ASTM D 2922	Density (Nuclear)	5 per lift
	ASTM D 3017	Moisture (Nuclear)	5 per lift

Notes:

1) If more than one (1) batching plant is being used, these frequencies shall apply to each batching plant separately.
2) Permeability test may be performed using fixed wall permeameter except that for every five such tests, there shall be performed one test using flexible wall permeameter.
3) Requirements of permeability on completed soil-bentonite cutoff wall are specified in Subparagraph: Slurry Trench.

TABLE 2
SOIL-BENTONITE SLURRY TRENCH QUALITY ASSURANCE TESTING

Subject	Test		
	Standard	Specific Test	Frequency
Initial Soil Bentonite Slurry Properties	API RP 13B-1	a. Viscosity b. Density c. pH	1 per 3 shifts (Note 1)
In-Trench Soil Bentonite Slurry Properties	API RP 13B-1	a. Viscosity b. Density c. Sand Content	1 per 3 shifts (Note 1)
Backfill Material	ASTM D 422 ASTM D 4318	Grain Size Atterberg limits	1 per 5000 cubic yds
Soil-Bentonite Backfill Material	ASTM C 143 API RP 13B-1	Slump Cone Density	1 per 3 shifts (Note 1)
	ASTM D 422	Grain Size	1 per 10000 cubic yds
	ASTM D 2216 EM 1110-2-1906	Moisture Permeability	1 per 500 ft. length or per new batch (Note 2)

Notes:
1) If more than one (1) batching plant is being used, these frequencies shall apply to each batching plant separately.
2) Permeability test may be performed using fixed wall permeameter except that for every five such tests, there shall be performed one test using flexible wall permeameter.
3) Requirements of permeability on completed soil-bentonite cutoff wall are specified in Subparagraph: Slurry Trench.

ZERO ACCIDENTS

SECTION 02215
GEOTEXTILE FILTER

INDEX

1. SCOPE
2. APPLICABLE PUBLICATIONS
3. MATERIALS
4. SHIPMENT AND STORAGE
5. INSTALLATION OF GEOTEXTILE
6. SUBMITTALS
7. MEASUREMENT AND PAYMENT

Attachments: Table 1 - Physical Strength Requirements

1. **SCOPE:** The work provided for herein consists of furnishing all plant, labor, material, and equipment and performing all operations required for furnishing, hauling, and placing the geotextile filter, complete, as specified herein and shown on the contract drawings, and maintaining the geotextile until placement of the compacted clay cover is completed and accepted.

2. **APPLICABLE PUBLICATIONS:** The following publications of the current 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:

2.1. **American Society for Testing and Materials (ASTM):**

D 123-85	Terminology Relating to Textiles Materials
D 1117-80	Non woven Fabrics (Trapezoidal Tear Test)
D 1682-64 (Rev 1975)	Breaking Load and Elongation of Textile Fabrics
D 1683-81	Failure in Sewn Seams of Woven Fabrics
D 3787-80a	Bursting Strength of Knitted Goods: Constant-Rate-of Traverse (CRT), Ball Burst Test
D 3884-80	Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)
D 4491-85	Test Methods for Water Permeability of Geotextiles by Permittivity

3. **MATERIALS:**

3.1. **Geotextile:** The geotextile shall be a non-woven or woven pervious sheet of plastic yarn as defined by ASTM D 123. The geotextile shall provide an Equivalent Opening Size (EOS) no finer than the U. S. Standard Sieve No. 100 and no coarser than the U. S. Standard Sieve No. 70. The geotextile fiber shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, amide or vinylidene-chloride, and shall contain stabilizers and/or inhibitors added to the base plastic if necessary to make the filaments resistant to deterioration due to ultra-violet and heat exposure. The geotextile shall conform to the physical strength requirements in Table No. 1. The geotextile should be fixed so that the yarns will retain their relative position with respect to each other. The edges of the geotextile shall be finished to prevent the outer yarn from pulling away from the

geotextile. If requested by the Contracting Officer, the Contractor shall provide to the Government geotextile samples for testing to determine compliance with any or all of the requirements in this specification. When samples are to be provided, they shall be submitted a minimum of 30 days prior to the beginning of installation of the same geotextile material. The terms "geotextile" and "geotextile filter" are one and the same.

3.2. **Seams:** The seams of the geotextile shall be sewn with thread of a material meeting the chemical requirements given above for geotextile yarn or shall be bonded by cementing or by heat. The sheets of geotextile shall be attached at the factory or another approved location to form sections not less than 10-feet wide. Seams shall be tested in accordance with method ASTM D 1683, using 1 inch square jaws and 12 inches per minute constant rate of traverse. The strengths shall be not less than 90 percent of the required tensile strength (Table 1) of the unaged geotextile in any principal direction.

3.3. **Acceptance Requirements:** All brands of geotextile and all seams to be used shall be accepted on the following basis. The Contractor shall furnish the Contracting Officer, in duplicate, a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the geotextile. The mill certificate or affidavit shall attest that the geotextile meets the chemical, physical and manufacturing requirements stated in this specification.

4. **SHIPMENT AND STORAGE:** During all periods of shipment and storage, the geotextile shall be protected from direct sunlight, ultraviolet rays, temperatures greater than 140°F, mud, dirt, dust and debris. To the extent possible, the geotextile shall be maintained wrapped in a heavy duty protective covering.

5. **INSTALLATION OF GEOTEXTILE:** The geotextile shall be placed in the manner and at the locations shown on the drawings. At the time of installation, geotextile shall be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage. Areas on which the geotextile is to be placed shall be excavated, trimmed, and shaped to a relatively smooth condition to conform to the cross sections shown on the plans. Where such areas are below grade, they shall be brought to grade and compacted to a density equal to the adjacent undisturbed material at no additional cost to the Government. The geotextile shall be laid smooth and free of tension, stress, folds, wrinkles or creases. The strips shall be placed to provide a minimum width of 12 inches of overlap for each joint. Temporary pinning of the geotextile will not be allowed. The Contractor shall place the geotextile as necessary to prevent any slippage of the geotextile. The geotextile shall be protected at all times during construction from contamination by surface runoff and any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile at no expense to the Government. Any damage to the geotextile during its installation or during placement of the compacted clay shall be replaced by the Contractor at no cost to the Government. The work shall be scheduled so that the covering of the geotextile with the compacted clay is accomplished within 5 days after placement of the geotextile. Failure to comply shall require replacement of geotextile. The geotextile shall be protected from damage due to the placement of compacted clay by limiting the height of drop of the riprap to less than 3 feet.

6. **SUBMITTALS:** In accordance with SECTION: SPECIAL CLAUSES, the Contractor shall submit the following items required by this section:

6.1. Category I: None.
6.2. Category II: (For Approval)
Samples (para 3.1)
Certified Test Results (para 3.3)

7. **MEASUREMENT AND PAYMENT:** No quantity measurement or separated payment will be made for the equipment, materials and associated work specified herein. The cost for all work, equipment and materials described in this section shall be included in the Contract Lump Sum Bid Item for All Remaining Work.

Table No. 1 - Physical Strength Requirements

Physical Property	Test Procedure	Acceptable Test Results
Tensile Strength +(unaged geotextile)	ASTM D 1682 Grab Test Method using 1 inch square jaws and a travel rate of 12 inches per minute.	200 pound minimum in any principle direction.
Breaking Elongation +(unaged geotextile)	ASTM D 1682 Measurement of Apparent Breaking Elongation	15 percent minimum in any principal direction.
Puncture Strength +(unaged geotextile)	ASTM D 3787 Tension Testing Machine with Ring Clamp except polished steel ball replaced with a 5/16 inch diameter solid steel cylinder with a hemispherical tip centered within the ring clamp.	80 pound minimum.
Abrasion Resistance	ASTM D 3884 Rotary Platform, Double Head Method; rubber-base abrasive wheels equal to CS-17 "Calibrase" by Taber Instrument Co.; 1 kilogram load per wheel; 1000 revolutions, determine residual breaking load.	55 pound minimum Residual Breaking Load in any principal direction.
Tear Strength	ASTM D 1117 Trapezoidal Tear Strength	30 pounds minimum in any principal direction.
Geotextile Permeability (kG)	ASTM D 4491 Test Methods for Water Permeability of Geotextiles By Permittivity.	The permeability of the Geotextile shall be greater than $1x10^{-2}$ cm/sec.

+Unaged geotextile is defined as geotextile in the condition received from the manufacturer or distributor.

ZERO ACCIDENTS

SECTION 02221
EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

INDEX

1. APPLICABLE PUBLICATIONS
2. DEFINITIONS
3. EXCAVATION
4. BACKFILLING
5. SPECIAL REQUIREMENTS
6. TESTING
7. PAVEMENT AND WALK REMOVAL AND REPLACEMENT

PART 1 - GENERAL

#(N)#

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 WOOD PRESERVER'S BUREAU (AWPB) STANDARD.**

LP-22	Softwood Lumber, Timber and Plywood Pressure Treated with Water Borne Preservatives for Ground Contact Use (Rev. March 1980)

1.2. **AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS.**

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-inch (457 mm) Drop
D 2167-84	Density and Unit Weight of Soil In Place by the Rubber-Balloon Method
D 2487-85	Classification of Soils for Engineering Purposes
D 2922-81	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D 3017-78	Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
E 548-84	Preparation of Criteria for Use in Evaluation of Testing Laboratories and Inspection Bodies

2. **DEFINITIONS.**

#(N)#

2.1. **SUITABLE MATERIALS.** Suitable materials shall consist of any material not included in the unsuitable materials definition.

#(N)#

2.2. **UNSUITABLE MATERIALS.** Unsuitable materials include but are not limited to those materials containing roots and other organic matter, trash, debris, frozen materials and stones larger than 3 inches, and materials classified in ASTM D 2487 as MH, PT, OH, and OL. Unsuitable materials also include landfill material, refuse material, debris from previous construction and materials too soft to properly support utility pipe, conduit, or appurtenance structures. Otherwise suitable material which is unsuitable due to excess

moisture content will not be classified as unsuitable material unless it cannot be dried by manipulation, aeration, or blending with other materials.

2.3. **COHESIONLESS AND COHESIVE MATERIALS.** Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

#(N)#

2.4. **ROCK.** Rock shall consist of boulders measuring 1/2 cubic yard or more and materials that cannot be removed without systematic drilling and blasting such as rock material in ledges, bedded deposits, unstratified masses and conglomerate deposits, and below ground concrete or masonry structures, exceeding 1/2 cubic yard in volume, except that pavements will not be considered as rock.

2.5. **SELECT GRANULAR MATERIAL.** Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall not contain more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the 1-inch sieve, with a maximum allowable aggregate size of 1 inch or the maximum size recommended by the pipe manufacturer, whichever is smaller, unless otherwise specified.

2.6. **DEGREE OF COMPACTION.** Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

PART 2 - EXECUTION

3. **EXCAVATION.** Excavation of every description and of whatever substances encountered shall be performed to the lines and grades indicated. [Rock excavation shall include removal and disposition of material defined as rock in paragraph DEFINITIONS. Earth excavation shall include removal and disposal of material not classified as rock excavation.] During excavation, material suitable for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench [sufficient to avoid overloading and to prevent slides or cave-ins] [equal to 1/2 the depth of the excavation, but in no instance closer than 2 feet]. Adequate drainage shall be provided for the stockpiles and surrounding areas by means of ditches, dikes, or other approved methods. The stockpiles shall also be protected from contamination with unsuitable excavated material or other material that may destroy the quality and fitness of the suitable stockpiled material. If the Contractor fails to protect the stockpiles and any material becomes unsatisfactory as a result, such material, if directed, shall be removed and replaced with satisfactory on-site or imported material from approved sources at no additional cost to the Government. Excavated material not required or not satisfactory for backfill shall be disposed of off Base [or shall be disposed of in waste areas shown on the drawings]. Grading shall be done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating therein shall be removed so that the stability of the bottom and sides of the excavation is maintained. Unauthorized overexcavation shall be backfilled in accordance with paragraph BACKFILLING at no additional cost to the Government.

#(N)#

3.1. **TRENCH EXCAVATION.** The trench below the top of the pipe shall not be excavated wider than the outside diameter of the pipe plus 24 inches for pipes of less than 24 inch inside diameter and no wider than the outside diameter of the pipe plus 36 inches for larger sizes. Where trench widths are exceeded, redesign using 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. Trench walls below the top of the pipe shall be vertical [or shall be sloped as shown] [or may be sloped as allowed by the pipe manufacturer's installation manual]. Trench walls above the top of pipe may be sloped or widened as necessary for the proper performance of the work.

#(N)#

3.1.1. **Bottom Preparation.** Trench bottoms shall be over excavated to allow the installation of granular bedding as detailed on the drawings.

#(N)#

3.1.2. **Removal of Rock.** Where [overdepth is not indicated and] rock is encountered in the bottom of the trench, such material shall be removed 12 inches below the required grade and replaced with suitable materials as provided in paragraph: BACKFILLING.

3.1.3. **Removal of Unsuitable Material.** Where unsuitable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING. When removal of unsuitable material is required due to the fault or neglect of the Contractor in his performance of work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

3.2. **EXCAVATION FOR APPURTENANCES.** Excavation for manholes or similar structures shall be [sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members] [of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown]. [Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed.] Removal of unsuitable material shall be as specified above. 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 level shall not be made until just before the concrete or masonry is to be placed.

3.3. **DEWATERING.** The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed, therein is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result. All excavations for concrete structures or trenches which extend down to or below ground water shall be dewatered by lowering and keeping the ground water level beneath such excavations 12 inches or more below the bottom of the excavation. Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property. Existing drainage facilities may be used for disposal of surface and ground water during dewatering operations subject to prior approval of the Contracting Officer. The Contractor shall be

responsible for all damages incurred to the drainage facilities as a result of the dewatering operations. All pipes or conduits shall be left clean and free of sediment.

3.4. **SHEETING AND SHORING.** Except where banks are cut back on a stable slope, excavation for structures and trenches shall be sheeted, braced, and shored, as necessary, to prevent caving or sliding, to provide protection for workmen and the work, and to provide protection for existing structures and facilities. Sheeting, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure, and shall be rigid, maintaining shape and position under all circumstances.

#(N)#

3.5. NOT USED. JACKING, BORING, OR TUNNELING shall be used at the locations indicated on the drawings for installation of a particular underground utility line. This method may also be used in other locations not indicated if, in the opinion of the Contracting Officer, the utility line cannot be safely installed and backfilled using open cut methods.

#(d)#

3.5.1. NOT USED. Casing Pipe shall be welded steel pipe with a minimum yield strength of 35,000 psi and a minimum wall thickness of _____ inches. Joints in the casing pipe shall be welded. See drawings for details on proper size selection of casing pipe.

3.5.2. NOT USED. Installation of casing pipe shall be by machine with a cutting head and a continuous auger mounted inside the casing pipe. Casing shall be installed simultaneously with the boring of the hole, and excavated earth removed by the auger through the casing. Boring methods using water will not be permitted.

#(d)#

3.5.3. NOT USED. Utility Line shall be supported inside the casing as indicated on the drawings with wood skids.

3.5.4. NOT USED. Preservative Treatment for wood skids and spacers shall be a water borne preservative in accordance with AWPB LP-22. A minimum of four tenths (0.4) pounds of preservative per cubic foot of skid or spacer shall be retained.

4. **BACKFILLING.** Backfill material shall consist of suitable material. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils, unless otherwise specified.

#(N)#

4.1. **TRENCH BACKFILL.** Trenches shall be backfilled to the grade shown. [The trench shall be backfilled to 1 feet above the top of pipe prior to performing the required pressure test. The joints and couplings shall be left uncovered during the pressure test.] [The trench shall not be backfilled until all specified tests are performed.]

4.1.1. **Not Used.**

4.1.2. **Replacement of Unsuitable Material.** Unsuitable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 6 inches loose thickness.

#(d)#

4.1.3. **Bedding.** Bedding shall conform to the details shown on the drawings and specified below. Material shall be deposited in 6 inch loose layers and compacted with approved methods to at least 95 percent maximum density. Care shall be taken to ensure thorough compaction of the fill under the pipe haunches. Bedding shall consist of select granular material.

4.1.3.1. NOT USED. Class A Bedding. Class A bedding is not required unless improper trenching or unexpected trench conditions require its use.

4.1.3.2. NOT USED. Class B Bedding. Class B bedding shall be used for all gravity sewer lines.

4.1.3.3. **Class C Bedding.** Class C bedding shall be used for all pressure pipe. A maximum allowable aggregate size of 1/2 inch shall be used for all plastic pressure pipe, ductile, or cast iron pipe.

4.1.4. **Initial Backfill** shall consist of suitable materials with a maximum stone size not exceeding the limits shown on the drawings. Initial backfill shall be placed in 6-inch loose thickness layers and compacted to at least 90 percent of maximum density at moisture contents that will facilitate compaction in granular materials and shall be within -1 and +4 percent of optimum for all other materials. Initial backfill shall be placed to a height of at least 1 foot above the top of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

4.1.5. **Final Backfill.** The remainder of the trench, except for special materials for roadways, railroads and airfields, shall be backfilled with suitable material. Backfill material shall be deposited and compacted as follows:

4.1.5.1. NOT USED. Roadways, Railroads, and Airfields. [Backfill below the elevation at which the special requirements given in SECTION: [GRADING] [EXCAVATION, EMBANKMENT, AND PREPARATION OF SUBGRADE FOR ROADWAYS, RAILROADS, AND AIRFIELDS] shall be placed in 6-inch layers compacted to 95 percent maximum density.] [Backfill shall be placed up to the elevation of the base course in 6-inch layers and compacted to 95 percent maximum density. Base course shall be compacted to 100 percent maximum density.] Pavement shall conform to PARAGRAPH: PAVEMENT AND WALK REMOVAL AND REPLACEMENT. Water flooding or jetting methods of compaction will not be permitted.

4.1.6. **Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas.** Backfill shall be deposited in layers of a maximum of 12-inch loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. [Water flooding or jetting methods of compaction will be permitted for granular non-cohesive backfill material. Water jetting shall not be allowed to penetrate the initial backfill.] [Compaction by water flooding or jetting will not be permitted.] This requirement shall also apply to all other areas not specifically designated above.

#(N)#

4.2. **BACKFILL FOR APPURTENANCES.** After the manhole or similar structure has been constructed [and the concrete has been allowed to cure for __2__ days], backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be placed in such a manner as to prevent eccentric loading and excessive stress on the structure.

5. **SPECIAL REQUIREMENTS.** Special requirements for both excavation and backfill relating to the specific utilities are as follows:

5.1. NOT USED. GAS DISTRIBUTION. Trenches shall be graded and shall provide the minimum cover as specified for pipe-laying requirements in SECTION: GAS DISTRIBUTION SYSTEM.
#(N)#

5.2. **WATER LINES.** Trenches shall be of a depth to provide a minimum cover of 5 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe. [For fire protection yard mains or piping, an additional 6 inches of cover is required.]

5.3. NOT USED. HEAT DISTRIBUTION SYSTEM. Bedding material and initial backfill shall be free of stones larger than 1/4 inch in any dimension.

5.4. **ELECTRICAL DISTRIBUTION SYSTEM.** Minimum cover from the finished grade [and special trenching requirements] for direct-burial electrical cables and conduits are specified in SECTION: ELECTRICAL WORK, and/on drawings. DISTRIBUTION SYSTEM: UNDERGROUND.
#(N)#

5.5. **PLASTIC MARKING TAPE.** Warning tape shall be of the type specifically manufactured for marking and locating underground utilities. The tape shall be installed directly above the pipe, at a depth of [18] [____] inches below finished grade unless otherwise shown. The tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch and shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise with an elongation factor of 350 percent. Tape color shall be as specified in Table 1 and shall bear a continuous printed inscription describing the specific utility.

Table 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

Tape for all nonmetallic utility lines shall have integral wires, foil backing, or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The metallic core shall be encased in a protective jacket or provided with other means to protect it from corrosion.

6. **TESTING.** Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government.
#(N)#

6.1. **DETERMINATION OF DENSITY.** Density tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the Contractor. Approval of testing facilities shall be based on compliance with ASTM E 548, and no work requiring testing will be permitted until the facilities have been inspected and approved by the Contracting Officer. Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained for each lift. One test shall be made for each [200] [____] linear feet or less for each layer of specified depth, except areas to receive

pavements, for which one test shall be made for each [100] [_____] linear feet or less. Laboratory tests for moisture-density relations shall be determined in accordance with ASTM D 1557, Method B, C, or D. A mechanical tamper may be used, provided the results are correlated with those obtained by the referenced hand tamper. Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2167[, or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in paragraph "Calibration" of ASTM D 2922. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gages shall be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gages shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Contracting Officer. If ASTM D 2922 is used for field density control, there should be at least one test performed according to ASTM D 1556 per every ten tests performed according to ASTM D 2922 for correlation of test results. Copies of calibration curves and results of calibration tests shall be furnished to the Contracting Officer within 24 hours of conclusion of the tests]. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Government.

#(N)#

6.2. NOT USED. DISPLACEMENT OF SEWERS. After other required tests have been performed and the trench backfill compacted to [_____ feet above the top of the pipe] [the finished grade surface], the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 36 inches shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by use of television cameras passed through the pipe. If, in the judgment of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

7. NOT USED. PAVEMENT AND WALK REMOVAL AND REPLACEMENT.

#(N)#

7.1. FLEXIBLE PAVEMENT. Where construction requires cutting and replacing of flexible pavement, cutting shall be so accomplished that the remaining exposed edges shall conform vertically and horizontally to a straight line. The full depth of surface and binder course shall be removed to a width of 10 feet with a saw cut on the edges. Base course shall be removed to a point 1 foot back from each side of the trench. The replaced pavement shall match the existing in section and depth and shall conform to [SECTION: BITUMINOUS INTERMEDIATE AND SURFACE COURSES,] [SECTION: CRUSHED AGGREGATE BASE COURSE,] [and] [SECTION: SUBBASE COURSE]. Concrete curb [and gutter] shall be removed to the nearest joint. Saw cutting to a minimum depth of 1 inch will be permitted if the remaining section to the next joint is 4 feet or more. Replaced section shall match the adjacent curb [and gutter] and shall be [3000] [4000] psi concrete, air-entrained. Waste materials shall be disposed of [in waste areas shown on the drawings] [off-Base].

7.2. RIGID PAVEMENT. Where construction requires removal and replacement of rigid pavement, the cutting shall be accomplished by a concrete saw;

minimum depth of vertical cut shall be 1 inch. The remaining depth of section may be broken out in any approved manner. Width of section removed shall be such that no area of pavement removed or replaced and no adjacent slab or portion of slab which remains in the pavement abutting the replacement slab shall have length or width between joints of less than 10 feet. Replaced pavement shall match the adjacent pavement and shall be [3000] [4000] psi air-entrained concrete. [Integral curb shall match the adjacent curb.] Concrete rubble resulting from the above operations shall be disposed of [in waste areas shown on the drawings] [off-Base].

7.3. **WALKS.** Where construction requires removal and replacement of concrete walks, removal shall be to the nearest joint. Saw cutting to a minimum depth of 1 inch will be permitted if the remaining section to the nearest joint is 4 feet or more. Replaced walk shall match the adjacent walk and shall be [3000] [4000] psi concrete, air-entrained.

#(N)#

7.4. **TEMPORARY PAVEMENT REPAIR.** The Contractor shall provide a temporary asphaltic cold mix patch on all roads which have not been permanently repaired within [5] [30] days of closing the pavement to traffic. The surface drainage shall be constructed to minimize the infiltration of water into the pavement. The Contractor shall be responsible for maintaining the temporary patch until the permanent repair, as specified above, is completed.

SECTION 02241

CRUSHED-AGGREGATE BASE COURSE
02/89

#(1)#

PART 1 GENERAL

#(2)#

1.1 SUMMARY (Not Applicable)

#(3)#

1.2 REFERENCES

#(4)#

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

\-AASHTO M 92-\	(1985) Wire-Cloth Sieves for Testing Purposes
\-AASHTO T 2-\	(1984) Sampling Aggregates
\-AASHTO T 19-\	(1980; Rev. 1986) Unit Weight and Voids in Aggregate
\-AASHTO T 27-\	(1984) Sieve Analysis of Fine and Coarse Aggregates
\-AASHTO T 84-\	(1986) Specific Gravity and Absorption of Fine Aggregate
\-AASHTO T 85-\	(1985) Specific Gravity and Absorption of Coarse Aggregate
\-AASHTO T 88-\	(1986) Particle Size Analysis of Soils
\-AASHTO T 89-\	(1987I) Determining the Liquid Limit of Soils
\-AASHTO T 90-\	(1987I) Determining the Plastic Limit and Plasticity Index of Soils
\-AASHTO T 96-\	(1987I) Resistance to Abrasion of Small-Size Coarse Aggregate by Use of the Los Angeles Machine

\-AASHTO T 180-\	(1986) Moisture-Density Relations of Soils Using a 10-Lb. [4.54 kg] Rammer and an 18-In. [457 mm] Drop
\-AASHTO T 191-\	(1986) Density of Soil In-Place by the Sand-Cone Method
\-AASHTO T 238-\	(1986) Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)
\-AASHTO T 239-\	(1986) Moisture Content of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM C 8-\	(1983) Soundness of Aggregates by Use of Sedium Sulfate or Magnesium Sulfate
\-ASTM C 117-\	(1984) Materials Finer Than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
\-ASTM C 127-\	(1984) Specific Gravity and Absorption of Course Aggregate
\-ASTM C 128-\	(1984) Specific Gravity and Absorption of Fine Aggregate
\-ASTM C 131-\	(1981; R 1987) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
\-ASTM C 136-\	(1984; Rev. a) Sieve Analysis of Fine and Coarse Aggregates
\-ASTM D 75-\	(1987) Sampling Aggregates
\-ASTM D 422-\	(1963; R 1972) Particle-Size Analysis of Soils
\-ASTM D 1556-\	(1982) Density of Soil In-Place by the Sand-Cone Method
\-ASTM D 1557-\	(1978) Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-Lb. (4.54-kg) Rammer and 18-In. (457-mm) Drop
\-ASTM D 2922-\	(1981) Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)

\-ASTM D 3017\ (1978) Moisture Content of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)

\-ASTM D 4318-\ (1984) Liquid Limit, Plastic Limit, and Plasticity of Soils

\-ASTM E 11-\ (1987) Wire-Cloth Sieves for Testing Purposes

#(N)#

[U.S. ARMY CORPS OF ENGINEERS HANDBOOK
FOR CONCRETE AND CEMENT

\-CRD-C 130-\ (1979) Scratch Hardness of Coarse Aggregate Particles]

#(N)#

1.3 NOT USED
#(5)#

1.4 DEFINITIONS

1.4.1 Crushed Aggregate Base

Crushed Aggregate Base as used herein is well graded, durable crushed aggregate uniformly moistened and mechanically stabilized by compaction.

1.4.2 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in [\-AASHTO T 180-\] [\-ASTM D 1557-\], Method D, abbreviated hereinafter as percent laboratory maximum density.

1.5 GENERAL

The work specified herein consists of the construction of a crushed-aggregate base course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes and typical sections shown in the plans.

1.6 SUBMITTALS
#(7)#

The following shall be submitted in accordance with Section: SPECIAL CLAUSES.

1.6.1 CATEGORY I. None

1.6.2 CATEGORY II. (For Information Only)
Test Reports (para 1.6.3)
Aggregate Records (Para 1.6.4)

1.6.3 Test Reports

Results of initial laboratory tests for prequalification purposes shall be submitted to the Contracting Officer prior to using the material.

Copies of field test results for quality control purposes shall be submitted within 24 hours after the tests are performed and prior to placing subsequent construction over completed base course.

Calibration curves and related test results shall be submitted prior to using the device or equipment being calibrated.

Sources of all materials shall be selected well in advance of the time that materials will be required in the work. Test results from samples shall be submitted for approval not less than 30 [ ] days before material is required for the work.

1.6.4 Records

Only one type of coarse aggregate shall be used on the project and a notification stating which aggregate is to be used shall be submitted.

1.7 WEATHER LIMITATIONS

Base shall not be constructed when the atmospheric temperature is less than 35 degrees F. Base course shall not be constructed on underlying material that is frozen or contains frost. When the temperature falls below 35 degrees F, completed or partially completed areas of base course shall be protected by the Contractor against any detrimental effects of freezing using approved methods.

1.8 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.8.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval prior to commencing work and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. The equipment shall be adequate and have the capability of producing the results specified.

1.8.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type weighing not less than 10 tons, with a minimum weight of 300 pounds per inch width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

1.8.3 Pneumatic-Tired Rollers

#(8)#

Pneumatic-tired rollers shall have four or more tires, each loaded to a minimum of 30,000 pounds and inflated to a minimum pressure of 150 psi. The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

1.8.4 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. The spreader shall contain a hopper, an adjustable screed, and outboard bumper rolls and be designed to have a uniform, steady flow of material from the hopper. The spreader shall be capable of laying material without segregation across the full width of the lane to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers shall conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

1.8.5 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

1.8.6 Tampers

Tampers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

1.8.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 10- foot straightedge for each bituminous paver, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.9 STOCKPILING MATERIALS

Materials shall be stockpiled in the manner and at locations designated. Before stockpiling of material, storage sites shall be cleared, leveled and graded to drain. Materials obtained from different sources shall be stockpiled separately.

1.10 SAMPLING AND TESTING

1.10.1 General Requirements

#(9)#

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor subject to approval. No work requiring testing shall be permitted until the facilities have been inspected and approved. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed at the frequency specified herein after and at the locations and times necessary to insure that in-place materials and compaction meet specified requirements. Copies of test results shall be furnished to the Contracting Officer as soon as tests results are available and in every case within 24 hours of completion of tests and prior to placing subsequent construction over completed base course.

1.10.2 Test Results

The Contractor shall select the source of materials and perform initial sampling and testing sufficiently in advace to not delay the work. The contractor shall control his oeprations during production and placement of material, so that materials in the completed course will comply with the specified requirements. When a material source is changed, the new material will be tested for compliance.

When deficiencies are found, the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or modified as directed by the Contracting Officer.

1.10.3 Sampling

All samples including those required and used by the Contractor for control of his operations, shall be representative of materials being placed. In addition, samples shall be taken from completed and compacted course. All aggregate samples shall be taken in conformance with [AASHTOT 2] [ASTM D 75] unless otherwise approved or directed.

1.10.4 Sieve Analysis

Before starting work, at least one sample of proposed material shall be tested in accordance with [\-AASHTO T 27-\] [\-ASTM C 136-\], ASTM C 117 and [\-AASHTO T 88-\] [\-ASTM D 422-\] on sieves conforming to [\-AASHTO M 92-\] [\-ASTM E 11-\]. After the initial test, a minimum of one analysis shall be performed for each 1000 square yards of each layer of material placed and compacted, crushed particles shall be determined by visual examination and measurement for each sieve analysis unless the material is crushed quarried rock or otherwise approved, with a minimum of three analyses for each day's run until the course is completed.

1.10.5 Liquid Limit and Plasticity Index

One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with [\-AASHTO T 89-\] [\-AASHTO T 90-\] [\-ASTM D 4318-\].

1.10.6 Laboratory Density

Tests shall provide a moisture-density relationship for the aggregate base course. Tests shall be conducted in accordance with [\-AASHTO T 180-\] [\-ASTM D 1557-\], Method D.

1.10.7 Soundess

Prior to commencing construction, a soundness test shall be determined in accordance with ASTM C 88 using magnesium sulfate.

1.10.8 Wear (L.A. Abrasion) Tests

Wear tests shall be performed in accordance with [\-AASHTO T 96-\] [\-ASTM C 131-\] prior to beginning construction. One test shall be run per [1000] square yards of completed base course. A minimum of one test per aggregate source shall be run.

1.10.9 Sampling and Testing During Construction

Quality control sampling and testing during construction shall be performed by the Contractor as specified in paragraph "FIELD QUALITY CONTROL" herein, and paragraph: CONTRACTOR QUALITY CONTROL in SECTION: SPECIAL CLAUSES.

PART 2 PRODUCTS

2.1 MATERIALS

#(10)#

2.1.1 Aggregates

Aggregates shall consist of crushed stone, crushed gravel, angular sand or other approved sound, durable materials processed and blended or naturally combined. Aggregates shall be durable and sound, free from foreign materials such as organic matter, lumps of clay and coatings. [Disintegrated granite shall not be used for production of any aggregate and the processed aggregate shall contain not more than 2.0 percent by weight of disintegrated granite particles in that portion of the total sample larger than the No. 4 sieve and not more than 4.0 percent in any individual sieve size listed in the required aggregate gradation for that portion larger than the No. 4 sieve. A disintegrated granite particle is defined as a soft, crumbly particle of igneous rock having a visible crystalline grain size and consisting essentially of feldspar and quartz with lesser amounts of micas and/or amphiboles and pyroxenes. Generally, the rock particle will be stained by iron oxide and the feldspar grains will have a dull, highly fractured appearance. The individual mineral grains are so weakly bonded that the particle will crumble under moderate pressure. When tested by Test Method CRD-C 130 the particle would be classified as soft.] The Contractor shall obtain materials that meet the requirements specified herein and that can be constructed to meet the gradation, compaction and smoothness requirements specified herein after placement. The material retained on a No. 4 sieve shall be known as coarse aggregate; that passing the No. 4 sieve shall be known as binder material.

2.1.1.1 Coarse Aggregate
#(11)#

Coarse aggregates shall consist of crushed stone or crushed gravel having angular fragments of uniform density and quality, and a percentage of wear not to exceed 50 percent after 500 revolutions when tested in accordance with [\-AASHTO T 96-\] [\-ASTM C 131-\]. When subjected to 5 cycles of the soundness test, in accordance with ASTM C 88 using magnesium sulfate, the loss in weight of coarse aggregate shall not exceed 18 percent. 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. Crushed gravel shall conform to the requirements of Crushed Gravel or Crushed Stone below. The Contractor shall notify the Contracting Officer in writing stating which subparagraphs the crushed gravel shall conform to, and the selection paragraph requirements shall be mandatory for the entire job.

a. Crushed Gravel: Crushed gravel shall be manufactured from gravel particles 50 percent of which by weight are retained on the maximum size gradation sieve specified.

b. Crushed Stone: Crushed stone 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.

2.1.2 Binder Material
#(12)#

Binder material shall consist of screenings, angular sand, or other finely divided mineral matter processed or naturally combined with the coarse aggregate. Liquid-limit and plasticity-index requirements 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 have a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.1.3 Gradation
#(13)#

Requirements for gradation specified shall apply to the completed base course. The aggregates shall have a [2] [1-1/2] [1]inch maximum size and shall be continuously graded within the limits below. The Contractor shall designate one of the following gradations for use on the project and all the material furnished for the project shall conform to the designated gradations after placement and compaction.

Sieve Designation	Percentage by Weight Passing Square-mesh Sieve

	No. 1	No. 2	No. 3
2-inch	100	---	---
1-1/2-inch	70-100	100	---
1-inch	45-80	60-100	100
1/2-inch	30-60	30-65	40-70
No. 4	20-50	20-50	20-50
No. 10	15-40	15-40	15-40
No. 40	5-25	5-25	5-25
No. 200	0-8	0-8	0-8
0.02 mm	0-3	0-3	0-3

NOTES

The above gradations represent the extreme limits which shall determine suitability of aggregate for use from all sources of supply. The aggregate used in the work shall have a gradation within the limits designated in the table, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but shall be well graded from coarse to fine.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the base is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the base course.

3.2 OPERATION OF AGGREGATE SOURCES (PITS OR QUARRIES)

#(14)#

All work involved in the clearing, stripping, and excavating in opening or operation of pits or quarries shall be performed by the Contractor. [Aggregate sources shall be cleared, stripped and excavated to working depths in a manner that produces excavation faces that are as nearly vertical as practicable for the materials being excavated. Strata of unsuitable materials overlying or occurring in the deposit shall be wasted. Methods of operating aggregate sources and the processing and blending of the materials may be changed or modified if necessary to obtain material conforming to the specified requirements. Upon completion of the work, aggregate sources shall be conditioned to drain readily and be left in a satisfactory condition.] [Aggregates shall be obtained from off-site sources.] Pits or quarries on private lands shall be conditioned in agreement with local laws and authorities.]

3.3 PREPARATION OF UNDERLYING COURSE

#(15)#

3.3.1 General Requirements

Before constructing base course, the previously constructed underlying course shall be cleaned of foreign substances. Surface of underlying course shall meet the specified compaction and surface tolerances. Subgrade shall conform to [Section \=02230=\ EXCAVATION, EMBANKMENT, AND PREPARATION OF SUBGRADE FOR ROADWAYS, RAILROADS, AND AIRFIELDS] [Section \=02210=\ GRADING (EARTHWORK)]. [Subbase course shall conform to [Section \=02234=\ SUBBASE COURSE] [Section \=02232=\ SELECT-MATERIAL SUBBASE COURSE].] [The granular filter course shall conform to SECTION: GRANULAR FILTER COURSE.] Ruts or soft, yielding spots that may appear in the underlying course, areas having inadequate compaction, and deviations of the surface from requirements specified shall be corrected to specification requirements before placing the base course. Finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until base course is placed.

3.3.2 Grade Control

Underlying material shall be excavated to sufficient depth for the required base course thickness so that the finished base course with the subsequent surface course will meet the fixed grade. Finished and completed base course shall conform to the lines, grades, cross section, and dimensions indicated. Line and grade stakes shall be placed by the Contractor as necessary for control in accordance with SPECIAL CLAUSES. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.4 INSTALLATION

3.4.1 Mixing and Placing
#(16)#

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 crushed aggregate base course material and at a uniform optimum water content for compaction. The Contractor shall make such adjustments in mixing or placing procedures or in equipment to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory base course.

3.4.2 Edges of Base Course

Approved material shall be placed along edges of crushed aggregate base course in such quantities as will compact to thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 1-foot width of the shoulder to be rolled and compacted simultaneously with rolling and compacting of each layer of base course.

3.4.3 Compaction
#(17)#

Each layer of crushed aggregate base course [including shoulders] shall be compacted. Water content shall be maintained at optimum. Density of compacted

mixture shall be at least 100 percent of laboratory maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods.

3.4.4 Layer Thickness

Compacted thickness of the crushed aggregate base course shall be as indicated. [When a compacted layer of 6 inches or less is specified, the material shall be placed in a single layer.] [When a compacted thickness of more than 6 inches is required, no single layer of the placed material shall be in excess of 8 inches nor less than 3 inches when compacted.]

3.4.5 NOT USED. [Proof Rolling]

#(18)#

[Proof rolling of the areas indicated shall be in addition to the compaction specified and shall consist of the application of 30 coverages with a heavy pneumatic-tired roller having four or more tires, each loaded to a minimum of 30,000 pounds and inflated to a minimum of 150 psi. In areas designated, proof rolling shall be applied to the top lift or layer on which base course is laid and to each layer of base course. Water content of the top lift or layer on which base course is laid shall be maintained at optimum or at percentage directed from start of compaction to completion of proof rolling of that layer. Water content of each layer of the base course shall be maintained at the optimum percentage directed from start of compaction to completion of proof rolling. Materials in base course or underlying materials that produce unsatisfactory results by rolling shall be removed and replaced with satisfactory materials and recompacted.]

3.4.6 Finishing

The surface of the top layer shall be finished to grade and cross section shown. Finished surface shall be of uniform texture. Light blading during compaction may be necessary for the finished surface to conform to the lines, grades, and cross sections. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic marked prior to completion, such unsatisfactory portion shall be scarified, reworked, recompacted, or replaced as directed.

3.4.6.1 Smoothness

Surface of each layer shall show no deviations in excess of 3/8 inch when tested with the [10-] foot straightedge applied both parallel with and perpendicular to the centerline of the base-course area. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting.

3.4.6.2 Thickness Control

#(19)#

Compacted thickness of the crushed aggregate base course shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected by the Contractor by scarifying, adding new material of proper gradation, reblading, and recompacting . Average job thickness shall be the average of all thickness measurements taken for the job as specified above, but shall be within 1/4 inch of the thickness indicated.

3.5 FIELD QUALITY CONTROL

3.5.1 \+Field Density+\

Field in-place density shall be determined in accordance with [\-ASTM D 1556-\] \or [\-ASTM D 2922-\] [\-AASHTO T 191-\] [\-AASHTO T 238-\]. For the method presented in [ASTM D 1556] [AASHTOT 191], the loose plate as shown shall be used. [When [\-ASTM D 2922-\] [\-AASHTO T 238-\] is used, the calibration curves shall be checked, and adjusted if necessary, using the sand cone method as described in paragraph "Calibration" of the [ASTM] [AASHTO] publication. [\-ASTM D 2922-\] [\-AASHTO T 238-\] results in a wet unit weight of soil, and when using this method, [\-ASTM D 3017-\] [\-AASHTO T 239-\] shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in [\-ASTM D 3017-\] [\-AASHTO T 239-\]. Calibration curves for the moisture and density gages shall be furnished and checked by the Contractor at the beginning of the job and on each type of material encountered on the job. If nuclear devices are used, not less than 1 of every 10 consecutive field density tests shall be in checked using [ASTM D 1556] [AASHTO T 191] to provide correlation. Calibration curves, calibration tests results and correlation tests shall be furnished within 24 hours of the conclusion of the tests. At least one field density test shall be performed for each [1000] square yards of each layer of base material, and not less than one test for each day's replacement. When the material is compacted by hand operated equipment a field density test shall be performed for each 100 square yards, or fraction thereof, on each layer placed.

3.5.2 \+Smoothness+\

Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the base course area centerline with a 10 foot straightedge. Measurements shall also be taken perpendicular to the centerline at [50] [_100____] foot intervals.

3.5.3 \+Thickness+\

The Contractor shall control his operations by measurements to insure placement of materials to the thickness specified. Thickness of the crushed aggregate base course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square yards or part thereof of crushed aggregate base course. Measurements shall be made in 3-inch diameter test holes penetrating the base course. Measurements may be made by the Government for verification of compliance; however, the Contractor shall not depend on such measurements for his control of operations.

3.6 TRAFFIC

Completed portions of the area may be opened to traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

3.7 MAINTENANCE

The basecrushed aggregate base course shall be maintained in a satisfactory condition until accepted. Areas of crushed aggregate base course, damaged by freezing, rainfall or other weather conditions shall be corrected to meet specification requirements.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for crushed aggregate base course, material that is removed for the required correction of defective areas, and waste material and debris shall be disposed of [as directed] [in waste disposal areas indicated].
#(20)#

ZERO ACCIDENTS

SECTION 02243
CRUSHED ROCK SURFACING

INDEX

1. APPLICABLE PUBLICATIONS
2. EQUIPMENT
3. APPROVAL, SAMPLING, AND TESTING
4. SUBMITTALS
5. WEATHER LIMITATIONS
6. STOCKPILING MATERIAL
7. NOT USED
8. MATERIALS
9. CONSTRUCTION
10. MAINTENANCE

#(N)#
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.

#(N)#
1.1. **AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS.**

C 88-83	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117-84	Materials Finer Than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
C 131-81	Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136-84	Sieve Analysis of Fine and Coarse Aggregates
D 75-87	Sampling Aggregates
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 Rammer and 18-inch Drop
D 2922-81	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D 3017-78	Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
D 4318-84	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
E 11-81	Wire-Cloth Sieves for Testing Purposes

#(N)#
1.2. **U. S. ARMY CORPS OF ENGINEERS HANDBOOK FOR CONCRETE AND CEMENT.**

CRD-C 130-79	Scratch Hardness of Coarse Aggregate Particles

2. **EQUIPMENT.** All plant, equipment, tools and machines used in the performance of the work shall be subject to approval prior to commencement of work. This equipment shall be maintained in satisfactory working condition at all times.

3. **APPROVAL, SAMPLING, AND TESTING.** Sampling and testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Sampling and testing shall be performed by an approved commercial testing laboratory, or by the Contractor subject to approval. Tests shall be performed at the frequency specified hereinafter. Copies of test results shall be furnished to the Contracting Officer as soon as tests are performed.

3.1. **GENERAL.** The Contractor shall select the source of materials and perform initial sampling and testing sufficiently in advance to not delay the work. The Contractor shall control his operations during production and placement of material, so that materials in the completed course will meet specified requirements. All quality control sampling and testing shall be performed by the Contractor in accordance with paragraph: CONTRACTOR QUALITY CONTROL in SECTION: SPECIAL CLAUSES, and as specified herein. The Government may perform verification tests for final approval of materials in the completed surfacing.

3.2. **SAMPLES.** All samples including those required and used by the Contractor for control of his operations, shall be representative of materials being placed. In addition, samples shall be taken from completed and compacted surfacing. All samples shall be taken in conformance with ASTM D 75 unless otherwise approved or directed.

#(N)#

3.3. **TESTS.** The following tests shall be performed by the Contractor.

3.3.1. **Sieve Analyses** shall be made in accordance with ASTM C 117 and C 136. Sieves shall conform to ASTM E 11.

3.3.2. **Wear (L.A. Abrasion) Test** shall be made in conformance with ASTM C 131.

#(N)#

3.3.3. **Soundness** shall be determined in accordance with ASTM Standard C 88 using magnesium sulfate.

3.3.4. **Liquid-Limit and Plasticity-Index** shall be determined in accordance with ASTM D 4318.

3.3.5. **Moisture-Density Determinations.** The maximum density and optimum moisture shall be determined in accordance with ASTM D 1557, Method D.

3.3.6. **Field Density.** Density shall be measured in the field in accordance with ASTM D 1556, or ASTM D 2922. For the method presented in ASTM D 1556, the base plate as shown in the drawing shall be used. Tests performed in accordance with ASTM D 2922 result in a wet unit weight of soil. When using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gages shall also be checked along with density calibration checks as described in ASTM D 3017. Calibration curves for the moisture gages as specified in ASTM D 3017 and for density gages as specified in ASTM D 2922 shall be furnished. The calibration curves for the moisture gages and density gages shall be checked at the beginning of the job and on each type of material encountered on the job. If nuclear devices are used, not less than 1 of every 10 consecutive field density tests shall be in accordance with ASTM D 1556 to provide correlation. Calibration curves, test results, and correlation tests shall be furnished within 24 hours of the conclusion of the tests. At least one field density test shall be performed for each 1,000 square yards of each layer of base material.

3.3.7. **Crushed Particles** shall be determined by visual examination and measurement.

3.3.8. **Degree of Compaction** required under the paragraph: COMPACTION is expressed as a percentage of the maximum density obtained by the test procedure in ASTM D 1557, Method D. This will be abbreviated hereinafter as percent laboratory maximum density.

3.4. **TESTING FREQUENCY.**

#(N)#

3.4.1. **Initial Tests.** One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material will meet all specified requirements when furnished and after placing and compaction.

Sieve Analysis
L.A. Abrasion
Particle Shape
Crushed Particles, unless material is crushed quarried rock
Soundness
Liquid-Limit and Plasticity-Index
Moisture-Density Relationship

#(N)#

3.4.2. **In-Place Tests.** One of each of the following tests shall be performed on samples taken from the placed and compacted crushed rock surfacing. Samples shall be taken for each 1,000 square yards of each layer of material placed in each area.

Sieve Analysis
Field Density and Moisture
Liquid Limit and Plasticity Index
Crushed Particles, unless the material is crushed quarried rock or unless otherwise approved

4. **SUBMITTALS.** In accordance with SECTION: SPECIAL CLAUSES, the Contractor shall submit data as specified herein on the following:

4.1. **CATEGORY I.** None.

4.2. **CATEGORY II.** (For Information Only)
Initial test results on proposed material (Para. 3.4.1)
In-place tests (Para. 3.4.2)

5. **WEATHER LIMITATIONS.** Crushed rock surfacing shall be constructed only when atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F., the Contractor shall protect, by approved methods, all areas of completed or partially completed crushed rock surfacing against freezing.

#(N)#

6. **STOCKPILING MATERIAL.** Prior to stockpiling of material, storage sites shall be cleared and leveled. Aggregates shall be stockpiled on designated cleared and leveled areas so as to prevent segregation. Aggregates and binders obtained from different sources shall be stockpiled separately.

#(N)#

7. **NOT USED.**

#(N)#

8. **MATERIALS.** Aggregates shall consist of crushed stone, crushed gravel, angular sand or other approved materials processed and blended or naturally combined. Aggregates shall be free from foreign materials such as organic matter, lumps of clay, coatings, etc., and shall be durable and sound. [Disintegrated granite shall not be used for production of any aggregate and the processed aggregate shall contain not more than 2.0 percent by weight of disintegrated granite particles in that portion of the total sample larger than the No. 4 sieve and not more than 4.0 percent in any individual sieve size listed in the required aggregate gradation for that portion larger than the No. 4 sieve. A disintegrated granite particle is defined as a soft, crumbly particle of igneous rock having a visible crystalline grain size and consisting essentially of feldspar and quartz with lesser amounts of micas and/or amphiboles and pyroxenes. Generally, the rock particle will be stained by iron oxide and the feldspar grains will have a dull, highly fractured appearance. The individual mineral grains are so weakly bonded that the particle will crumble under moderate pressure. When tested by Test Method CRD-C 130 the particle would be classified as soft.] The Contractor shall obtain materials that will meet the requirements specified herein and that can be constructed to meet the gradation, compaction and smoothness requirements specified herein after placement. 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.

#(N)#

8.1. **COARSE AGGREGATE** conforming to the requirements specified above shall have a percentage of wear not to exceed 50 percent after 500 revolutions as determined by ASTM C 131. Coarse aggregate shall be either crushed ledge rock or crushed gravel. Crushed gravel shall meet one of the following options:

Option 1. Crushed gravel retained on each individual sieve specified for coarse aggregate and passing the next larger sieve specified shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces.

Option 2. Crushed gravel shall be produced from pit run material having at least 30 percent by weight retained on the 3/4-inch sieve. All oversize material shall be crushed and blended with the finished product except that, at the Contractor's option, cobbles larger than 4-inch size may be excluded.

When subjected to five cycles of the soundness test, in accordance with ASTM C 88 using magnesium sulfate, the loss in weight of coarse aggregate shall not exceed 18 percent. Coarse aggregate shall consist of angular fragments 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. An elongated particle is one having a ratio of length to width greater than 3.

8.2. **BINDER MATERIAL** shall consist of screenings, angular sand or other finely divided mineral matter processed or naturally combined with the coarse aggregate. The portion of the completed course passing the No. 40 sieve shall have a liquid limit not greater than 30 and a plasticity index between 4 and 10. If the addition of clay binder is necessary to meet the requirements specified herein, the clay binder shall have at least 65 percent passing the No. 10 sieve and shall have a liquid limit not greater than 50 and a plasticity

index not greater than 20. If the aggregate consists of crushed limestone, the minimum plasticity limit specified hereinbefore will be waived provided the Contractor demonstrates to the satisfaction of the Contracting Officer that similar material used in previous construction produces sufficient "recementing effect" to eliminate the need for plastic binder, when placed and compacted by approved procedures.

8.3. **GRADATION** requirements shall apply to the completed surface course. The aggregates shall have a maximum size of 3/4 inch and shall be well graded within the limits specified below.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieve
3/4 inch	100
3/8 inch	60-90
No. 4	45-80
No. 10	35-70
No. 40	20-45
No. 200	8-20

The above gradation represents the extreme limits which shall determine suitability of aggregate for use from all sources of supply. The aggregate used in the work shall have a gradation within the limits designated in the table, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but shall be well graded from coarse to fine.

9. CONSTRUCTION.

9.1. **GRADE CONTROL.** During construction the lines and grades including crown and cross slope indicated shall be maintained by means of line and grade stakes placed by the Contractor in accordance with SPECIAL CLAUSES.

9.2. **OPERATION OF PITS OR QUARRIES.** All work involved in the clearing, stripping, and excavating in opening or operation of pits or quarries shall be performed by the Contractor. There are no pits or quarries on Government land. Pits or quarries on private lands shall be conditioned in agreement with local laws and authorities.

#(N)#

9.3. **PREPARATION OF [SUBGRADE] [SUBBASE COURSE].** Prior to constructing crushed rock surfacing, the previously constructed [subgrade] [subbase course] shall be cleaned of all foreign substances. [The subgrade shall conform to SECTION: GRADING.] [The subbase course shall conform to SECTION: CRUSHED AGGREGATE SUBBASE COURSE.] Ruts or soft, yielding spots in the [subgrade] [subbase course] areas having inadequate compaction, and deviations of the surface from requirements set forth therein shall be corrected to specification requirements prior to placing the crushed rock surfacing. The finished [subgrade] [subbase] shall not be disturbed by traffic or other operations and shall be maintained by Contractor in a satisfactory condition until crushed rock surfacing is placed.

9.4. **MIXING AND PLACING.** 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 crushed rock surfacing material and at a uniform optimum water content for compaction. Contractor shall make such adjustments in mixing or placing procedures or in equipment to obtain the true grades, to minimize

segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory crushed rock surfacing course.

9.5. COMPACTION. [Each layer of] cCrushed rock surfacing [including shoulders] shall be compacted. Water content shall be maintained at optimum. Density of compacted mixture shall be at least 100 percent of laboratory maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods.

#(N)#

9.6. LAYER THICKNESS. The compacted thickness of the crushed rock surfacing shall be as indicated. [When a compacted layer of 6 inches or less is specified, the material shall be placed in a single layer.] [When a compacted thickness of more than 6 inches is required, no single layer of the placed material shall be in excess of 8 inches nor less than 3 inches when compacted.]

#(N)#

9.7. EDGES OF THE CRUSHED ROCK SURFACING. The manner of construction and the type of edge required for the crushed rock surfacing will depend on the type of road section and the adjacent construction.

9.7.1. With Shoulders. [The tapered edge of the shoulders shall be constructed in such manner as the Contractor elects subject to the approval of the Contracting Officer, but the finished surface of the shoulders and tapered edges shall conform to the line, grade, and section shown on the drawings.]

9.8. FINISHING. The surface of the top layer shall be finished to grade and cross section shown. Finished surface shall be of uniform texture. Light blading during compaction may be necessary for the finished surface to conform to the lines, grades, and cross sections. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic marked prior to completion, such unsatisfactory portion shall be scarified, reworked, recompacted, or replaced as directed.

#(N)#

9.9. SMOOTHNESS. The surface of [each] [the] layer shall show no deviations in excess of 3/8 inch when tested with a 10-foot straightedge applied both parallel with and at right angles to the centerline of the crushed rock surfacing area. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting.

#(N)#

9.10. THICKNESS CONTROL. The Contractor shall control his operations by measurements to insure placement of materials to the thickness specified. Thickness measurements shall be made by test holes at least 3 inches in diameter through the surfacing. One depth measurement shall be made for each 500 square yards or part thereof of crushed rock surfacing. Measurements may be made by the Government for verification of compliance; however, the Contractor shall not depend on such measurements for his control of operations. The completed thickness of the crushed rock surfacing shall be within 1/2 inch plus or minus of the thickness shown on the drawings. Where the measured thickness is deficient by more than 1/2 inch, the Contractor shall correct such areas by scarifying, adding mixture of proper gradation, reblading and recompacting. The

average job thickness shall be the average of the job measurements as specified above but within 1/4 inch of the thickness indicated.

10. **MAINTENANCE.** The crushed rock surfacing shall be maintained in a satisfactory condition until accepted. Areas of crushed rock surfacing damaged by freezing, rainfall or other weather conditions shall be corrected to meet specified requirements.

ZERO ACCIDENTS

SECTION 02280
GROUND-WATER EXTRACTION TRENCH

1. SCOPE
2. APPLICABLE PUBLICATIONS
3. GEOTECHNICAL SITE CONDITIONS
4. DEFINITIONS
5. SUBMITTALS
6. QUALIFICATIONS FOR SLURRY TRENCH CONSTRUCTION
7. NOT USED
8. NOT USED
9. MATERIALS
10. EQUIPMENT
11. EXTRACTION TRENCH EXCAVATION
12. QUALITY CONTROL
13. QUALITY ASSURANCE
14. EXTRACTION EQUIPMENT
15. MEASUREMENT
16. PAYMENT

1. SCOPE. The work covered by this section of the specifications consists of furnishing all plant, labor, equipment, and materials and of performing all operations in connection with constructingexcavating the slurryground-water extraction trench , hereinafter referred to as the extraction trench by the biodegradable polymer slurry trench method, in accordance with these specifications and applicable drawings.

2. 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 reference thereto.

2.1 American Petroleum Institute (API) Standard Specifications.

Code RP 13B-1 June 1, 1990	Recommended Practice Standard Procedures for Testing Drilling Fluids; and Supplements
Spec 13A, Sections 4,9,10 July 1, 1990	Specification for Oil-Well Drilling Fluid Materials

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

D 422-63	Particle-Size Analysis of Soils
C 136-84	Sieve Analysis of Fine and Coarse Aggregates

3. GEOTECHNICAL SITE CONDITIONS.

3.1 Exploratory Borings. Subsurface exploratory borings have been obtained by the Government to determine the character of materials to be excavated. Locations of the borings are shown on the plans and the condensed logs of those borings which fall within the area of this contract are included

in the drawings for the convenience of the Contractor. The Government assumes no responsibility for interpretation or deductions made by the Contractor from the logs and borings. Local minor variations in the subsurface materials are to be expected and, if encountered, will not be considered as being materially different within the purview of Article 4 paragraph PHYSICAL DATA of the GENERAL PROVISIONSSECTION: SPECIAL CLAUSES. Soils classifications shown on the logs are the result of field visual classifications and laboratory classifications in accordance with the Unified Soil Classifications System. The full logs and results of all laboratory testing, including rock and soil, are available for review by the Contractor in the Omaha District Office. *(Attention is invited to Paragraph in the SPECIAL PROVISIONS entitled: SUBSURFACE INVESTIGATIONS, for availability of core borings and soil samples for inspection.)

3.2 Subsurface Conditions. Subsurface strata in the area of the ground-water extraction trench consist of unconsolidated silty sand and silty clayey sand ranging from loose to medium dense and moist to saturated, and sandy clay and sandy silty clay ranging from stiff to very stiff and moist to wet.

3.3 Groundwater. Ground-water elevations measured at the time of drilling in the extraction trench area were 5238.8 and 5237.9.

4. DEFINITIONS. The terms used in this section are defined as follows:

4.1 Ground-water Extraction Trench. The extraction trench is a 3 foot minimum width trench excavated through the existing ground or prepared working surface using the slurry method of excavation and backfilled with a specified graded material below and soil above hereinafter referred to as the backfill material, to form a pervious drain.

4.2 Slurry Method of Excavation. The slurry method of excavation consists of excavating a vertical walled trench and at the same time keeping the trench filled with a biodegradable polymer slurry mixture. The purpose of the slurry is to support the walls of the trench and prevent movement of ground water.

4.3 Polymer. Polymer is a biodegradable organic colloid material.

4.4 Slurry. Slurry is a colloidal mixture of polymer and water.

4.5 Backfill. A graded granular material and a select soil which is used as the final filling of the extraction trench to construct the ground-water extraction system.

4.6 Ground Water Level. The ground water level is the piezometric level of the ground water as determined from wells.

4.7 Working Surface. The working surface is the top of the prepared natural ground or the surface of previously compacted fill from which the slurry trench shall be constructed. The elevations and materials of the working surfaces shall be as shown on the drawings and/or specified hereinafter.

4.8 NOT USED. Impervious Stratum. The impermeable soil or rock unit to or into which the bottom of the slurry trench is excavated.

4.9 Slurry Trench Specialist. A slurry trench specialist is an individual who has had at least 2 successful years of experience in slurry trench construction and has knowledge in all aspects of slurry trench construction which includes but is not limited to: (1) the use, testing, and control of bentonitepolymer as a slurry, (2) the mixing methods required to properly mix the slurry and backfill materials as required, (3) trench

excavation and backfill procedures, and (4) a thorough knowledge of construction equipment and material testing required for slurry trench construction.

5. SUBMITTALS. In accordance with SECTION 01100: SPECIAL CLAUSES, the Contractor shall submit data for approval by the Contracting Officer for the following items required by this section.

5.1 Category I.

5.1.1 Schedule and Sequence of Operations . The schedule and sequence of operations shall include but is not limited to *(drilling and sampling prior to trench excavation,) trench excavation, disposal of excavated material, waste management, slurry preparation, slurry placement, slurry maintenance, method of mix constituent measurement, bottom cleaning, backfill preparation, backfilling, and final grade closure.

5.1.2 Layout of Operations. The layout of operations shall include but is not limited to drawings depicting bentonite storage area, slurry preparation area, hydration pond(s) slurry storage area, backfill storage area, location and sizes of all stationary equipment, water storage tanks, pumps, valves, lines, hoses, and materials, and waste areas.

5.1.3 Extraction Trench Construction Method and Equipment.

5.1.4 NOT USED. Blast Plan.

5.1.5 NOT USED. Equipment and Procedure to Obtain *(Bedrock) *(Impervious Stratum) Samples.

5.1.6 Quality Control Testing Equipment and Procedures.

5.2 Category II

5.2.1 Contractor's Qualifications.

5.2.2 Slurry Trench Specialist's Qualifications.

5.2.3 Polymer Certification (from Supplier).

5.2.4 Backfill Gradation

5.2.5 Excavation and Backfill Soundings.

5.2.6 Results of all Contractor Quality Control (CQC) Tests and Measurements.

5.3 At the Contractors option, the Category I submittals may be submitted in one document, called the Extraction Trench Implementation Plan. Whether submitted individually or as one document, they should be submitted approximately 2 months prior to the anticipated construction starting date to allow for full review time.

6. QUALIFICATIONS FOR SLURRY TRENCH CONSTRUCTION.

6.1 Contractor. The Contractor shall be experienced in biodegradable polymer slurry trench construction. The Contractor and key personnel who manage the project shall submit evidence that verifies the experience and competency required to construct the extraction trench in accordance with these specifications including methods such as backhoe and clamshell. The evidence shall be submitted with the Contractor's bid and shall include the qualifications and experience of all personnel who shall be responsible for conducting the operations contained in these specifications. A slurry trench specialist shall be employed by the Contractor.

6.2 Slurry Trench Specialist. The slurry trench specialist shall be a Geotechnical Engineer and have a minimum of 2 years successful experience in the following: controlling composition, mixing, placing, cleaning, and maintaining biodegradable polymer slurry; supervision of alignment,

verticality and depth of slurry trenches; controlling placement of backfill methods such as clamshell operation. The slurry trench specialist's responsibility shall be solely for the construction of the ground-water extraction trench including all testing, inspection, and records. The slurry trench specialist shall be on site at all times during trenching and backfilling operations. The slurry trench specialist specified herein may be the same person as the slurry trench specialist for the soil-bentonite slurry trench. The name and qualifications of the slurry trench specialist shall be submitted with the Contractor's Bid.

7. NOT USED. SUBSURFACE INVESTIGATIONS.

7.1 General . Borings shall be made to locate the top of the impervious stratum as defined hereinbefore. Borings shall be drilled along the alignment of the cutoff wall prior to excavation. Borings shall be located at a maximum spacing of feet as measured along the alignment of the slurry trench. Borings shall be completed to a point at least feet in advance of the trenching operation at all times. If the elevation of the top of the impervious stratum encountered in the soil borings differs by more than feet between two adjacent borings, an additional boring shall be drilled midway between the other two. The number of additional borings is not anticipated to exceed percent of that specified.

7.2 Drilling . Drilling equipment shall be rotary type, approved by the Contracting Officer, which allows sampling of in-place native soil using bentonite slurry drilling fluid. At the time of sampling, the borehole shall be cleaned of drill cuttings and shall have maximum of inches of slough in the bottom of the borehole.

7.3 Sampling . Sampling shall be performed by the *(Standard Penetration Test in accordance with ASTM D 1586,) *(Coring,) *(Drive samples) or (other methods approved by the Contracting Officer.) Core catchers or other devices shall be used to insure all samples are retained during sampler extraction from the borehole. The samples shall be placed in suitable containers as approved by the Contracting Officer and the container shall be clearly marked to indicate boring number, location, depth of sample, and date sample was obtained. Samples shall be taken continuously from a depth of *(5) * ( ) feet above the anticipated depth of the impervious stratum to a depth of *(4) * ( ) feet below the top of the impervious stratum actually encountered or deeper if directed. Following completion of the slurry trench, all samples shall be disposed of *(in the waste disposal area) *(as directed by the Contracting Officer.)

7.4 Survey . The elevation of the ground surface at each boring location shall be determined within an accuracy of 0.1 feet. The location of each soil boring shall be determined within an accuracy of *(2.0) * ( ) feet.

8. NOT USED. INSTRUMENTATION MONITORING. The Contractor shall be responsible for monitoring instrumentation at the project as outlined herein and as shown on the contract plans. The results shall be reported to the Contracting Officer as specified herein.

8.1 Piezometers . Each piezometer to be monitored is listed in Table and shown on Drawings(s) and . The elevation of the top of each riser is also shown on Table . If any change is made in

the top of the riser elevation, the Contractor shall establish the new top of riser elevation and report it in writing to the Contracting Officer. The water level in each piezometer shall be measured to the nearest tenth of a foot and shall be reported as an elevation on a standard form on the same day as they are measured. Any fluctuations noted that could be related to construction activities shall be reported immediately to the Contracting Officer. The Contractor shall begin monitoring the piezometers as soon as the site work begins and shall continue until the contract is completed. Readings on all the piezometers shall be made at least once a . Piezometers which are within feet of any slurry trench construction activities shall be monitored. These piezometers shall be monitored *(daily) * ( ) until they have stabilized from any effects of the construction activity or from the closure of the slurry trench in that area. Any piezometer which is damaged or becomes plugged as a result of the Contractor's negligence shall be repaired or washed out within five days at the Contractor's expense. If the piezometer is destroyed, it shall be replaced as directed by the Contracting Officer.

9. MATERIALS. The requirements for the materials to be utilized in the slurry trench construction are as follows:

9.1 Polymer. The polymer shall be a biodegradable natural organic colloid material. The Contractor shall furnish to the Contracting Officer a certificate of compliance and a copy of the test reports from the polymer manufacturer for each lot of polymer shipped to the site stating that the polymer complies with provisions of this contract. No polymer from the polymer manufacturer shall be used prior to acceptance by the Contracting Officer. All polymer will be subject to inspection, sampling, and verification of quality of testing by or under the supervision of the Government. Polymer not meeting specifications shall be promptly removed from the site of the work and replaced with polymer conforming to specifications requirements at the Contractor's expense. Polymer shall be protected from moisture during transit and storage.

9.2 Water. The Contractor shall supply all water required for mixing with polymer to produce slurry. Water will be furnished by the Government. The water shall be clean, fresh, and comply with the standards specified below:

a. A pH equal to 7.0 plus or minus 1.0

b. Total dissolved solids not greater than 500 parts per million.

c. Oil, organics, acids, alkali, or other deleterious substances not greater than 50 parts per million each.

d. Hardness less than or equal to 100 ppm.

The Contractor shall submit water quality test results for water used for mixing the polymer slurry to assure conformance with the above limits.

9.3 Polymer Slurry. The polymer slurry for supporting the sides of the trench shall consist of a stable colloidal suspension of natural organic biodegradable polymer in water. It is the responsibility of the Contractor that the slurry meets the necessary properties. Mixture adjustments of the slurry within specified limits may be required by the Contracting Officer. The properties of the slurry used in all construction sequences shall be in accordance with the testing procedures described in API Code RP 13B-1 and shall conform to the following requirements:

9.3.1 Initial Polymer Slurry Mixture. At the time of introducing polymer slurry into the trench excavation, the slurry mixture shall have a minimum apparent viscosity of 60 seconds as measured by the Marsh funnel. The slurry density shall be a minimum of 64 pounds per cubic foot. The water loss shall not be greater than 30 cubic centimeters in 30 minutes as measured by a filter press at 100 psi. The pH shall not be less than 8.0. Mixture adjustment shall conform to the requirements in subparagraph: Additional Polymer.

9.3.2 Trench Polymer Slurry Mixture. The minimum apparent viscosity of the polymer slurry mixture in the trench at any time shall be 60 seconds as measured by the Marsh funnel. The density of the slurry mixture in the trench at any level shall be greater than 64 pounds per cubic foot and shall not exceed 85 pounds per cubic foot at any time. Mixture adjustments shall conform to the requirement in subparagraph: Additional Polymer.

9.3.3 Additional Polymer. If directed by the Contracting Officer, the Contractor shall thicken the slurry to a more viscous condition than the limits specified above. The Contractor shall use additional polymer, as directed.

9.4 Additives. Additives of the types used in the control of polymer drilling muds such as thinners, dispersents, and flocculants may be used to control standard properties of the slurry such as apparent viscosity and filtration characteristics subject to the approval of the Contracting Officer. Peptizing or bulking agents shall not be mixed with the slurry Extender additives may be mixed with the slurry.

9.5 Backfill Material. The materials to be used in backfilling the extraction trench shall consist of a graded granular material below the water table and a soil above. The soil shall be obtained from Government furnished borrow areas. All backfill shall be free of roots and other deleterious materials. The lower filter backfill material shall conform to the following physical property requirements.

Screen Size or Number (U.S. Standard)	Percent Passing by Dry Weight
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10

10. EQUIPMENT. The Contractor shall furnish all necessary plant and equipment for efficient; stripping, cutting, and/or filling and compacting to form the slurry-mixing surface; excavating the trench; mixing and placing slurry; cleaning of slurry and trench bottom; hauling, mixing and placement of backfill; disposal of contaminated excavated material in accordance with other provisions of this contract; preparation for and placement of the final cap on the completed trench, and for quality control testing of the materials used in such processes.

10.1 Trench Excavation. Equipment required for excavating the trench shall be furnished by the Contractor. The trench shall be excavated by extended-reach backhoe or by a crane-mounted, slurry-trench clamshell. The

buckets utilized with such equipment may be tapered and equipped with bottom-side cutter teeth protruding no more than 6 inches on each side. The bucket shall be designed to maintain the specified width of the trench and to minimize ravelling of the trench sides during use. Regardless of the equipment used, the bucket shall be capable of excavating the minimum required width in a single pass.

10.2 Mixing and Placing Slurry. Slurry mixing and placing equipment will be approved by the Contracting Officer. The slurry mixing plant shall be equipped with a high-speed/high-shear, collodial mixer or a high-velocity/high pressure venturi jet mixer used in conjunction with a high-speed/high-shear centrifugal pump. The Contractor may, at his option, design a concrete pad of sufficient size and with sufficient berms around the edges for mixing slurry with a bulldozer. The Contractors reasons and rationale for selecting the mixing method and equipment shall be included in the Slurry Trench Construction Method and Equipment submittal (or the Slurry Trench Implementation Plan submittal). The plant shall be equipped with a mechanically or hydraulically agitated sump and shall include pumps, valves, hoses, supply lines, tools, and other equipment and materials required to prepare the slurry and deliver it in a continuous supply from the hydration pond to the extraction trench. The Contractor shall have sufficient ponds and pits for storage of hydrated polymer slurry. The ponds and pits shall be mechanically or hydraulically agitated. No slurry is to be made in the trench.

10.3 Field Laboratory Equipment. Field laboratory equipment will be that specified in SECTION 02214: SOIL BENTONITE SLURRY TRENCH CUTOFF.

10.4 Cleaning of Slurry. Slurry cleaning equipment shall include but not be limited to a vibratory shaker screen, centrifugal sand separator, and/or stilling ponds.

10.5 Preparation of Trench Bottom. The bottom of the trench shall be prepared by using crane mounted clamshell or jet pipes, air lift pumps, vibrating shaker screens, probe pipes, and necessary pipes, hoses, and fittings or other suitable equipment.

10.6 Placing Backfill. The equipment used for the placing of the backfill material, including but not limited to bulldozers, tremie pipes and haul trucks shall be suitable for placement of the backfill material in the trench as specified herein. All placement of filter backfill in the trench shall be by tremie pipe and shall prevent free fall, segregation, and entrapment of slurry. Soil backfill shall be placed by equipment approved by the Contracting Officer.

11. EXTRACTION TRENCH ~~CONSTRUCTION~~EXCAVATION.

11.1 General. The extraction trench shall be constructed to the elevations, lines, grades, and cross-sections shown on the drawings and in accordance with these specifications, unless otherwise directed by the Contracting Officer. The Government may modify the dimensions and quantities of the work as determined necessary. The Contractor shall submit a general work sequence schedule and layout plan of operations to the Contracting Officer for approval, a minimum of 8 weeks prior to the start of construction.

11.2 Working Surface. The working surface from which the extraction trench is to be constructed shall be defined in paragraph DEFINITIONS, and shall constitute the top of the ground-water extraction trench for the purpose of measurement for payment. However, the Contractor may construct, at no

expense to the Government, a working surface to a level higher then the defined working surface for his own convenience providing it is approved by the Contracting Officer. There will be no payment for any additional excavation, fill, or ground-water extraction trench required as the result of constructing for the convenience to the Contractor a higher level working surface than the defined working surface. In the event that the static ground water table is encountered at a depth of *(1.0) * ( ) foot or less below the designated working surface, the Contractor shall, at the direction of the Contracting Officer, raise the working surface to a height of *(1), *(3) feet above the measured static ground water level with approved fill material. The working surface thus constructed shall be utilized as a basis for measurement for payment.

11.3 Excavation. The excavation shall be by the slurry method of excavation. Construction shall proceed in such a manner that the up-gradient section of the slurry trench is complete before the down gradient section. This will prevent "damming" of the groundwater at the site that could cause a significant rise in the water level over the site during construction. Excavation shall be conducted in a manner which provides for a continuous 3 ft minimum width trench to the required depth at all points along the centerline of the excavation. The Contractor shall excavate the extraction trench from the working surface. Excavation shall be conducted by the slurry method. The excavation shall be carried immediately to the minimum depth shown on the drawings at the point where excavation is started. The Contracting Officer may direct the Contractor to deepen the trench based on examination of bucket cuttings or drive samples taken at specified locations. The toe of the slope of the trench excavations shall not precede the toe of the backfill slopes by less than *(50) * ( ) feet or more than *(105) * ( ) feet. The trench excavation shall be enlarged and deepened as necessary to accomodate the pre-fabricated wet well. The extraction trench shall be constructedexcavated without undue interruption until complete. If for a reason approved by the Contracting Officer, it is necessary for a slurry trench boundary to be constructed in more than one straight line segment, reexcavation of a section of the previously constructed slurry trench backfill material will be required at points of intersection. The reexcavation of the placed backfill shall consist of the removal of I0 feet perpendicular to the slope of the backfill for the full depth of the slurry trench. That section of the slurry trench backfll material that is removed and rebackfilled shall be considered incidental to the slurry trench cutoff pay item. A minimum overlap length of 2 feet throughout the entire depth of backfill shall be constructed at any slurry trench corner to obtain continuous trench backfill through the entire length of the slurry trench.

11.4 NOT USED. Bedrock Excavation. The bedrock excavation shall be carried the full width of the trench to the depths shown on the drawings or as otherwise directed by the Contracting Officer. *(Any *(sandstone) * ( ) lenses encountered at the minimum excavation depth shall be removed for the full width of the trench and into the underlying impervious stratum.) The bedrock shall then be sampled in accordance with subparagraph Samples of Impervious Stratum . Termination of excavation will be approved by the Contracting Officer.

11.5 NOT USED. Blasting. Any blasting shall be approved by the Contracting Officer. Blasting shall be conducted in accordance with an approved blasting plan. The blasting plan shall include hole spacings and

depths, loading, delay sequence, type of explosives, safety program, and any other pertinent information that will be necessary for the Contracting Officer's evaluation. Explosive materials shall *(shall not) be stored on the site. *(Onsite storage shall be at .) *(A drawing showing the top and bottom elevations of the *(sandstone) * ( ) at each blasting drill hole shall be submitted to the Contracting Officer.)

11.6 Placement of Slurry. Slurry shall be introduced into the trench at the time excavation begins. The level of the slurry in open trenches shall be at all times maintained a minimum of 5 feet above ground water level and no more than 1 foot below the working surface until the placement of backfill material is complete. The Contractor shall have sufficient personnel, equipment, slurry storage areas, and stored slurry materials ready to raise the slurry level at all times in the excavated trench during construction within the limitations specified in this subparagraph. To this end, the Contractor shall have personnel on call to raise the slurry level at any time this occurs, weekends and/or holidays included. Dilution of slurry by surface waters shall be prevented. The Contractor shall take all precautionary measures necessary to minimize damage to the work from groundwater and surface water. The quality of the slurry shall be maintained at all times, including periods of work stoppage, in a condition which meets the requirements set forth in subparagraph Polymer Slurry. Conditioning of the slurry may require recirculation through shaker screens or the addition of approved additives.

11.7 Excavated Material. Material excavated from the trench shall not be used in the backfill. Material not used in the backfill shall be placed inside the Lime Basins.

11.8 NOT USED. Backfilling Trench in Case of High Water. In the event the ground water rises or is expected to rise to within 3 feet of the top of the working surface, the Contracting Officer reserves the right to require the Contractor to stop excavation and to begin continuous operations to either dike around the open trenches and raise the slurry levels or to fill all or part of the open trenches with slurry trench backfill mixed and placed as specified in subparagraph Backfilling. Continuous operations shall consist of expeditiously performing the required operations twenty-four hours per day until the operations are completed or the water level falls to a depth of more than 3 feet below the top of the working surface.

11.9 Stability. The Contractor shall be responsible for insuring and maintaining the stability of the excavated trench at all times for its full length and depth and shall be responsible for maintaining slurry densities and levels within specified limits. The Contractor shall control surcharges from all excavation and backfilling equipment, waste, berm construction, backfill stockpiles, and any other loading situations that may affect trench stability. It is the Contractor's sole responsibility to ensure that any stockpiles do not affect the open trench stability. Slopes of stockpiles and excavated material shall be no steeper than 1 Vertical to 2 Horizontal and no higher than 10 feet above the working surface. In the event of failure of the trench walls prior to completion of backfilling, the Contractor shall at his expense reexcavate the trench and remove all material displaced into the trench and take corrective action to prevent further deterioration.

11.10 Treatment of Trench Bottom.

11.10.1 NOT USED. Treatment of Rock Surface.

NOTE: IF SLURRY TRENCH IS TO EXTEND TO OR INTO ROCK THE SPECIFY ANY SPECIAL TREATMENT OF THE ROCK BEYOND THAT CALLED FOR BELOW; I.E., GROUTING.

11.10.2 Cleaning. Trench bottom shall be cleaned by an air lift pump or other suitable equipment to insure removal of all sand, gravel, sediment, and any other material left in the trench during excavation and/or which has settled out of the slurry. After the Contractor cleans the trench bottom by removing all loose rock and gravel, he shall then probe the trench bottom for possible potholes, cracks, and crevices. Such depressions shall be cleaned out by *(air lifting) * ( ). All cleaning equipment shall be operated in such a manner to prevent removal of materials from the walls of the trench. The Contracting Officer will supervise the cleaning and probing operations and may require additional cleaning as he deems necessary.

11.10.3 NOT USED. Sampling. After the trench bottom has been cleaned thoroughly, the Contractor shall sample the trench bottom with a *(split-spoon sampler) * ( ) approved by the Contracting Officer. Rock surfaces that cannot be penetrated by a split-spoon sampler shall not be required to be sampled. After examining the samples, the Contracting Officer will either approve the termination of excavation at the points checked or require additional excavation. If additional excavation is required, then additional samples shall be furnished by the Contractor as specified above.

11.10.4 Preparation. The bottom of the trench shall be sounded in the presence of the Contracting Officer to determine the nature of material on the bottom of the trench before backfilling operations. The soil-bentonite backfill shall key into the designated stratum with removal of all loosened excavation and settled materials, such as sand. The final elevation of the bottom of the trench shall be approved by the Contracting Officer.

11.11 Backfilling.

11.11.1 Placing. Prior to placing the filter backfill material, the existing slurry in the trench shall be replaced with new slurry. The filter backfill material shall be placed by tremie pipe in the excavated trench in such a manner that no pockets of slurry are trapped in the completed extraction trench. The Contractor shall place 1 foot of graded filter backfill on the bottom of the trench prior to placing the drain pipe and lift station. After the placement of the drain pipe and lift station the remainder of the graded filter backfill shall be placed in two 3-foot lifts. The Contractor shall backfill continuously from the beginning of the trench in the direction of the excavation to the end of the trench. Placing operations shall proceed in such fashion that the top of the backfill below the surface of the slurry shall follow a reasonably smooth grade and shall not have hollows which may trap pockets of slurry during subsequent backfilling. To this end, the face of the backfill below the surface of the slurry may require rodding, and the Contractor shall have such equipment available at the job site. Free dropping of graded filter backfill material through the slurry will not be permitted. The method of initial soil-bentonite backfill placement shall be included in the Construction Method and Equipment submittal. Two acceptable alternatives are placing by lowering it to the bottom of the trench with crane and clamshell bucket until the surface of the backfill rises above the surface of the slurry trench at the end of the trench or by the use of clamshell bucket to begin excavation at a point outside of the limits of work which will provide a sufficient distance for the backfill face to form by dozing the backfill into the trench before the toe of the backfill reaches the point

where the slurry trench is required. No payments will be made for the portions of such trenches which lie outside of the limits of work. Backfill shall then be placed in such a manner that the backfill enters the trench by sliding down the forward face of the previously placed backfill. To accomplish this, the Contractor shall backfill from the initial backfill toward the opposite end of the trench. Backfilling operations shall proceed in such a manner that the slope of the initial backfill will be maintained. The new backfill material will be allowed to slide down the slope of the previously placed backfill and shall be placed in such a manner that pockets of slurry will not be trapped during the backfilling. The remaining soil backfilling may be accomplished by the use of bulldozer or other approved equipment and in such a manner that the backfill below the slurry surface will be pushed along the trench. The extraction trench shall have backfill material placed to the lines and grades shown on the drawings.

11.11.2 Placing During Cold Weather. No mixing or placing of the backfill shall be performed when the air temperature is below 20 degrees F. Frozen backfill shall not be placed in the trench.

11.12 Cleanup. Removal of all excavation spoil, unused backfill, and slurry shall be accomplished following completion of final backfilling and trench site grading. These materials will be disposed of inside the Lime Settling Basins as directed by the Contracting Officer.

12. QUALITY CONTROL. The Contractor shall be responsible for project quality control and quality control records. Observation, measurements, and tests described in these specifications shall be performed for quality control. All quality control records, routine testing procedures, observations, and measurements shall be available for inspection by the Contracting Officer's Representative at any time.

12.1 Water. Prior to the start of construction, the source of water to be mixed with the polymer shall be tested for pH, total dissolved solids and oil, organics, acids,alkali and other deleterious substances. Subsequent to the start of construction testing shall be conducted once a month once for every 100 lineal feet of extraction trench. Tests shall conform with the requirements of API Code RP 13B-1.

12.2 Slurry Properties. All tests specified in this paragraph shall be conducted in accordance with API Code RP 13B-1. The polymer slurry shall be tested prior to placing the slurry in the trench a minimum of 2 times each shift per batching plant. The following tests shall be performed: viscosity, filtration, and density. At the time of placing into the slurry-filled trench, the replacement polymer slurry within the trench shall be tested for viscosity, density, and sand content. The polymer slurry in the trench shall be sampled a minimum of 2 times per shift at intervals of every 10 feet of depth and maximum 20 foot horizontal intervals and within 1 foot of the bottom of the trench. The sampling devices and procedures will be in accordance with Appendix G of API RP 13B-1. The Contractor shall be required to obtain additional samples for the government at any time or location requested. Personnel shall be provided by the Contractor for conducting the tests and they must have a working knowledge of test procedures for drilling fluids in accordance with applicable API standard procedures. Equipment for polymer slurry testing shall be furnished and maintained by the Contractor.

12.3 Excavation and Backfill Soundings. The Contractor shall make excavation and backfill soundings every 10 feet along the trench centerline

using a weighted tape, cable, or other devices approved by the Contracting Officer. The soundings at each 10 foot interval shall record the following:

12.3.1 Elevation of Bottom of Excavation. The determination of the bottom of excavation will be made by the Contracting Officer using impervious stratum samples as described under subparagraph Samples of Impervious Stratum. The minimum excavation line is shown on the drawings. The Contractor shall determine the elevation of the bottom of the trench.

12.3.2 Elevation of Bottom Prior to Backfilling. This sounding shall record the thickness of sediments accumulated at the trench bottom. Additional material removal from the trench bottom prior to backfilling may be required by the Contracting Officer. This sounding shall not precede the toe of the soil-bentonite backfill slope more than 50 feet be conducted for the entire reach of the trench.

12.4 Backfill Properties. The graded filter backfill material shall be tested for gradation based on one representative sample for each 25 cubic yards of backfill material prior to placement in the trench, and one representative sample for each 100 cubic yards of soil backfill. Sampling equipment shall be subject to the Contracting Officer's approval and shall be maintained onsite for the duration of the job. Testing of gradation samples shall be by set sieving and shall conform to ASTM C 136.

12.5 Records. Records shall be maintained by the Contractor for all testing, measurements, and inspections performed to ascertain that the groundwater extraction trench construction meets the specifications. Required reports, records, and documentation shall be furnished to the Government daily. The Contractor's required records are outlined below.

12.5.1 As-Built Profile. An as-built profile of the trench bottom, including descriptions of materials encountered in the trench shall be continuously maintained by the Contractor. This profile shall indicate extent of excavation and the profile at the end of each work day, as determined from soundings.

12.5.2 Results. The results of all construction control testing required in these specifications, including water tests, slurry tests, backfill tests, and depth soundings shall be furnished by the Contractor. The Contractor shall furnish records of all observations, measurements, and tests performed, identified with the location and time of testing. These records shall be furnished no later than 24 hours after the tests, measurements, and/or observations were made.

12.5.3 Polymer Slurry Mix. Polymer slurry mix quantities, proportions of all additives utilized, and placement locations into the trench shall be recorded by the Contractor. Any adjustments in the polymer slurry mix shall also be recorded.

12.5.4 Construction Log. The Contractor shall maintain a construction log of daily activities which shall include delays encountered during construction, causes of delays, locations of affected areas, and extent of delays. The log shall also record unusual conditions or problems encountered, and the dispositions made.

13. QUALITY ASSURANCE. The Government may perform quality assurance testing on the polymer slurry and backfill materials using the laboratory and equipment furnished by the Contractor. The Government testing will in no way relieve the Contractor of the responsibility of performing tests necessary to meet the construction requirements. The Contractor shall provide the

equipment and laboratory space to government personnel on demand and these services shall be considered a subsidiary obligation of the groundwater extraction trench construction. All routine testing procedures being conducted by the Contractor shall be available for inspection by the Contracting Officer at any time.

14. EXTRACTION EQUIPMENT. Piping and related equipment to extract groundwater is specified in SECTION: COLLECTION DRAIN SYSTEM and SECTION: LIFT STATION.

15. MEASUREMENT.

15.1 Lines and Grades. The ground-water extraction trench shall be constructed to the elevations, lines, grades, and cross sections shown on the drawings, unless otherwise directed by the Contracting officer. The Government reserves the right to modify the elevations, lines, grades, and/or cross sections as may be determined necessary by the Contracting Officer.

15.2 Ground-Water Extraction Trench. Measurement for Ground-Water Extraction Trench shall be based on the area in square feet of polymer slurry measured in a vertical plane through the centerline of the trench within the boundaries established by the working surface as defined in subparagraph Working Surface, the bottom of the excavated trench as approved, and vertical lines at each end of the approved full depth of the excavated trench. Measurement shall be based on surveys and soundings taken at the site as directed and approved by the Contracting Officer.

16. PAYMENT. Payment for Ground-Water Extraction Trench measured as specified hereinbefore shall be made at the contract unit price per square foot. Such price shall include all costs of stripping, excavating by the slurry method of excavation, cleaning the trench bottom, spoiling excavated materials, obtaining backfill materials, placing the extraction trench backfill, and all other items incidental to the construction and completion of the extraction trench. No separate payment will be made for slurry materials including polymer, additives, equipment and handling and cleaning the slurry, diking around the open trench, and overtime during continuous operations, cleanup, and assistance in the collection and maintenance of records; such items being included in the price of ground-water extraction trench.

ZERO ACCIDENTS

SECTION 02410
SUBDRAINAGE COLLECTION DRAIN SYSTEM

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#(N)#

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.**

RR-F-621	Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
SS-C-1960/3B	Cement, Portland
SS-L-351B	Lime: Hydrated (for) Structural Purposes
WW-P-402C & Am-1	Pipe, Corrugated (Aluminum Alloy)
WW-P-405B & Am-1	Pipe, Corrugated (Iron or Steel, Zinc Coated)

1.2. **DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, HANDBOOK FOR CONCRETE AND CEMENT.**

CRD-C 41-81	Air Content of Freshly Mixed Concrete by the Pressure Method
CRD-C 575-74	Change in Weight of Rubber on Immersion in Water

1.3. **AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO) STANDARDS.**

M 45-83I	Aggregate for Masonry Mortar
M 65-80	Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated
M 86-83I	Concrete Sewer, Storm Drain, and Culvert Pipe
M 175-82	Perforated Concrete Pipe
M 178-84	Concrete Drain Tile
M 179-84	Clay Drain Tile
M 246-86	Precoated Galvanized Steel Sheet for Culverts and Underdrains
M 252-85	Corrugated Polyethylene Drainage Tubing
M 278-81	Class PS 50 Polyvinyl Chloride (PVC) Pipe

(R 1986)

M 294-86	Corrugated Polyethylene Pipe, 12 to 24 in. Diameter

#(N)#

1.4. **AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS.**

A 227-83	Steel Wire, Cold-Drawn for Mechanical Springs
A 229-83	Steel Wire, Oil-Tempered for Mechanical Springs
C 4-62 (R 1986)	Clay Drain Tile
C 14-82	Concrete Sewer, Storm Drain and Culvert Pipe
C 141-85	Hydraulic Hydrated Lime for Structural Purposes
C 412-83	Concrete Drain Tile
C 425-86	Compression Joints for Vitrified Clay Pipe and Fittings
C 444-80	Perforated Concrete Pipe
C 654-82	Porous Concrete Pipe
C 700-88	Porous Concrete Pipe Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
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-inch (457 mm) Drop
D 1682-64 (R 1975)	Breaking Load and Elongation of Textile Fabrics
D 1683-81	Failure in Sewn Seams of Woven Fabrics
D 1751-83	Preformed Expansion Joint Filler 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
D 2167-84	Density and Unit Weight of Soil In-Place by the Rubber-Balloon Method
D 2487-85	Classification of Soils for Engineering Purposes
D 2751-83a	Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
D 2922-81	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D 3017-78	Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D 3034-85b	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D 3212-86	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
F 405-85	Corrugated Polyethylene (PE) Tubing and Fittings
F 667-85	Large Diameter Corrugated Polyethylene Tubing

	and Fittings
F 758-82	Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
F 949-86a	Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

2. **DELIVERY, STORAGE, AND HANDLING OF MATERIALS.**

2.1. **DELIVERY AND STORAGE.** Materials delivered to site shall be inspected for damage, unloaded, and stored with the minimum of handling. Materials shall not be stored directly on the ground. Inside of pipes and fittings shall be kept free of dirt and debris. [During shipment and storage, filter fabric shall be wrapped in burlap or similar heavy duty protective covering. The storage area shall be such that the fabric is protected from mud, soil, dust, and debris. Filter fabric materials that are not to be installed immediately shall not be stored in the direct sunlight.] Plastic pipe shall be protected from exposure to direct sunlight over extended periods.

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

3. **STRENGTH TESTS OF PIPE.** to determine conformance with the crushing strength requirements specified in the applicable specifications for subdrains shall be the three-edge bearing test for clay, concrete, and porous concrete pipe.

#(N)#

4. **NOT USED.**

#(N)#

5. **PIPE FOR COLLECTION DRAIN** SUBDRAINS shall be as indicated and shall conform to the requirements for the pertinent type or types in the following lists:

5.1. NOT USED. CONCRETE PIPE shall be either standard or extra strength as indicated and shall conform to ASTM Specification C 14 or AASHTO Standard M 86.

5.2. NOT USED. CLAY PIPE shall be either standard strength or extra strength as indicated. Standard strength pipe shall conform to AASHTO Standard M 65 or ASTM Specification C 700. Extra-strength pipe shall conform to AASHTO Standard M 65 or ASTM Specification C 700.

5.3. NOT USED. PERFORATED CONCRETE PIPE shall be either standard or extra strength as indicated and shall conform to ASTM Specification C 444 or AASHTO Standard M 175.

5.4. NOT USED. PERFORATED CLAY PIPE shall be either standard or extra strength and shall conform to AASHTO Standard M 65 or ASTM Specification C 700. Plain-end pipe conforming to the strength and perforation requirements of AASHTO Standard M 65 or ASTM Specification C 700 will also be acceptable if provided with spring wire clips of approved type to maintain a taut but elastic joint between the sections of pipe when laid. Clips shall be constructed of not smaller than No. 9 hard-drawn or oil-tempered steel wire conforming to ASTM Specification A 227 or A 229, and shall be coated with a japan enamel or other approved rust preventive. Wire clips shall withstand 25 cycles of alternate loading and unloading using a stressing force of 125 pounds. The permanent set resulting from this test shall be less than 5 percent, based on the original

length of the fastener. Compression joints conforming to ASTM C 425 will also be acceptable.

5.5. NOT USED. PERFORATED CORRUGATED-STEEL PIPE shall conform to Fed. Spec. WW-P-405. Gage of pipe shall be as indicated.

5.6. NOT USED. PERFORATED CORRUGATED-STEEL PIPE, FULLY BITUMINOUS COATED, shall conform to the applicable portions of Fed. Spec. WW-P-405. Gage of pipe shall be as indicated.

#(N)#

5.7. NOT USED. DRAIN TILE. Clay drain tile shall conform to ASTM Specification C 4 or AASHTO Standard M 179. Concrete drain tile shall conform to ASTM Specification C 412 or AASHTO Standard M 178, standard, extra, or special quality.

5.8. NOT USED. POROUS CONCRETE PIPE shall conform to ASTM C 654 standard or extra strength as indicated.

#(N)#

5.9. NOT USED. PERFORATED CORRUGATED ALUMINUM ALLOY PIPE shall conform to Fed. Spec. WW-P-402. Sheet thickness or gage of pipe shall be as indicated.

#(N)#

5.10. NOT USED. PERFORATED CORRUGATED ALUMINUM ALLOY PIPE, FULLY BITUMINOUS COATED shall conform to the applicable portions of Fed. Spec. WW-P-402. Sheet thickness or gage of pipe shall be as indicated.

5.11. NOT USED. PRECOATED CORRUGATED STEEL PIPE shall conform to Fed. Spec. WW-P-405, class 1 or II shape 1 precoated as required by AASHTO M 246.

5.12. **PLASTIC PIPE.** Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight. The piping shall be capable of withstanding a load of 40 psi, with deflection of < 5%.

5.12.1. NOT USED. Acrylonitrile-Butadiene-Styrene (ABS) Piping. Acrylonitrile-butadiene-styrene (ABS) piping and fittings shall conform to ASTM D 2751, with maximum SDR of 35.

5.12.2. Polyvinyl Chloride (PVC) Pipe and Fittings. Polyvinyl Chloride (PVC) pipe and fittings shall conform to ASTM D 3034 [F 949,] [F 758, Type PS 46]] or [AASHTO M 278 with a minimum pipe stiffness of 46].

5.12.3. **Corrugated Polyethylene (PE) Pipe and Fittings.** Use either [ASTM F 405 for pipes 3 to 6 inches in diameter, inclusive, ASTM F 667 for pipe 8 to 24 inches in diameter] or [AASHTO M 252 for pipes 3 to 10 inches, M 294 for pipes 12 to 24 inches in diameter]. Fittings shall be manufacturer's standard type and shall be capable of withstanding the stress asscociated with the installation of the pipe conform to the indicated specification.

5.12.4. **Pipe Perforations.** Water inlet area shall be a minimum of 0.5 square inch per linear foot. Manufacturer's standard perforated pipe which essentially meets these requirements may be substituted with prior approval of the Contracting Officer.

5.12.4.1. **Circular Perforations in Plastic Pipe.** Circular holes shall be cleanly cut not more than 3/8 inch or less than 3/16 inch in diameter and arranged in rows parallel to the longitudinal axis of the pipe. perforations shall be approximately 3 inches center-to-center along rows. The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The rows shall be spaced over not more than 155 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for

a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.

5.12.4.2. **Slotted Perforations in Plastic Pipe.** Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Piping slot size shall be No. 20 slots similar to those used in well piping. The slots shall be symetrically spaced around the entire circomference of the pipe. Width of slots shall not exceed 1/8 inch nor be less than 1/32 inch. The length of individual slots shall not exceed 1-1/4 inches on 3-inch diameter tubing, 10 percent of the tubing inside nominal circumference on 4- to 8-inch diameter tubing, and 2-1/2 inches on 10-inch diameter tubing. Rows of slots shall be symmetrically spaced so that they are fully contained in 2 quadrants of the pipe. Slots shall be centered in the valleys of the corrugations of profile wall pipe.

#(N)#

6. NOT USED. FILTER CLOTHS shall consist of woven or nonwoven pervious sheets fabricated from a plastic material having a satisfactory record of service in this type of use. Seams shall be sewn with yarns of the same material and have a tensile strength determined by ASTM Method D 1683 equal to or greater than the weakest tensile strength of the cloth. The filter cloth shall have physical characteristics as determined by the indicated tests in the following table:

PHYSICAL CHARACTERISTICS OF FILTER CLOTH

Grab Method, ASTM Specification D 1682

Minimum tensile strength:	[175] [___] lb in the stronger direction
	[100] [___] lb in the weaker direction
Maximum elongation:	[30] to [70] percent
Special Test:	
Apparent opening size	U S. Standard Sieve No. _____
Special Test:	
Open area	_____ percent

Percent open area (POA) is not applicable to nonwoven filter cloth.

#(N)#

7. **MATERIALS FOR DRAINAGE STRUCTURES.**

7.1. NOT USED. CONCRETE. Unless otherwise specified, concrete and reinforced concrete shall have a minimum compressive strength of 3,000 psi at 28 days age and shall conform to the requirements in SECTION: CONCRETE FOR BUILDING CONSTRUCTION. The concrete mixtures shall have air content, by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent. Air content shall be determined in accordance with Corps of Engineers Handbook CRD-C 41. The concrete covering over steel reinforcing
shall be not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall be at least 3 inches thick between the steel and the ground. Expansion-joint filler material shall conform to ASTM Specification D 1751 or D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM Specification D 1752.

#(N)#

7.2. NOT USED. MORTAR for pipe joints and connections to other drainage structures shall be composed of 1 part by volume of Portland cement and 2 parts

of sand. The Portland cement shall conform to Fed. Spec. SS-C-1960/3, Type IA or IIA. The sand shall conform to the requirements of AASHTO Standard M 45. Hydrated lime may be added to the mixture of sand and cement in an amount equal to 5 percent, by volume, of cement used. Hydrated lime shall conform to Fed. Spec. SS-L-351, type F, or to ASTM Specification C 141. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar, but shall in no case exceed 7 gallons of water per sack of cement. Water shall be clean and free of injurious acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes from the time the ingredients are mixed with water.

7.3. NOT USED. FRAMES AND COVERS. Frames and covers shall be cast gray iron, class 35B or cast ductile iron, Grade 65-45-12 and shall conform to Fed. Spec. RR-F-621. Weight, shape, and size shall be as indicated. Frames and covers shall have a minimum transverse proof-load strength of 25,000 pounds.

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8. **GRANULAR SUBDRAIN FILTER MATERIAL.** Filter material shall be washed sand, sand and gravel, crushed stone, crushed-stone screenings, or slag composed of hard, tough, durable particles free from adherent coating. Filter material shall not contain corrosive agents, organic matter, or soft, friable, thin, or elongated particles in quantities considered deleterious by the Contracting Officer and shall meet the gradation requirements listed in Table 1 herein. Filter materials shall be uniformly graded between the limits specified in Table 1. Points on the individual grading curves obtained from representative samples of filter materials not only shall lie between the boundary limits as defined by smooth curves drawn through the tabulated grading limits plotted on a mechanical-analysis diagram, but also shall exhibit no abrupt changes in slope denoting skip grading, scalping of certain sizes, or other irregularities that would be detrimental to the proper functioning of the filter. Filter materials shall be clean and free from soil slurries and foreign materials. Filter material found to be dirty or otherwise contaminated after installation shall be removed and replaced with satisfactory material by the Contractor at no expense to the Government.

TABLE 1. FILTER MATERIAL FOR SUBDRAINS

Sieve Designation	Percentages by Weight Passing Square-Mesh Sieves
1-1/2"	100
1/2"	80-100
1/4"	70-85
No. 10	55-75
No. 20	35-65
No. 40	15-50
No. 100	0-10
No. 200	0-5

BACKFILL MATERIAL. Backfill material is specified in SECTION: GROUND WATER EXTRACTION TRENCH.

9. **EXCAVATION AND BACKFILLING FOR DRAINAGE STRUCTURES** shall be as specified in paragraphs on TRENCHING AND BEDDING FOR SUBDRAINS and INSTALLATION OF FILTER MATERIAL AND BACKFILLING FOR SUBDRAINS.

#(N)#

10. **DRAINAGE STRUCTURES** shall be of the following types and shall be constructed of the materials specified for each type and in accordance with the indicated details.

10.1. **LIFT STATION** shall be constructed of 36-inch diameter polyethylene pipe as described in SPECIFICATION: LIFT STATION. cast-in-place or precast reinforced concrete, and shall be complete with frames and covers and with fixed galvanized steel ladders, as indicated.

10.2. **OBSERVATION RISERS** shall be constructed of non-perforated pipe of the same material as that used for the subdrain pipe, complete with frames and covers, as indicated.

11. **INSTALLATION OF FILTER CLOTH AND PIPE FOR SUBDRAINS.**

11.1. NOT USED. INSTALLATION OF FILTER CLOTH.

11.1.1. NOT USED. Overlaps on Pipes. One layer of filter cloth shall be wrapped around perforated or slotted collector pipes in such a manner that longitudinal overlaps of cloth are in unperforated or unslotted quadrants of the pipes. The overlap shall be about 2 inches. The cloth shall be secured to the pipe in such a manner that backfill material will not infiltrate through any cloth overlaps.

#(N)#

11.1.2. NOT USED. Joints. One layer of filter cloth shall be wrapped around open pipe joints. The overlap should be about 2 inches. The cloth shall be secured to the pipe in such a manner that backfill material will not infiltrate through the overlap or the edges of the cloth to either side of the joint.

#(N)#

11.1.3. NOT USED. Trench Lining and Overlaps. Trenches to be lined with filter cloth shall be graded to obtain smooth side and bottom surfaces so that the cloth will not bridge cavities in the soil or be damaged by projecting rock. The cloth shall be laid flat but not stretched on the soil, and shall be secured with anchor pins. Overlaps shall be _____ inches and anchor pins shall be used along the overlaps.

#(N)#

11.1.4. NOT USED. Protection from Exposure to Sun. Prior to and during installation, the cloth may be exposed to sunlight no more than _____ day(s). All filter cloth installations shall be inspected and approved by the Contracting Officer before backfilling, and any defective or damaged cloth shall be rejected. Backfill shall be that specified for subdrains, shall be placed as indicated, and shall be of composition specified in paragraph: GRANULAR SUBDRAIN FILTER MATERIAL.

11.2. **PIPELAYING.** The piping and lift station shall be attached above ground and shall be gradually lowered into the trench through the slurry in one continuous piece. All joints in the pipe shall be welded. Each joint shall be carefully inspected to insure that it can withstand the stress associated with the installation process. Each pipe shall be carefully inspected before it is laid. Any defective or damaged pipe shall be rejected. The laying of pipe shall proceed upgrade beginning at the lower end of the pipeline. Centering devices shall be placed on the pipe at 30 ft. intervals. No pipe shall be laid when the trench conditions or weather is unsuitable for such work. Full responsibility for the diversion of drainage of trenches during construction shall be borne by

the Contractor. Pipe shall be laid to the grades and alinement as indicated. The pipe shall be bedded to the established gradeline. Pipe of either the bell-and-spigot type or the tongue-and-groove type shall be laid with the bell or groove end upstream. All pipe in place shall be approved before backfilling.

11.3. JOINTING.

11.3.1. NOT USED. Nonperforated Concrete and Clay Pipe shall be laid with 1/8- to 1/4-inch opening between ends of pipe, or as required by spacing lugs constructed in the pipe. Three small portions of mortar mix, composed of one part cement and not more than two parts sand, shall be placed in the joint and pressed firmly into place to hold the pipe securely in line. The mortar shall be the full depth of the bell or groove and approximately 1 inch in width, and shall be located at the third points around the joint with the top point at the center of the pipe. The inside of the pipe shall be free of excess mortar.

11.3.2. NOT USED. Perforated Concrete and Clay Pipe shall be laid with closed joints with positive position for centering each section of the pipe in the bell or groove of the previously placed section. Plain-end perforated clay pipe sections shall be securely fastened together with spring wire clips furnished by the pipe manufacturer.

11.3.3. NOT USED. Perforated Corrugated-Metal Pipe, or Unpaved Bituminous- Coated, Perforated Corrugated-Metal Pipe. The sections of perforated corrugated-metal pipe or bituminous-coated, perforated corrugated-metal pipe shall be securely fastened together with standard connecting bands and bolts furnished by the manufacturer of the pipe.

11.3.4. NOT USED. Drain Tile shall be bedded as provided for bell-and-spigot or tongue-and-groove types of pipe and laid with open joints of approximately 1/8-inch width, but not over 1/4-inch width. Drain tile shall be protected against the entrance of filter material into the line by the use of woven filter cloth, roofing paper, burlap, or similar material placed over at least the top 180 degrees of the tile.

11.3.5. NOT USED. Porous Concrete Pipe shall be installed with cemented joints.

11.3.6. NOT USED. Acrylonitrile-Butadiene-Styrene (ABS) Piping. Solvent cement or elastomeric joints for ABS pipe shall be in accordance with ASTM D 2751, dimensions and tolerances in accordance with Table 2 therein.

11.3.7. **Poly(Vinyl Chloride) (PVC) Pipe.** Joints shall be solvent welded in accordance with the requirements of ASTM D 3212 2855, Standard Recommeded Practice for making Solvent Cemented Joints with PVC Pipe and Fittings.

11.3.8. **Corrugated Polyethylene (PE) Tubing Piping and Fittings.** Joints shall be in accordance with manufacturers recommendations. the requirements of ASTM F 405.

11.3.8.1. Connection to Polyethylene Lift Station. The lift station shall be as decribed in SECTION: LIFT STATION. The lift station shall be provided with a six inch fitting to be connected to the collection drain piping. The method of connection of the collection drain to the lift station shall be in accordance with the pipe manufacturer's and lift station manufacturers recommendations. The Contractor shall provide the means and fittings necessary for a secure connection between the manhole and collection drain. The connection shall be capable of withstanding any stress encountered during the installation of the lift station and collection drain.

#(N)#
12. NOT USED. INSTALLATION OF AND BACKFILLING FOR BLIND OR FRENCH DRAINS. Blind or french drains shall be backfilled with filter materials specified hereinafter for subdrains. The filter material shall be placed as indicated or specified and shall be compacted as specified in paragraph: INSTALLATION OF FILTER MATERIAL AND BACKFILLING FOR SUBDRAINS. The filter material shall extend to a suitable outlet or to an outlet through a pipeline as indicated or as specified. Overlying backfill material shall be compacted as specified hereinafter for subdrains.

#(N)#
13. INSTALLATION OF FILTER MATERIAL AND BACKFILLING FOR COLLECTION DRAIN SUBDRAINS. Filter material shall be placed in the trench as described in SECTION: GROUND WATER EXTRACTION TRENCH. After pipe for subdrains has been laid, inspected, and approved, filter material shall be placed around and over the pipe to the depth indicated.

13.1. NOT USED. COMPACTION. The filter material shall be placed in layers not to exceed 8 inches, and each layer shall be saturated by flooding, and shall be thoroughly compacted by mechanical tampers or rammers. The remainder of the trench backfill shall be placed as follows:

Under Pavements - Not more than six-inch layers, with at least 90 percent maximum density for cohesive soils and at least 95 percent maximum density (as defined in ASTM D 1557) for cohesionless soils up to the elevations at which the requirements for pavement subgrade materials and compaction control.

All Other Areas - Not more than twelve-inch layers, with at least 85 percent maximum density for cohesive soils and at least 90 percent maximum density for cohesionless soils (as defined in ASTM D 1557).

Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. When results of compaction tests for moisture-density relationships 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. Where greater compaction requirements are specified elsewhere for protection of overlying pavements or structures, the same requirements shall apply to the backfill around or over subdrain under such pavements or structures. Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. Tests shall be performed in an approved sufficient number to insure that the specified density is being obtained. At least one density test shall be made for each layer of fill for each [1000] [_____] sq. yds. or less of trench. The soil density test shall be performed in the field in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922 and D 3017. When ASTM D 2922 is used, the

calibration curves shall be checked, and adjusted if necessary, using the sand cone method as described in paragraph "Calibration" of ASTM D 2922. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with the density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Contracting Officer. If ASTM D 2922 is used for field density control, there should be at least one test performed according to ASTM D 1556 per every 10 tests performed according to ASTM D 2922 for correlation of test results. The moisture-density relationships shall be determined in the laboratory by the Contractor's testing laboratory in accordance with ASTM D 1557, Method B, C, or D. A moisture-density test series shall be performed for each principal type of material or combination of materials encountered or utilized. Construction equipment shall be operated in such manner that no damage to the pipe will result. Where so directed, any sheeting and/or portions of the bracing used shall be left in place, and the contract price will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

14. **TRENCHING AND BEDDING FOR COLLECTION DRAIN SUBDRAINS.** Shall be as described in SECTION: GROUNDWATER EXTRACTION TRENCH.

14.1. TRENCHING in width and depth shall be as indicated.
#(N)#

14.2. NOT USED. REMOVAL OF ROCK. Rock in either ledge or boulder formation shall be removed to the depth necessary to provide space for placement of the specified depth of filter material. Rock excavation shall be as specified and defined in SECTION: EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES SYSTEMS.
#(N)#

14.3. NOT USED. REMOVAL OF UNSUITABLE MATERIAL. Removal of unsuitable material shall be as specified and defined in SECTION: EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

14.4. NOT USED. BEDDING SURFACE shall provide a firm foundation of uniform density. Each section of pipe shall rest upon the pipe bed for its full length, with recesses excavated to accommodate bells and joints. Subdrains shall be placed on the natural soil foundation or on filter material, as indicated. The filter material shall be graded and compacted as specified in paragraph: INSTALLATION OF FILTER MATERIAL AND BACKFILLING FOR SUBDRAINS.

14.5. NOT USED. PROTECTION OR REMOVAL OF UTILITY LINES. Existing utility lines that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation and that are to be retained, as well as utility lines constructed during excavation operations, shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired by the Contractor at his expense. In the event that the Contractor damages any existing utility lines that are not shown on the drawings or the locations of which are not known to the Contractor, report thereof shall be made immediately to the Contracting Officer. If the Contracting Officer determines that repairs shall be made by the Contractor, such repairs will be made in accordance with the clause Entitled "Changes" of the CONTRACT CLAUSES. When utility lines that

are to be removed are encountered within the area of operations, the Contractor shall notify the Contracting Officer in ample time for the necessary measures to be taken to prevent interruption of the service.

15. **FLUSHING OF COLLECTION DRAIN.** Upon satisfactory completion of the installation of collection drain, the Contractor shall flush the collection drain with water. The source water shall be the same as was mixed with the polymer as specified in SECTION: GROUNDWATER EXTRACTION TRENCH. Any sediments washed to the lift station shall be removed by means of an air lift pump. The sediments and water generated from the flushing of the collection drain activities shall be handled and disposed of in accordance with SECTION: HANDLING AND DISPOSAL OF CONTAMINATED MATERIALS.

January 1989

ZERO ACCIDENTS

SECTION 02430
STORM-DRAINAGE SYSTEM

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#(N)#

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.).**

HH-G-156d & Int. Am-1 (GSA-FSS)	Gasket Material, General Purpose; Rubber Sheets, Strips, and Special Shapes
RR-F-621	Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
RR-S-1301	Safety Equipment, Climbing
SS-S-210A	Sealing Compound, Preformed Plastic, For Expansion Joints and Pipe Joints

1.2. NOT USED. FEDERAL STANDARD (Fed. Std).

No. 601 & Change Notices 1 thru 7	Rubber: Sampling and Testing

1.3. **AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO) PUBLICATIONS.**

M 33-81	Preformed Expansion Joint Filler for Concrete (Bituminous Type)
M 36-86	Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
M 64-84	Ductile Iron Culvert Pipe
M 65-80 (R 1986)	Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated
M 86-83	Concrete Sewer, Storm Drain, and Culvert Pipe
M 167-84	Structural Plate for Pipe, Pipe Arches, and Arches
M 170-85	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

M 190-80 (R 1986)	Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
M 196-84	Corrugated Aluminum Alloy Culverts and Underdrains
M 198-75 (R 1986)	Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
M 199-85	Precast Reinforced Concrete Manhole Sections
M 206-85	Reinforced Concrete Arch Culvert Storm Drain, and Sewer Pipe
M 219-84	Aluminum Alloy Structural Plate for Field Bolted Conduits
M 243-81 (R 1986)	Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
M 245-86	Corrugated Steel Pipe, Polymer Precoated, for Sewers and Drains
M 246-86	Sheet Metal, Metallic-Coated and Polymer Precoated for Corrugated Steel Pipe
M 252-85	Corrugated Polyethylene Drainage Tubing
M 259-84	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
M 273-86	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers With Less Than 2-ft of Cover Subject to Highway Loadings
M 294-86	Corrugated Polyethylene Pipe, 12- ,to 24-in

1.4. NOT USED. AMERICAN CONCRETE INSTITUTE (ACI) PUBLICATION.

ACI 346-81	Specifications for Cast-in-Place Nonreinforced Concrete Pipe

1.5. NOT USED. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARD.

A 14.3-74	American National Standard Safety Requirements for Fixed Ladders

1.6. NOT USED. AMERICAN RAILWAY ENGINEERING ASSOCIATION (AREA) PUBLICATION.

Manual for Railway Engineering (Fixed Properties) (Current to July 31, 1985)

1.7. **AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS.**

A 36-87	Structural Steel
A 48-83	Gray Iron Castings
A 615-87	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 123-84	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 307-86a	Carbon Steel Bolts and Studs
A 716-86	Ductile Iron Culvert Pipe
A 798-82	Practice for Installing Factory-Made Corrugated Steel Sewer Pipe
A 807-82	Practice for Installing Corrugated Steel Structural Plate Pipe for Sewers
A 849-85	Post Coated (Bituminous) Corrugated Steel Sewer and Drainage Pipe
C 12-86	Installing Vitrified Clay Pipe Lines

C 14-82	Concrete Sewer, Storm Drain and Culvert Pipe
C 33-86	Concrete Aggregates
C 76-85a	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C 94-83	Ready-Mixed Concrete
C 150-86	Portland Cement
C 227-87	Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
C 231-82	Air Content of Freshly Mixed Concrete by the Pressure Method
C 260-86	Air Entraining Admixtures for Concrete
C 270-86B	Mortar for Unit Masonry
C 425-86	Compression Joints for Vitrified Clay Pipe and Fittings
C 311-87	Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete
C 443-85a	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
C 478-85a	Precast Reinforced Concrete Manhole Sections
C 494-86	Chemical Admixtures for Concrete
C 500-84	Method of Testing Asbestos-Cement Pipe
C 506-84b	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
C 507-84a	Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
C 700-86 (R 1983)	Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
C 789-85	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
C 850-85a	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers With Less Than 2 ft of Cover Subjected to Highway Loadings
C 618-87	Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
C 666-84	Resistance of Concrete to Rapid Freezing and Thawing
D 1056-85	Flexible Cellular Materials--Sponge or Expanded Rubber
D 1171-86	Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
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-inch (457 mm) Drop
D 1751-83	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
D 1752-84	Preformed Sponge Rubber and Cork Expansion

	Joint Fillers for Concrete Paving and Structural Construction
D 2167-84	Density and Unit Weight of Soil in Place by the Rubber-Balloon Method
D 2321-83a	Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
D 2487-83	Classification of Soils for Engineering Purposes
D 2922-81	Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D 3017-78	Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D 3034-85b	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D 3212-86	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

2. **SUBMITTALS.** In accordance with SECTION: SPECIAL CLAUSES, the Contractor shall submit for approval, the following items required by this section:

2.1. **CATEGORY I.** None.

#(N)#

2.2. **CATEGORY II.** (For information only)
[Hydrostatic Test Results on Sample Joint (Para. 10)]
Pipe Laying Installation Recommendations (Para. 13)

3. **DELIVERY, STORAGE, AND HANDLING OF MATERIALS.**

3.1. **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.

3.2. **HANDLING.** Materials shall be handled in such a manner as to insure delivery to the trench in sound undamaged condition. Pipe shall be carried 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.

#(N)#

4. **NOT USED.**

#(N)#

5. **PIPE FOR CULVERTS AND STORM DRAINS** shall be as indicated and shall conform to requirements for the following pertinent types:

#(N)#

5.1. **REINFORCED CONCRETE PIPE.** ASTM C 76 or AASHTO M 170, Class [I] [II] [III] [IV] [V].

#(N)#

5.2. NOT USED. REINFORCED CONCRETE ARCH CULVERT AND STORM DRAINPIPE. ASTM C 506 or AASHTO M 206, Class [A-II] [A-III] [A-IV].

#(N)#

5.3. NOT USED. REINFORCED CONCRETE ELLIPTICAL CULVERT AND STORM DRAINPIPE. ASTM C 507. Horizontal elliptical pipe shall be Class [HE-A] [HE-I]

[HE-II] [HE-III] [HE-IV]. Vertical elliptical pipe shall be Class [VE-II] [VE-III] [VE-IV] [VE-V] [VE-VI].

#(N)#

5.4. NOT USED. NONREINFORCED CONCRETE PIPE. Nonreinforced concrete pipe shall conform to ASTM C 14 or AASHTO M 86, [Class 1] [Class 2] [Class 3].

#(N)#

5.5. NOT USED. PRECAST REINFORCED CONCRETE BOX SECTIONS. For highway loadings with 2-feet of cover or more or subjected to dead load only, ASTM C 789 or AASHTO M 259; for less than 2-feet of cover subjected to highway loading, ASTM C 850 or AASHTO M 273.

#(N)#

5.6. NOT USED. CAST-IN-PLACE NONREINFORCED CONCRETE CONDUIT. ACI 346, except that testing shall be the responsibility of and at the expense of the Contractor. In the case of other conflicts between ACI 346 and project specifications, requirements of ACI 346 shall govern.

#(N)#

5.7. CLAY PIPE. Clay pipe shall be [standard] [or] [extra strength], as indicated, conforming to ASTM C 700 or AASHTO M 65.

#(N)#

5.8. CORRUGATED STEEL PIPE AND PIPE ARCH. AASHTO M 36, [zinc coated] [aluminum coated] [aluminum-zinc alloy coated], Type [I] [II] with [annular] [helical] corrugations. Sheet thickness and corrugation size of pipe, pipe arch shall be as indicated.

#(N)#

5.9. FULLY BITUMINOUS-COATED, CORRUGATED STEEL PIPE. AASHTO M 190 Type A and AASHTO M 36 [zinc coated] [aluminum coated] [aluminum-zinc alloy coated] Type [I] [II] corrugated steel pipe with [annular] [helical] corrugations. Sheet thickness and corrugation size of pipe, pipe arch shall be as indicated.

#(N)#

5.10. HALF BITUMINOUS-COATED, PART-PAVED, CORRUGATED STEEL PIPE. AASHTO M 190 Type B and AASHTO M 36 [zinc coated] [aluminum coated] [aluminum-zinc alloy coated] Type [I] [II] corrugated steel pipe with [annular] [helical] corrugations. Sheet thickness and corrugation size of pipe, pipe arch shall be as indicated.

#(N)#

5.11. FULLY BITUMINOUS-COATED, PART-PAVED, CORRUGATED STEEL PIPE. AASHTO M 190 Type C and AASHTO M 36 [zinc coated] [aluminum coated] [aluminum-zinc alloy coated] Type [I] [II] corrugated steel pipe with [annular] [helical] corrugations. Sheet thickness and corrugation size of pipe, pipe arch shall be as indicated.

#(N)#

5.12. FULLY BITUMINOUS-COATED, FULLY PAVED, CORRUGATED STEEL PIPE. AASHTO M 190 Type D and AASHTO M 36 [zinc coated] [aluminum coated] [aluminum-zinc alloy coated] Type [I] [II] corrugated steel pipe with [annular] [helical] corrugations. Sheet thickness and corrugation size of pipe, pipe arch shall be as indicated.

#(N)#

5.13. CONCRETE-LINED CORRUGATED STEEL PIPE. AASHTO M 36, zinc coated Type I corrugated steel pipe with [annular] [helical] corrugations and a concrete lining. Sheet thickness and corrugation size of pipe shall be as indicated. The concrete lining shall conform to ASTM A 849.

#(N)#

5.14. **FULLY BITUMINOUS-COATED, CONCRETE-LINED CORRUGATED STEEL PIPE.** AASHTO M 190 Type A and AASHTO M 36 zinc coated Type I corrugated steel pipe with [annular] [helical] corrugations and a concrete lining. Sheet thickness and corrugation size of pipe shall be as indicated. The concrete lining shall conform to ASTM A 849.

#(N)#

5.15. **PRECOATED CORRUGATED STEEL PIPE AND PIPE ARCH.** AASHTO M 245 Type [I] [II] corrugated steel pipe with [annular] [helical] corrugations, fabricated from AASHTO M 246 Type [A] [B] [C] precoated sheet. Sheet thickness and corrugation size of pipe shall be indicated.

#(N)#

5.16. **CORRUGATED ALUMINUM ALLOY PIPE AND PIPE ARCH.** AASHTO M 196 Type [I] [II] with [annular] [helical] corrugations. Sheet thickness and corrugation size of pipe or pipe arch shall be as indicated.

#(N)#

5.17. **FULLY BITUMINOUS-COATED, CORRUGATED ALUMINUM ALLOY PIPE AND PIPE ARCH.** AASHTO M 190 Type A and AASHTO M 196 Type [I] [II] corrugated aluminum alloy pipe with [annular] [helical] corrugations. Sheet thickness and corrugation size of pipe or pipe arch shall be as indicated.

#(N)#

5.18. **FULLY BITUMINOUS-COATED, PART-PAVED, CORRUGATED ALUMINUM ALLOY PIPE AND PIPE ARCH.** AASHTO M 190 Type C and AASHTO M 196 Type [I] [II] corrugated aluminum alloy pipe with [annular] [helical] corrugations. Sheet thickness and corrugation size of pipe or pipe arch shall be as indicated.

#(N)#

5.19. **STRUCTURAL-PLATE STEEL PIPE, PIPE ARCHES, AND ARCHES.** Assembled, with galvanized steel nuts and bolts, from galvanized corrugated steel plates conforming to AASHTO M 167. [Pipe coating shall conform to the requirements of [AASHTO M 190 Type A] [AASHTO M 243].] Thickness of plates shall be as indicated.

#(N)#

5.20. **STRUCTURAL-PLATE ALUMINUM PIPE, PIPE ARCHES.** Assembled with either aluminum alloy, aluminum coated steel, stainless steel or zinc coated steel nuts and bolts. Nuts and bolts and aluminum alloy plates shall conform to AASHTO M 219. [Pipe coating shall conform to the requirements of [AASHTO M 190 Type A] [AASHTO M 243].] Thickness of plates shall be as indicated.

5.21. **POLYVINYL CHLORIDE (PVC) PIPE.** ASTM D 3034, Type PSM, SDR-35.

5.22. **CORRUGATED POLYETHYLENE (PE) PIPE.** AASHTO M 252 or M 294, Type III, Grade P34, Class C.

5.23. **DUCTILE IRON CULVERT PIPE.** AASHTO M 64 or ASTM A 716.

#(N)#

6. **DRAINAGE STRUCTURES.**

6.1. **MANHOLES.** Construction shall be of precast reinforced concrete manhole sections, complete with frames and covers and with fixed galvanized steel ladders where indicated. Manhole bases [and junction boxes] shall be cast-in-place or precast reinforced concrete.

6.2. **CURB AND AREA INLETS.** Construction shall be of cast-in-place or precast reinforced concrete as indicated.

6.3. NOT USED. **HEADWALLS.** Construction shall be of reinforced concrete, as indicated.

6.4. **FLARED END SECTIONS.** Sections shall be of a standard design with pipe manufacturer and manufactured of the same materials as specified for the pipe. Sections for corrugated metal pipe shall have the same metallic coating as specified for the pipe being used.

#(N)#

7. MATERIALS FOR DRAINAGE STRUCTURES.

#(N)#

7.1. **CONCRETE.** Concrete and the equipment, workmanship, and materials therefor, including all sampling and testing and submittals, shall conform to the applicable requirements of ASTM C 94, Alternate No. 2, except as hereinafter specified. Concrete shall be composed of cement, fine aggregate, coarse aggregate, water, and an air entraining mixture. At the Contractor's option, fly ash may be used as a partial replacement of portland cement, subject to the requirements specified hereinafter. All fly ash mixtures shall contain fly ash in the proportion of 20 percent of the total cementitious material, by absolute volume (based on the specific gravity of the portland cement and the fly ash). However, final mix proportions shall be stated by weight and the cementitious materials shall be batched by weight. Concrete shall have a minimum compressive strength of 3000 psi at 28 days age. The maximum size of coarse aggregate shall be 1-1/2 inch. Concrete shall have a slump of not more than 3 inches. The concrete mixtures shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall be not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground.

7.1.1. Aggregate. Aggregate shall conform to ASTM C 33, except Procedure A of ASTM C 666 shall be used for fine aggregate requiring freezing and thawing tests. Aggregate shall have a maximum nominal size of 1-1/2 inches.

7.1.2. Admixtures.

7.1.2.1. Air-entraining admixture shall conform to ASTM C 260.

7.1.2.2. Accelerating admixture shall conform to ASTM C 494, Type C, and shall be used only when cold weather protection is required and only when approved in writing.

7.1.2.3. Water-reducing or retarding admixtures shall conform to ASTM C 494, Type A, B, or D.

7.1.3. Cement. Cement shall be portland cement. Portland cement shall conform to ASTM C 150, type I or II. The cement shall meet the requirements for low alkali and for false set contained therein. If the Contractor can satisfactorily demonstrate that the proposed composition of cement and aggregate to be used in the concrete mix is nonreactive when tested in accordance with ASTM C 227, the low alkali requirement may be waived. Certified test results and supporting test data for determining nonreactivity must be submitted for approval and no substitutions shall be permitted in the aggregate and cement used in the work without additional testing.

7.1.4. Fly Ash. Fly ash shall conform to the requirements of ASTM C 618, class F or C, including the Supplementary Optional Chemical Requirement for available alkalies and the Supplementary Optional Physical Requirements for uniformity and reactivity with cement alkalies. Maximum loss on ignition shall not be over 4 percent. Samples shall be obtained, prepared, and tested in

accordance with ASTM C 311. Only one class of fly ash from a single source may be used. Unless otherwise specified, concrete and reinforced concrete shall have a minimum compressive strength of 3000 psi at 28 days age and shall conform to the requirements under SECTION: CONCRETE FOR BUILDING CONSTRUCTION. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall be not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground. Expansion-joint filler material shall conform to ASTM D 1751, D 1752, or AASHTO M 33 or shall be resin impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

7.2. REINFORCING. Reinforcing steel shall conform to the requirements of ASTM A 615, Grade 60. No welding shall be performed on reinforcing steel.

7.3. JOINT MATERIALS.

7.3.1. Expansion Joint Filler material shall conform to ASTM D 1751, D 1752, or AASHTO M 33 or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

7.4. **MORTAR.** Mortar for [pipe joints and] connections to other drainage structures, and block construction shall conform to ASTM C 270, Type M, except the maximum placement time shall be 1 hour.

7.4.1. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but in no case shall exceed 5.0 gallons of water per sack of cement. 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.

#(N)#

7.4.2. The inside of the joint shall be wiped clean and finished smooth. In pipe too small for a man to work inside, wiping may be done by dragging a suitable swab or long-handled brush through the pipe as work progresses. The mortar bead on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

#(N)#

7.5. **PRECAST REINFORCED CONCRETE MANHOLE RISERS** 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] [or] [joints shall be made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph: Flexible Gasket Joints.]

7.6. **PRECAST REINFORCED CONCRETE MANHOLE TOPS** shall conform to ASTM C 478 or AASHTO M 199.

7.7. **PRECAST REINFORCED CONCRETE MANHOLE BASES** shall be as indicated and shall be of such design as to effect suitable connection with influent and effluent lines and provide a suitable base structure for riser sections.

7.8. **FRAME AND COVER OR GRATINGS.** Frame and cover or gratings shall be cast gray iron, class 35 B or cast ductile iron, Grade 65-45-12 and shall conform to Fed. Spec. RR-F-621. Weight, shape, size, and waterway openings for frames and grates or covers shall be as indicated on the drawings. Frames, covers, and

gratings shall have a minimum transverse proof-load strength of 25,000 pounds.
#(N)#

7.9. NOT USED. STEEL LADDERS. Steel ladders conforming to the requirements in ANSI A14.3 shall be installed where the depth of the manhole exceeds _____ feet. These ladders will be not less than 16 inches in width with 3/4-inch-diameter rungs spaced 12 inches apart. Ladders shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet apart vertically and shall be so installed as to provide at least 7 inches of space between wall and center of rungs. The ladders and inserts shall be galvanized after fabrication with 2.3 oz. of zinc per square foot of surface area in conformance with ASTM A 123. A ladder climbing safety device conforming to Fed. Spec. RR-S-1301 shall be installed where the depth of the manhole exceeds 20 feet. The wall along the line of the ladder shall be vertical for its entire length.

8. NOT USED. DOWNSPOUT BOOTS. Boots used to connect exterior downspouts to the stormdrainage system shall be of gray cast iron conforming to ASTM A 48, class 30B or 35B. Shape and size shall be as indicated.

#(N)#

9. **JOINTS.** Pipe joints shall be one of the following types [and shall meet the test requirements of paragraphs: HYDROSTATIC TEST ON WATERTIGHT JOINTS].
#(N)#

9.1. **FOR CONCRETE [AND CLAY] PIPE.**
#(N)#

9.1.1. **Cement-Mortar Bell-and-Spigot Joint.** The first pipe shall be bedded to the established gradeline, with the bell and 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, the 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 joint shall be as specified in paragraph: MATERIALS FOR DRAINAGE STRUCTURES: Mortar. 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.
#(N)#

9.1.2. **Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe.** A closely twisted gasket shall be made of jute or oakum, 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 caulking 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 cheesecloth. 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: Mortar.

#(N)#

9.1.3. **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 caulked with a twisted jute or oakum. Before caulking, the inside of the bell and the outside of spigot shall be clean.

9.1.3.1. Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut into such lengths that 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 the ends to be twisted at top of pipe to hold band securely in place; bands shall be accurately centered around lower portion of joint.

9.1.3.2. 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 band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be carefully forced out by the pouring and removed.

9.1.3.3. 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 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: Mortar.

#(N)#

9.1.4. **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 grooved 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 grooved 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: Mortar.

#(N)#

9.1.5. **Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe.** The joint shall be of the type described in paragraph: Cement-Mortar Tongue-and-Groove Joint above, 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 joint shall be kept at least five joints behind the actual laying of the pipe. No backfilling around the 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 the paragraph: MATERIALS FOR DRAINAGE STRUCTURES: Mortar.

#(N)#

9.1.6. **Plastic Sealing Compound Joints for Tongue-and-Groove Pipe.**

9.1.6.1. **Materials.** Design of joints and physical requirements for preformed plastic sealing compound shall conform to Fed. Spec. SS-S-210.

9.1.6.2. **Installation.** Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound 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, a slight protrusion of the material is not visible along the entire inner and outer circumference of joint when joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions will be cut off flush with the inner surface of pipe.

#(N)#

9.1.7. **Flexible Gasket Joints.**

#(N)#

9.1.7.1. **Materials.** Flexible joints shall be made with plastic or rubber-type gaskets for concrete pipe [and with factory-fabricated resilient materials for clay pipe]. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443 or AASHTO M 198. [Factory-fabricated resilient joint materials shall be, at the option of the Contractor, one of three types and of the materials and manufacture conforming to ASTM C 425.] Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of pipe being gasketed exceeds 54 inches.

#(N)#

9.1.7.2. **Test Requirements.** Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. [Gaskets or jointing materials shall not swell more than 100 percent by volume when immersed in accordance with Method 6211 of Fed. Std. 601, in immersion medium No. 3 for 70 hours at 212 deg. F.] [Gaskets or jointing materials shall meet the low-temperature flexibility requirements of Fed. Spec. HH-G-156.] Alternate types of watertight joint may be furnished if specifically approved.

9.1.7.3. **Installation.** 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.

#(N)#

9.2. NOT USED. FOR CORRUGATED METAL PIPE. Unless otherwise specified herein, bands shall meet the requirements specified in the applicable standards or specifications for the pipe and shall meet the general performance requirements described in ASTM A 798. Joints shall be made with outside bands, each band consisting of one or two pieces. The ends of the pipe sections shall be placed within approximately 1 inch to enable corrugations of the bands to mesh with the corrugations of the pipe. Space between pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber, or plastic to take up slack and insure a tight joint. The annular space between abutting sections of part-paved, and fully-paved pipe and pipe arch, in sizes 30 inches or larger, shall be filled with a bituminous material after jointing. Coupling bands may be the next thickness lighter than that used for the pipe but not more than 0.109 nor less than 0.052 inch thick and shall be the same material and have the same coating as specified for the pipe being used. [Exterior rivet heads in the longitudinal seam of riveted pipe under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded.] [Pipe with helical corrugations shall have each end factory reformed to annular corrugations of the same dimensions as those in the pipe. Width of reformed end shall be equal to at least half the width of the band being used.]

9.2.1. **Coupling Bands.** Coupling bands shall be one of the following types:

9.2.1.1. **Bands with Annular Corrugations and Rod and Lug Type Connector.** Bands shall have a sleeve type gasket and shall be not less than four corrugations wide for pipe 12 to 24 inches in diameter and not less than eight corrugations wide for pipe 30 inches and greater in diameter. Four-corrugation wide bands shall have two rods and lugs and eight-corrugation wide bands shall have four rods and lugs. The corrugations in the band shall have the same dimensions as the corrugations in the pipe end.

9.2.1.2. **Semi-Corrugated (Hugger) Bands with Rod and Lug Type Connector.** Bands shall have two O-ring gaskets, a sealant strip where the band ends overlap, and shall be not less than 10-1/2 inches wide. Bands shall have two rods and lugs with a single harness, bolt, bar, and strap connector.

#(N)#

9.2.1.3. **Bands with Annular Corrugations and Angle-Bolt Type Connector.** Bands shall have a sleeve-type gasket and shall be not less than

7 inches wide for pipe 12 to 24 inches in diameter, 12 inches wide for pipe 30 to 60 inches in diameter, and 24 inches wide for pipe 66 to 120 inches in diameter. The 7-inch wide bands shall have not less than two bolts per connection, the 12-inch wide bands not less than three, and the 24-inch wide bands not less than five bolts per connection. The corrugations in the band shall have the same dimensions as the corrugations in the pipe end.

9.2.2. Gaskets.

#(N)#

9.2.2.1. **Sleeve Gaskets.** Sleeve gaskets used with circular pipe having not more than 5 percent ellipse shall be made of approximately 3/8-inch thick by 7-inch minimum width closed cell, expanded synthetic rubber, fabricated in the form of a cylinder with a diameter approximately 10 percent less than the nominal pipe size. The gasket material shall conform to the requirements of ASTM D 1056, Grade [2A3] [2B3 or 2C3] and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall then be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened.

9.2.2.2. **O-Ring Gaskets.** O-ring gaskets shall conform to the requirements of AASHTO M 198 or ASTM C 443. Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2-inch deep end corrugations. O-ring gaskets shall be 1-3/8 inch diameter for pipe having 1-inch deep end corrugations.

9.2.3. Connectors.

9.2.3.1. **Rod and Lug.** Rods shall be not less than 1/2-inch in diameter and shall conform to ASTM A 307. Lugs shall be manufactured with material conforming to ASTM A 48, class 35B. Nuts shall conform to the requirements of AASHTO M 36. Rods, lugs, and nuts shall be zinc or cadmium coated in accordance with AASHTO M 36.

9.2.3.2. **Bolt, Bar, and Strap.** The connection bolts shall be zinc or cadmium coated, not less than 1/2-inch in diameter per connection, and shall conform to the requirements of AASHTO M 36. Bars shall be not less than 7/8-inch in diameter and straps shall be not less than 0.109 inches in thickness. Bars and straps shall be zinc-coated in accordance with AASHTO M 36.

9.2.3.3. **Angle-Bolt.** Angles shall be not less than 2 inches by 2 inches by 3/16-inch by the width of the band minus 1 inch, adequately fastened to each end of band and half bands. The angles shall conform to ASTM A 36 and shall be zinc-coated in accordance with AASHTO M 36. The connection bolts shall be zinc or cadmium coated, not less than 1/2-inch in diameter per connection. Bolts and nuts shall conform to the requirements of AASHTO M 36.

9.2.4. Installation. The band shall be tightened evenly, even tension being kept on the rods, and the gasket shall be closely observed to see that it is seating properly in the corrugations. Joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip

on the rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured. Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements.

9.3. NOT USED. FOR POLYVINYL CHLORIDE (PVC) PIPE. Joints shall be in accordance with the requirements of ASTM D 3212.

9.4. NOT USED. FOR CORRUGATED POLYETHYLENE (PE) PIPE. Use couplings and fittings recommended by the pipe manufacturer

9.5. NOT USED. FOR DUCTILE IRON PIPE. Use couplings and fittings recommended by the pipe manufacturer.

#(N)#

10. NOT USED. HYDROSTATIC TEST ON WATERTIGHT JOINTS. A hydrostatic test shall be made on the watertight joint types proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty workmanship, an additional sample joint may be tested. Copies of test results shall be submitted to the Contracting Officer. During the test period the joint shall be protected from high temperatures that might soften or adversely affect the jointing materials. The possibility that some water may be absorbed by concrete pipes during this test will be considered before rejecting any rubber seals proposed. No allowance will be made for leakage in the seams of corrugated metal pipe. Performance requirements for joints in reinforced [and nonreinforced] concrete pipe shall conform to ASTM C 443 or AASHTO M 198 [and test requirements for joints in clay pipe shall conform to ASTM C 425]. For corrugated metal pipe with annular joints in straight alignment, watertight joints shall be required to withstand an internal hydrostatic pressure of 10 psi without isible leakage over a 10-minute period. Upon completion of the test for corrugated metal pipe with annular joints in straight alignment, the test sections shall be deflected from alignment by an angle whose tangent is 1/2 inch divided by the pipe diameter in inches. Joints shall be required to withstand an internal hydrostatic pressure of 10 psi without visible leakage for 10 minutes. Test requirements for joints in PVC pipe shall conform to ASTM D 3212.

#(N)#

11. **EXCAVATION AND TRENCHING FOR PIPE CULVERTS, STORM DRAINS AND DRAINAGE STRUCTURES.** Excavation of trenches for culverts and storm drains shall be in accordance with the applicable portions of SECTION: EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS and the following requirements:

#(N)#

11.1. **TRENCHING.** Width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 24 inches for pipes of less than 24 inch inside diameter and no wider than the outside diameter of the pipe plus 36 inches for larger sizes to permit satisfactory jointing and thorough tamping of the bedding material under and around pipe. Sheeting and bracing where required shall be placed within the trench width as specified. Care shall be taken not to over excavate. 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.

#(N)#

[11.2. NOT USED. REMOVAL OF ROCK. Rock in either ledge or boulder formation shall be replaced with selected materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2-inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in SECTION: EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.]

#(N)#

11.3. REMOVAL OF UNSUITABLE MATERIAL. Removal of unsuitable material shall be as specified and defined in SECTION: EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

#(N)#

12. BEDDING. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded carefully in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. 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. Bedding for clay pipe shall be as specified by ASTM C 12. Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A 798. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, it is recommended to either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow V-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A 807. Bedding for PVC pipe and corrugated PE pipe shall meet the requirements of ASTM D 2321. Bedding for ductile iron culvert pipe shall meet requirements of AASHTO M 64.

13. 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 alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. 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. 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 prior to installation. Installation of the item will not be allowed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

13.1. CONCRETE, CLAY, POLYVINYL CHLORIDE (PVC), AND DUCTILE IRON PIPE. Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

13.2. **CIRCULAR CONCRETE PIPE WITH ELLIPTICAL REINFORCING.** Placement shall be so that reference lines designating top of pipes will be not more than 5 degrees from the vertical plane through the longitudinal axis of the pipe. In all backfilling operations care shall be taken to prevent damage to or misalignment of the pipe.

13.3. NOT USED. **CORRUGATED POLYETHYLENE (PE) PIPE:** Laying shall be with the separate sections joined firmly, and shall follow manufacturer's recommendations.

13.4. **CORRUGATED METAL PIPE AND PIPE ARCH.** Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Part-paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of the pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material specified in AASHTO M 190 or AASHTO M 243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs, when used, shall be placed to facilitate moving pipe without damage to exterior or interior coatings. During installation, pipe or pipe arch shall be handled with care to preclude damage to the bituminous coating or paving or concrete lining. Damage to chipped or spalled concrete linings should be repaired in accordance with the manufacturer's recommendations. Prior to placing backfill, damaged areas of coupling bands and pipe shall be given a coating of bituminous material specified in AASHTO M 190 or AASHTO M 243. Pipe on which bituminous coating or paving or concrete lining has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced without additional cost to the Government. Vertical elongation, where indicated, shall be accomplished by side-fill compaction, factory elongation, or an approved method of strutting, as indicated. Suitable markings or properly placed lifting lugs shall be provided to insure placement of factory elongated pipe in a vertical plane.

13.5. **STRUCTURAL-PLATE STEEL PIPE, PIPE ARCHES, AND ARCHES.** Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to insure that all bolts are tightened to meet the torque requirements of 200 foot-pounds plus or minus 50 foot-pounds. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for amount of torque produced. Power wrenches shall be checked and adjusted frequently as needed, according to type or condition, to insure proper adjustment to supply the required torque.

13.6. **STRUCTURAL-PLATE ALUMINUM PIPE, PIPE ARCHES, AND ARCHES.** Structural-plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to insure that all bolts are torqued to a minimum of 100 foot-pounds on aluminum alloy bolts and a minimum of 150 foot-pounds on galvanized steel bolts. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for the amount of torque

produced. Power wrenches shall be checked and adjusted as frequently as needed, according to type or condition, to insure proper adjustment to supply the required torque.

#(N)#

13.7. **MULTIPLE CULVERTS.** Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 3 feet apart, whichever is less.

13.8. **JACKING PIPE THROUGH FILLS.** Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in AREA Manual 1-4.

#(N)#

14. **BACKFILLING.**

14.1. **BACKFILLING PIPE IN TRENCHES.** After the bedding has been prepared and the pipe installed, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. Care shall be taken to insure thorough compaction of the fill under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 6 inches, except that under unpaved areas, the thickness may be 12 inches. Tests for density will be made as necessary to insure conformance to the compaction requirements specified in "Compaction" below. Where it is necessary in the opinion of the Contracting Officer, any 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.

14.2. NOT USED. **BACKFILLING PIPE IN FILL SECTIONS.** For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified above and in "Compaction" below. The fill material shall be uniformly spread in layers longitudinally on both sides of pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 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 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 6 inches, except that under unpaved areas, the thickness may be 12 inches.

14.3. **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 the construction shall be at the Contractor's risk. Any pipe damaged thereby shall be repaired or replaced at the expense of the Contractor.

14.4. **COMPACTION.** Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

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. Compaction shall be accomplished by approved equipment and procedures. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. When questionable or borderline materials are encountered, the Contracting Officer will determine the compaction requirements to be used. Each layer shall be compacted to not less than the percentage of maximum density specified hereinafter.

14.4.1. **Compaction, Density and Tests.**

14.4.1.1. Where cohesionless materials are used for fills or backfills, sands or poorly graded gravels (either of which contain less than 15% passing the No. 200 sieve) shall be placed and compacted fully saturated to prevent bulking. Well-graded gravel shall be placed and compacted at a moisture content between 1 percent below and 4 percent above optimum moisture content. The materials shall be compacted to a density equal to 95% of maximum density as determined by ASTM D 1557, Method B, C, or D.

#(N)#

14.4.1.2. For all other materials, each layer shall be moistened or aerated to a moisture content after compaction of [1% below to 4% above optimum] [_____ to _____ percent above optimum] and compacted to [at least 90% of] [between _____ and _____ percent of] maximum density as determined by ASTM D 1557, Method B, C, or D. Upon completion of areas to receive concrete, the applicable moisture-density relations shall be maintained until placement of the concrete.

14.4.1.3. Tests For and Control of Density. Testing shall be the responsibility of the Contractor and shall be performed at his expense by an approved commercial testing laboratory. When test results indicate that compaction is not as specified, the material shall be removed and replaced or recompacted to meet specification requirements at no expense to the Government. Subsequent tests on recompacted areas shall be performed to determine conformance with specification requirements.

14.4.1.3.1. **Quality Control.** All quality control sampling and testing shall be performed by th*e Contractor in accordance with paragraph: CONTRACTOR QUALITY CONTROL of SECTION: SPECIAL CLAUSES, and as specified herein.

14.4.1.3.2. **Density-Moisture Determinations.** Tests for determination of maximum density and optimum moisture shall be performed by the Contractor in accordance with the requirements of ASTM D 1557, Method B, C, or D. Samples shall be representative of the materials to be placed. An optimum moisture-density curve shall be obtained for each principal type of material or combination of materials encountered or utilized. Results of these tests shall be the basis of control for compaction. The above testing shall include Atterberg limits, grain size determinations and specific gravity.

14.4.1.3.3. **Density Control.** The Contractor shall adequately control his compaction operations by tests made in accordance with ASTM Standard D 1556, ASTM D 2167 or nuclear devices to insure placement of materials within the limits of densities specified. Nuclear testing equipment and procedures shall conform to ASTM Standard D 2922 and D 3017. When ASTM D 2922 is used, the calibration curves shall be checked, and adjusted if necessary, using the sand cone method as described in paragraph "Calibration"

of ASTM D 2922. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with the density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Contracting Officer. If ASTM D 2922 is used for field density control, there should be at least one test performed according to ASTM D 1556 per every 10 tests performed according to ASTM D 2922 for correlation of test results. One test shall be made for each [3,000] [1000] sq. yds. or less for each layer of specified depth, except areas to receive pavements, for which one test shall be made for each [2,000] [_____] sq. yds. or less for each layer. Additional tests shall be made as necessary. All test results shall be furnished daily to the Contracting Officer. Acceptance tests may be made by the Government for verification of compliance; however, the Contractor shall not depend on such test for his control of operations.

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15. NOT USED. LEAKAGE TESTS. Lines shall be tested for leakage by either infiltration tests or exfiltration tests, as appropriate. Prior to testing for leakage, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. When the Contracting Officer determines that infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed [250 gallons per inch diameter per mile of pipeline per day] [0.2 gallons per inch diameter per 100 feet of pipeline per hour]. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Government.

ZERO ACCIDENTS

SECTION 02480
SEEDING

INDEX

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13. HERBICIDES, INSECTICIDES, AND PESTICIDES
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Attachments: Seeding Methods, Std. Dwg. No. 16-10-01, Sheet 2
Soil Erosion Control Blanket Placement Details,
Std. Dwg. No. 16-10-01, Sheet 3

PART 1 - GENERAL

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

1.1. **FEDERAL SPECIFICATION (Fed. Spec.).**
O-F-241D Fertilizer, Mixed, Commercial

1.2. **U.S. DEPARTMENT OF AGRICULTURE.**
Federal Seed Act of 9 August 1939 (53 Stat. 1275)

2. **GENERAL REQUIREMENTS.** The specified seed varieties and quantities shall be uniformly distributed over all ground areas disturbed by grading and/or trenching and not otherwise surfaced and in such manner that will produce an even stand of grass over the entire area seeded, as shown on attached Standard Drawing No. 16-10-01, Sheet 2. The Contractor shall notify the Contracting Officer at least 10 days prior to seeding operations.

3. **NOT USED.**

4. **SUBMITTALS.** In accordance with SECTION: SPECIAL CLAUSES, the Contractor shall submit the following items:

4.1. **CATEGORY I.** None.

4.2. **CATEGORY II.**

4.2.1. **Certificates of Compliance:**

4.2.1.1. Seed.

4.2.1.2. Fertilizer.

4.2.2. **Manufacturer's Literature:**

4.2.2.1. Hydro-Mulch Tackifier.

4.2.2.2. Erosion Control Materials.

5. **DELIVERY, STORAGE, AND HANDLING.**

5.1. **DELIVERY.**

5.1.1. **Seeding Material** shall be inspected upon arrival at the jobsite, and unacceptable material shall be removed from the jobsite.

5.1.2. **During Delivery, Seed** shall be protected from any drying or contamination by detrimental material.

5.1.3. **Fertilizer** shall be delivered to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis, name, trade name, trademark, and conformance to state and federal law.

5.1.4. **Chemical Treatment of Materials.** Pesticides and Herbicides shall be delivered to the site in the original unopened containers. Containers without labels and EPA registration numbers and the manufacturer's registered uses will be rejected by the Contracting Officer.

5.2. **STORAGE.**

5.2.1. **Seed and Fertilizer** shall be stored in cool, dry locations away from contaminants.

5.2.2. **Pesticides and Herbicides** shall not be stored with other landscape materials and shall be handled and stored following manufacturer's directions.

5.2.3. **Materials** shall be stored in areas designated or as approved by the Contracting Officer.

PART 2 - PRODUCTS

6. **MATERIALS.**

6.1. **SEED** shall be state-certified seed of the latest season's crop and shall be delivered in original sealed packages bearing the producer's guaranteed analysis for percentages of mixtures, purity, germination, weed-seed content, and inert material. Labels shall conform with USDA Federal Seed Act, Rules & Regulations and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected.

6.1.1. NOT USED.

6.1.2. **Field Seed Mixture.** The mixture of each seed lot shall contain the following types of seed and their pounds of Pure Live Seed (PLS) per acre:

Field Grass Seed Mixture	PLS / ACRE
Buffalo Grass Buchloe dactyloides	4
Blue Grama Bouteloua Gracilis	2
Crested Wheatgrass 'Ephraim' Agropyron cristatum	3
Sheep Fescue Festuca ovina	2
Western Wheatgrass 'Native' Agropyron smithii	4
Arizona fescue	3

The following formula shall be used to determine the amount of commercial seed required to provide in each kind of seed the specified quantities of pure live seed, with Purity and Germination expressed as whole numbers:

Pounds of Pure Live Seed x 100 x 100 = Pounds Commercial Seed Required
(% Purity) x (% Germination)

6.2. **FERTILIZER** shall be controlled-release, commercial grade, granular free flowing, uniform in composition, delivered in fully labeled sealed containers, and shall conform to applicable state and federal regulations. Fertilizer shall conform to Fed. Spec. O-F-241, and shall bear the manufacturer's guaranteed statement of analysis.

6.2.1. Granular fertilizer shall contain a minimum percentage by weight of the following elements: 33% Nitrogen (of which 50% shall be a slow release organic type), 46% Phosphoric acid, and 0% Potassium. The fertilizer mixture used shall be derived from either sulfur coated urea, urea formaldehyde, plastic or polymer coated prills or isobutylenediurea.

6.3. **TOPSOIL.** Specified under SECTION: GRADING.

6.4. **TOPSOIL FOR REPAIR.** Erosion repair topsoil shall be obtained by the Contractor from on Base stockpile areas identified by the Contracting Officer if topsoil is not available from the grading operations. Topsoil for repair shall be a natural, friable soil representative of agriculturally productive soils in the vicinity. It shall be obtained from well-drained areas and shall be free of any admixture of subsoil, toxic substances, and any material or substance that may be harmful to plant growth.

6.5. **MULCH.**

6.5.1. **Straw Mulch** shall be long stem native grass hay that is free from noxious weeds, mold, or other objectionable material. The straw mulch shall contain at least 50 percent by weight of the material to be 10 inches or longer. Straw shall be in an air-dry condition and suitable for placing with blower equipment.

6.5.2. **Hydro Mulch Overspray Tackifier** shall be a wood cellulose (from virgin wood fibers) or recycled slick paper (containing wood cellulose and kaolin clay) and shall not contain any growth or germination-inhibiting factors and shall be dyed an appropriate color to facilitate visual metering during application. Composition on air-dry weight basis: Wood Cellulose Fiber 9 to 15 percent moisture, pH range from 4.3 to 8.5., Slick Paper 8 percent moisture maximum, ph 4.5 - 6.5. When added to water, it forms a homogenous slurry specifically for use in hydraulic mulching equipment. Wood cellulose fiber containing 90 percent or greater organic matter or recycled slick paper shall be applied at a minimum of 750 pounds per acre. This material when sprayed on the straw mulch becomes a tackifier/binder and provides a stable bed for seed germination.

6.6. **WATER** shall be a quality suitable for irrigation.

6.7. **CHEMICAL TREATMENT MATERIAL** shall be EPA registered and approved herbicides and pesticides. These materials shall comply with all applicable state and federal laws.

6.8. **SOIL EROSION CONTROL MATERIAL, AND STAPLES.**

6.8.1. **Soil Erosion Control Blanket** shall consist of a machine-laid mat of curled wood excelsior, fibers of which 80 percent are 6 inches or longer. The excelsior fiber shall be burred wood fiber from nonresinous timber. The fiber thickness shall be consistent and evenly distributed over the entire area of the blanket. The top side of each blanket shall be covered with a photodegradable extruded plastic mesh. Mesh size shall be a minimum of 1 inch by 2 inches. Blankets shall be made smolder resistant without chemical additives. Roll size specifications are: roll width 48 inches, length 180

feet average, area coverage 80 square yards average, roll weight approximately 78 pounds.

6.8.2. **Staples** shall meet the Erosion Control Material manufacturer's instructions.

6.9. **SILT FENCE.** Silt Fence shall be the same as or equal to Mirafi Sedimentation Control Fence with factory installed stakes. Fence shall be installed with a dug in trench securing the fabric on the uphill side of the fence. Consult Manufacturers recommendations for exact installation. Install fence where shown on the drawings.

PART 3 - EXECUTION

7. **DATES FOR SEEDING.**

7.1. NOT USED.

7.2. **FIELD SEEDING.** The Contractor shall prepare the seedbed and perform field seeding as specified in paragraph: MATERIALS between the dates of:

Fall: 1 AUG to 30 Aug
Spring: 1 May to 31 May (Preferred)
Dormant: 1 November to April 30 (Used when schedules do not allow spring planting. Dormant seeding only after soil temperatures are below 60 deg. F. No seeding when soil is frozen or muddy.)

8. **PREPARATION OF SEEDBED.**

8.1. **GENERAL.** The Contractor shall place topsoil and establish finish grades in accordance with the SECTION: GRADING. Any eroded finish grades shall be repaired in accordance with the MATERIALS paragraph: TOPSOIL FOR REPAIR.

8.2. **TILLAGE.** The soil shall be tilled to a depth of at least 4 inches by plowing, disking, harrowing, or rototilling. When drought, excessive moisture, or other unsatisfactory conditions prevail, the work should be stopped. The soil surface shall be leveled to meet finish grade requirements before seeding. Seedbed preparation shall be performed on the contour to reduce soil loss. Slopes 2 horizontal to 1 vertical and greater, minimum tillage depth shall be 2 inches.

8.3. **APPLICATION OF FERTILIZER.** Fertilizer shall be incorporated into the soil to a depth of 2 inches during seedbed preparation.

8.4. **FERTILIZER RATE.**

8.4.1. Apply fertilizer at a rate to supply no less than 132 pounds of fertilizer mix per acre

8.4.2. NOT USED.

9. **PLANTING SEED.**

9.1. **GENERAL.** Prior to seeding, any previously prepared seedbed areas compacted or damaged by interim rains, traffic, or other cause, shall be reworked to restore the ground condition previously specified. Seed shall be planted at the rate specified herein.

9.2. **METHODS.** Seed planting shall be accomplished by:

9.2.1. **Broadcast Seeding.** The Contractor shall broadcast seed by hand or with approved gravity or cyclone types of spreading equipment in areas which are not accessible to drill seeding equipment. Broadcast seedings shall be covered to an average depth of 1/4 inch. Completed seeding shall be

mixed into soil with a harrow or rake a compacted with a cultipacker-type roller providing 60 to 90 pounds weight per linear foot of roller, or by equivalent approved hand rolling or compacting methods. Broadcast seeding will not be permitted when wind velocity is such as to prevent uniform seed distribution.

9.2.2. **Drill Seeding.** The Contractor shall plant seed with a grass seed drill equipped with seeding mechanisms, agitator, double disk furrow openers and packer wheels or drag chains. The seed drill shall plant, cover and compact the seedbed in the same operation. The distance between drill rows shall not be more than 6-1/2 inches apart with planting depth of 1/4 - 1/2 inch. Drill seeding is required over broadcast for large areas of field seeding.

9.3. VEGETATIVE MULCHING. The contractor shall perform vegetative mulching on the same day as planting seed.

9.3.1. **Applying Mulch.** Straw mulch shall be spread uniformly in a continuous blanket over the seeded areas, using 2 1/2 tons of material per acre. The mulch shall be spread in such manner as to prevent bunching. Mulch shall be applied by mechanical straw blower.

9.3.2. **Securing Mulch.** Immediately following (the same day) the spreading of the mulch, the material shall be anchored securely to the soil by use of the Hydro Mulch Overspray Tackifier material. The material shall be applied by a hydro seed blower at the rate specified. Apply the material in a raining technique to prevent bunching and displacement of the straw mulch.

10. **SOIL EROSION CONTROL MATERIAL** shall be installed on all ditches and on all foreslopes and backslopes. Installation of erosion control materials shall be in accordance with the manufacturer's instructions or as shown on the Standard Drawing 16-10-01, Sheet 3.

10.1. **SOIL PREPARATION.** The surfaces of ditches and slopes to receive soil erosion control material shall be topsoiled, finished, tilled, fertilized, and seeded in accordance with the paragraph: PREPARATION OF SEEDBED.

10.2. **PLACEMENT OF SOIL EROSION CONTROL MATERIAL.**

10.2.1. **General.** Soil erosion control material shall be unrolled and placed with the netting on top. Apply wire staples or stakes vertically through the netting and blanket into the ground. Material shall be installed in accordance with the manufacturer's instructions. Erosion control material placement shall be accomplished without damage to the installed material or distortion of established grades.

10.2.2. **Ditches.** Erosion control material shall be laid in the direction of the flow of water and smoothed and secured in place as shown on attached Standard Drawing No. 16-10-01, Sheet 3, with all overlaps in direction of water flow.

10.2.3. **Slopes.** Erosion control material may be laid horizontally or vertically on the slope and secured as shown on attached Standard Drawing No. 16-10-01, Sheet 3.

10.3. **MAINTENANCE.** The erosion control material shall be maintained by the Contractor until all work on the entire contract or designated portion thereof has been completed and accepted. Maintenance includes repair of eroded areas, the repair or replacement and restapling of loose or undermined erosion control material. Also includes reseeding eroded areas with installed erosion control materials.

11. **PROTECTION AND CLEANUP.** After seeding and mulching operations have been completed, barricades and approved warning signs shall be erected by the Contractor as required to provide protection against traffic and trespass. Excess material from seeding and mulching operations, and all debris, shall be cleaned up and disposed of off the site.

12. **ESTABLISHMENT AND MAINTENANCE PERIOD.**

12.1. NOT USED.

12.2. **FIELD SEEDING.** The Contractor is responsible for the establishment and maintenance of field seeding for a minimum period of 45 days or until all of the work on the project has been completed and accepted by the Contracting Officer, for whichever period is longer.

12.2.1. Watering of field seeding is not required.

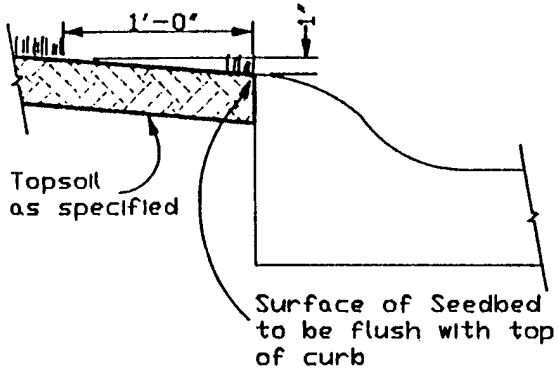
12.2.2. Mowing shall be provided by the Contractor for weed control and as directed by the Contracting Officer. The Contractor shall maintain an approximate 6-inch minimum height of grass and weeds during the maintenance period.

12.2.3. **Reseeding and Repair.** During the maintenance period, any eroded or damaged seeding shall be repaired and reseeded by the Contractor.

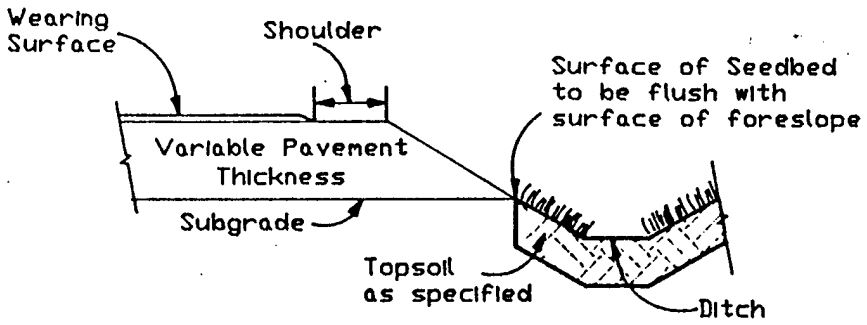
13. **CHEMICAL TREATMENT.** Herbicides and pesticides shall be applied as directed by the Contracting Officer for the control of weeds or pests that may damage seeded areas. Application shall be by a certified applicator and performed in accordance with manufactures recommendations stated on the container label. When weeds are sprayed they should be 4 to 6 inches high if they are thick enough to shade the ground completely. The seeded grass should be in at least a two- to four-leaf stage before spraying.

14. **FINAL ACCEPTANCE.** Final inspection and acceptance will be at the end of the Establishment and Maintenance Period. Acceptance will be based upon material, performance and completion of all the items of work specified for SEEDING. Unacceptable work shall be reseeded by the Contractor.

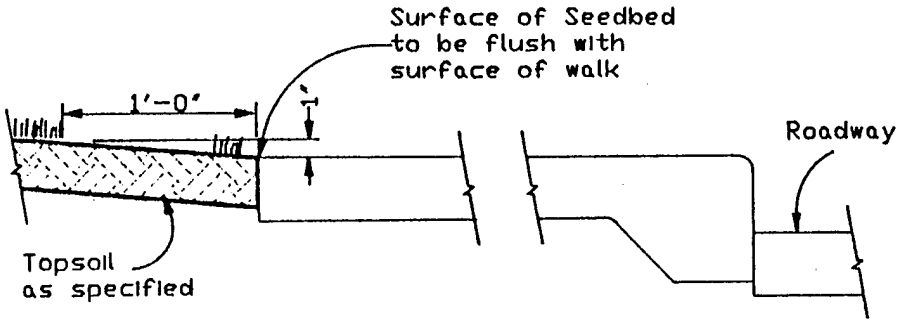
SEEDING AT CURB



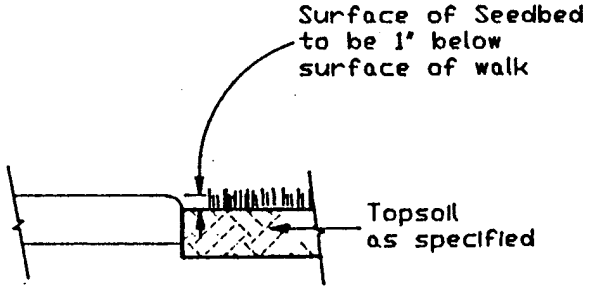
SEEDING ALONG ROADWAY



SEEDING AT DOUBLE-PURPOSE WALK



SEEDING AT SINGLE-PURPOSE WALK

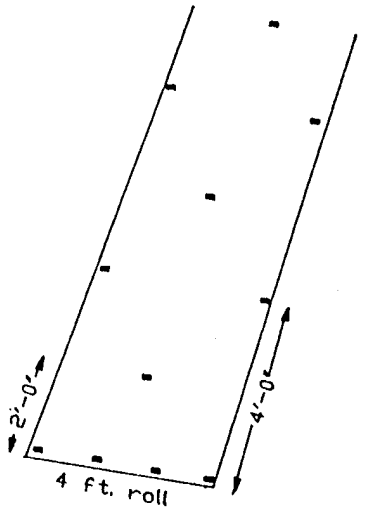


SEEDING METHODS

Dwg. No. 16-10-01 Sheet No. 2

NO SCALE September 1987

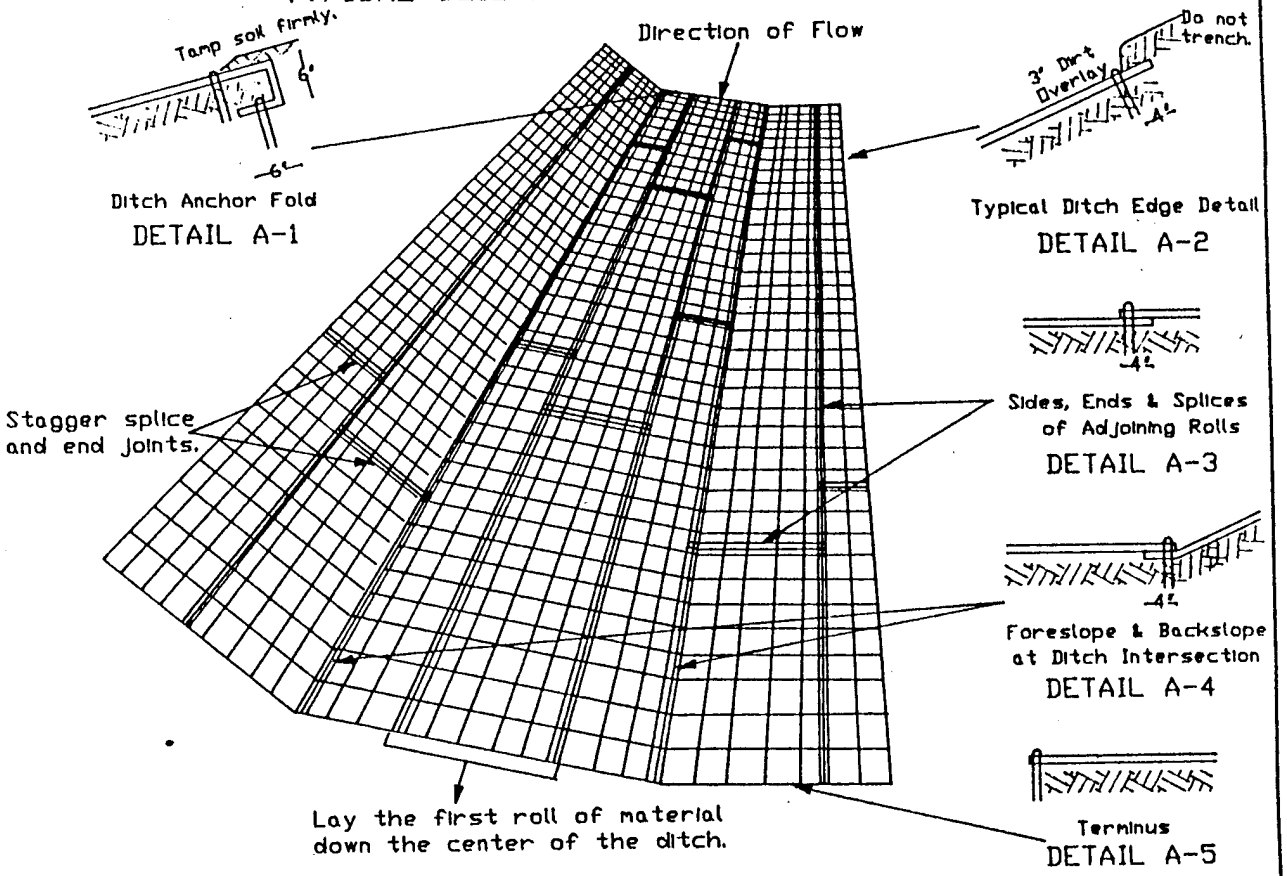
STAPLING PATTERN



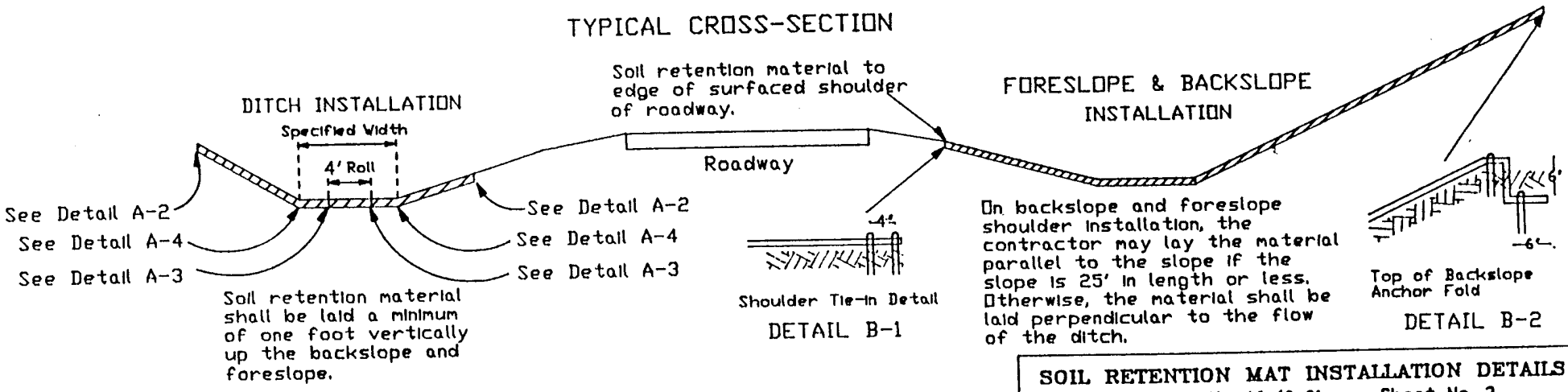
Use 4 staples across at the start of each roll and continue to staple sides at 4-foot intervals. Staple center of each roll beginning 2 feet from start of roll and continue at 4-foot intervals.

Overlapping edges of sides, ends, and splices will be commonly stapled. (See Detail A-3).

TYPICAL SOIL RETENTION MAT INSTALLATION



TYPICAL CROSS-SECTION



SOIL RETENTION MAT INSTALLATION DETAILS

Dwg. No. 16-10-01 Sheet No. 3

NO SCALE Revised September 1987

ZERO ACCIDENTS

SECTION 02724
FORCE MAINS, SEWER

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#(N)#

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 basic designation only.

1.1. **AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI) STANDARDS.**

A21.11-1980	Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
B16.1-1975	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
B16.3-1985	Malleable Iron Threaded Fittings, Class 150 and 300

1.2. **AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS.**

A 120-84a	Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses
C 478-87	Precast Reinforced Concrete Manhole Sections

#(N)#

C 541-83	Lining for Asbestos-Cement Pipe
D 1785-86	Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
D 1869-78 (R 1983)	Rubber Rings for Asbestos-Cement Pipe
D 2122-85	Method of Determining Dimensions of Thermoplastic Pipe and Fittings
D 2146-82	Propylene Plastic Injection and Extrusion Materials
D 2241-87	Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
D 2464-76	Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
D 2564-84	Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
D 2657-87	Heat-Joining Polyolefin Pipe and Fittings
D 2774-72 (R 1983)	Underground Installation of Thermoplastic Pressure Piping
D 2996-83	Filament-Wound Reinforced Thermosetting Resin Pipe
D 3035-85	Polyethylene (PE) Plastic Pipe (SDR-PR) Based

	on Controlled Outside Diameter.
D 3139-84	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
D 3350-84	Polyethylene Plastics Pipe and Fittings Materials
D 3517-86	Fiberglass (Glass-Fiber-Reinforced Thermo-setting-Resin) Pressure Pipe
F 477-76 (R 1985)	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.3. **AMERICAN WATER WORKS ASSOCIATION (AWWA) STANDARDS.**

C104-80	Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water
C110-82	Ductile-Iron and Gray-Iron Fittings, 3-In. Through 48-In. for Water and Other Liquids
C115-83	Flanged Ductile-Iron and Gray-Iron Pipe With Threaded Flanges
C151-86	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds on Sand-Lined Molds for Water or Other Liquids
C400-80 & Erratum & C400a-83	Asbestos-Cement Distribution Pipe, 4 In. Through 16 In. (100mm Through 400mm) NPS, for Water and Other Liquids
C508-82	Swing-Check Valves for Waterworks Service 2-In. Through 24-In. NPS
C600-82	Installation of Ductile-Iron Water Mains and Their Appurtenances
C603-78	Installation of Asbestos Cement Pressure Pipe
C900-81 & Erratum	Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In. for Water
M16-78	Work Practices for Asbestos-Cement Pipe

1.4. **THE MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS) PUBLICATION.**

SP-78	Cast Iron Plug Valves, Flanges and Threaded Ends (1977)

2. **TESTING.** Testing shall be the responsibility of the Contractor. Testing shall be performed by an approved independent testing laboratory or by the Contractor subject to approval. The test may be witnessed by the Contracting Officer. The Contracting Officer shall be notified at least 7 days in advance of equipment tests. The final test report shall be delivered to the Contracting Officer within 30 days of the test.

3. **DELIVERY AND STORAGE.** All materials delivered and stored shall be handled and stored in such a manner that pipe, fittings and accessories, and pipe coatings are not damaged.

4. **EXCAVATION, TRENCHING, AND BACKFILLING FOR FORCE MAINS WATER LINES.** Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of SECTION: EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS except as modified herein.

5. **SUBMITTALS.** In accordance with SECTION: SPECIAL CLAUSES, the Contractor shall submit for approval, data as specified herein on the following:

#(N)#

5.1. **CATEGORY I.** none.

[Coating/Wrapping System for Gray or Cast-iron Pipe and Fittings] (Para. 6.6)

5.2. **CATEGORY II.** (For Information Only)

#(N)#

Manufacturer's Instructions (Para. 7)
Manufacturer's Data (Para. 7)
Hydrostatic Tests (Para. 8)
Final Test Reports (Para. 8)
Test Lead Location Plan (Para. 7.10)
Asbestos-Cement Pipe Location Plan (Para. 7.2)

6. **MATERIALS.**

#(N)#

6.1. **PIPE AND FITTINGS.**

6.1.1. General.

6.1.1.1. **Less Than 4 Inches.** Buried piping shall be polyvinyl chloride (PVC), polyethylene (PE), or polypropylene pipe. Piping installed in pump stations shall be galvanized steel.

6.1.1.2. NOT USED. 4 Inches and Larger. Buried piping shall be ductile iron, asbestos-cement, polyvinyl chloride (PVC), polyethylene (PE), reinforced thermosetting resin (RTRP), or reinforced plastic mortar pressure pipe (RPMP). Piping installed inside pump stations or valve vaults shall be ductile iron with bolted flanged joints.

#(N)#

[6.1.1.3. NOT USED. All pipe, fittings, valves, and other force main appurtenances constructed of either gray or ductile cast-iron and installed below grade shall be provided with corrosion protection as described in paragraph: Corrosion Protection, regardless of pipeline material].

6.1.2. NOT USED. Ductile Iron Pipe and Fittings.

6.1.2.1. NOT USED. Ductile Iron Pipe. AWWA C151, working pressure not less than 150 psi and a depth of bury of _____ feet unless otherwise shown or specified. Pipe shall be cement-mortar lined in accordance with AWWA C104. Linings shall be standard thickness.

6.1.2.2. NOT USED. Push-On Joints. ANSI A21.11.

6.1.2.3. NOT USED. Mechanical Joints. ANSI A21.11 as modified by AWWA C151.

6.1.2.4. NOT USED. Flanged Joints. AWWA C115.

6.1.2.5. NOT USED. River Crossing Pipe. AWWA C151, minimum thickness Class 54 with joints in compliance with applicable requirements of AWWA C110.

#(N)#

6.1.2.6. NOT USED. Fittings, Mechanical. AWWA C110, rated for 150 psi.

#(N)#

6.1.2.7. NOT USED. Fittings, Push-On. AWWA C110 and ANSI A21.11, rated for 150 psi.

6.1.3. **Steel Pipe and Fittings.**

6.1.3.1. **Pipe.** ASTM A 120, standard weight galvanized with threaded joints.

6.1.3.2. **Fittings.** ANSI B16.3, galvanized.

#(N)#

6.1.4. NOT USED. Asbestos-Cement Pipe and Fittings.

6.1.4.1. NOT USED. Asbestos-Cement Pipe, AWWA C400, Class _____.

6.1.4.2. NOT USED. Asbestos-Cement Pipe Fittings, AWWA C110, rated 150 psi.

6.1.4.3. NOT USED. Gaskets, ASTM D 1869.

#(N)#

6.1.5. **Polyvinyl Chloride (PVC) Pipe and Fittings.**

6.1.5.1. **PVC Pipe and Fittings.**

6.1.5.1.1. **PVC Pipe and Fittings Less Than 4 Inches in Diameter.** ASTM D 1785, Schedule [80] [120] with screw joints, or D 2241, SDR [21] [26] [32.5], with push-on joints or solvent weld joints.

6.1.5.1.2. NOT USED. PVC Pipe and Fittings 4-Inches in Diameter and Larger. ASTM D 2241, SDR [21] [26] [32.5], or AWWA C900, Class [100] [150] [200], with push-on joints.

6.1.5.2. **Screw Joint Fittings.** ASTM D 2464, Schedule 80.

6.1.5.3. **Push-On Joint Fittings.** ASTM D 3139, with ASTM F 477 gaskets.

6.1.5.4. **Solvent Cement.** ASTM D 2564.

6.1.5.5. Couplings for use with plain end pipe shall have centering rings or stops to insure the coupling is centered on the joint.

6.1.6. **Polyethylene (PE) Pipe and Fittings.**

6.1.6.1. **PE Pipe and Fittings.** ASTM D 3350 and D 3035, minimum pressure rating of 100 psi at 73.5 degrees F.

6.1.6.2. **Heat Fusion Joints.** ASTM D 2657.

6.1.6.3. **Flanged Joints.** ANSI B16.1 or AWWA C207.

6.1.6.4. **Mechanical Joints.** ANSI B16.1.

6.1.7. **Polypropylene Pipe and Fittings.**

6.1.7.1. **Polypropylene Pipe and Fittings.** ASTM D 2122 and ASTM D 2146.

6.1.7.2. **Heat Fusion Joints.** ASTM D 2657.

6.1.8. **Reinforced Thermosetting Resin Pipe and Fittings.**

6.1.8.1. **Reinforced Thermosetting Resin Pipe.** ASTM D 2996, 350 psi rated, cast-iron pipe dimensions only, with elastomeric gasket joints.

6.1.8.2. **Fittings.** AWWA C110, rated 150 psi. When mechanical joint fittings are used, inside sleeves provided by the manufacturer shall be used.

6.1.9. **Reinforced Plastic Mortar Pressure (RPMP) Pipe.**

6.1.9.1. **Pipe.** ASTM D 3517.

6.1.9.2. **Fittings.** Fittings shall be compatible with the pipe supplied and shall be suitable for working and testing pressures specified for the pipe.

6.2. **VALVES.**

6.2.1. **Check Valves.** Check valves shall permit free flow of sewage forward and provide a positive check against backflow. Check valves shall be

designed for a minimum working pressure of 150 psi or as indicated. The body shall be iron. Directly cast on the body shall be the manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow.

6.2.1.1. **Ball Check Valves.** Valves shall be iron body, shall have flanged ends, and shall be the non-slam type. Flanges shall be the 125-pound type complying with ANSI B16.1. Ball shall be stainless steel unless otherwise specified.

#(N)#

6.2.1.2. **Swing Check Valves.** Valves shall comply with AWWA C508 and shall be iron body, bronze mounted, and shall have flanged ends. Flanges shall be the 125-pound type complying with ANSI B16.1.

6.2.2. NOT USED. Plug Valves. MSS SP-78, non-lubricated type, regular pattern with resilient plug facing of Buna N, Hycar, or other material resistant to hydrocarbons. Valves installed in pump stations or valve vaults shall be provided with lever operators and position indicators. Buried valves shall be provided with operating nuts. All exposed bolts and nuts shall be zinc-plated or stainless steel.

6.2.3. NOT USED. Pinch Valves. Pinch valves shall be double acting, jamproof type with unobstructed streamlined flows and built-in operator. The body shall be iron with a non-rising handwheel. The sleeve shall be of pure gum rubber, neoprene, Buna N or hypalon as required for service. The valve shall have flanged ends. Flanges shall be of the 125-pound type complying with ANSI B16.1.

6.2.4. NOT USED. Air Release Valves. Air release valves shall be designed to permit release of air from an empty pipe during filling and shall be capable of discharging accumulated air in the line while the line is in operation and under pressure. Valves shall be attached by means of threaded pipe connections. Valves shall be vented to the atmosphere. Automatic air release valves shall be used unless otherwise indicated.

6.2.4.1. NOT USED. Manual Air Release Valves. Manual air release valves shall consist of a 3-inch gate valve and 3-inch ductile iron pipe and fittings. The valve shall be installed with its line of flow in the horizontal position.

6.2.4.2. NOT USED. Automatic Air Release Valve. Automatic air release valves shall be of the compound lever type capable of withstanding operating pressures of 150 psi. The valves shall have a 1/2-inch outlet. The body and cover of the valve shall be of iron with a stainless steel float. All internal parts shall be stainless steel or bronze. The valve shall be specifically adapted for use with sewage. Each valve shall be complete with hose and blow-off valves to permit backflushing without dismantling the valve.

#(N)#

6.3. NOT USED. VALVE BOXES. Valve boxes shall be cast iron. Cast iron boxes shall be the extension type with slide type adjustment and with flared base. The minimum thickness of metal shall be 3/16 inch. The boxes shall be of such length as will be adapted, without full extension, to the depth of cover over the pipe at the valve locations. The word "Sewer" shall be cast in the cover.

#(N,d)#

6.4. NOT USED. VALVE VAULTS. Valve vaults shall be precast concrete units conforming to ASTM C 478 or cast-in-place as shown on the drawings.

Concrete for cast-in-place structures shall conform to the SECTION: CONCRETE.

6.5. **MISCELLANEOUS MATERIALS.** Miscellaneous materials shall comply with the following requirements.

#(N)#

[6.5.1. **Pipe Coatings and Linings for Asbestos Cement.** ASTM C 541.]

6.5.2. **Joint Lubricants.** Joint lubricants shall be as recommended by the pipe manufacturer.

6.5.3. **Bolts, Nuts and Glands.** ANSI A21.11.

6.5.4. **Bond Wire.** Type RHW or USE, Size 1/0 AWG, neoprene jacketed copper conductor shaped to stand clear of the joint.

6.6. NOT USED. CORROSION PROTECTION shall be provided for all buried gray or ductile cast-iron piping, fittings, valves, and other force main appurtenances, regardless of pipe material. Corrosion protection shall consist of a cathodic protection system in accordance with SECTION: CATHODIC PROTECTION (GALVANIC ANODE TYPE) and a coating and/or wrapping system. The coating system may be of the fusion bonded epoxy coating or coal-tar epoxy types or other approved system. The coating system shall have a minimum dry coating thickness of 12 mils for fusion bonded epoxy or 22 mils for coal-tar epoxy types and other approved systems. Wrapping systems shall have a minimum thickness of 20 mils. Pipe primer shall be used when required. For highly irregular surfaces, fillers, putty, or coatings as recommended by tape manufacturer shall be used. Tape system shall be applied per manufacturer's recommendations. Polyethylene encasement shall not be used.

6.6.1. NOT USED. Inspection of Coatings and/or Wrappings. Any damage to the protective covering during transit and handling shall be repaired by the Contractor before installation. After field coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current in accordance with NACE RP-02 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. All holidays in the protective covering shall be repaired immediately upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer to determine suitability of the detector.]

7. **INSTALLATION.** All pipe, pipe fittings, and appurtenances installed at the locations indicated. Excavation, trenching, and backfilling shall be as specified in SECTION: EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES SYSTEMS.

7.1. **UTILITY SEPARATION.** Pressure sewer pipe and water pipe shall be separated at least 10 feet horizontally. If conditions prevent 10 feet separation, a minimum of 6 feet horizontal distance shall be provided along with a minimum vertical separation of 12 inches from the bottom of the water pipe to the top of the pressure sewer pipe. Where pressure sewer pipe must cross water pipe, pressure sewer pipe shall always cross beneath water pipe. A vertical distance of 2 feet between the bottom of water pipe and the top of pressure sewer pipe shall be maintained. The force main joints shall not be closer than 3 feet horizontally to the point of crossing.

7.2. **CUTTING.** Pipe shall be cut in a neat manner with mechanical cutters. Wheel cutters shall be used where practicable. Sharp and rough edges shall be ground smooth and loose material removed from the pipe before laying except as otherwise specified. Asbestos-cement pipe shall be cut and machined in

accordance with AWWA M16. Use of power-driven abrasive discs or sanders will not be permitted. All operations in which asbestos-cement pipe is cut, sanded, machined, drilled, or abraded shall be performed in strict compliance with Occupational Safety and Health Act (OSHA) requirements established by 29 CFR 1910.1001. The Contractor shall submit a separate accurately dimensioned reproducible drawing showing the exact location where asbestos-cement pipe is installed under this contract.

7.3. **LAYING.** Except where authorized, pipe shall be laid with bells facing the direction of laying. Before lowering and while suspended, the pipe shall be inspected for defects. Defective material shall be rejected. Pipe shall be laid in compliance with the following:

7.3.1. NOT USED. Ductile Iron. AWWA C600.

7.3.2. NOT USED. Asbestos-Cement. AWWA C603.

7.3.3. **Polyvinyl Chloride.** Manufacturer's instructions.

7.3.4. **Polyethylene.** ASTM D 2774.

7.3.5. **Polypropylene.** ASTM D 2774.

7.3.6. **Reinforced Thermosetting Resin.** Manufacturer's instructions.

7.3.7. **Reinforced Plastic Mortar.** Manufacturer's instructions.

7.4. **JOINTING.**

7.4.1. NOT USED. Ductile Iron Pipe. Installation of mechanical and push-on type joints shall comply with AWWA C600 and the manufacturer's instructions. Installation of flanged joints shall comply with manufacturer's instructions. Flanged joints shall be used only inside of structures.

7.4.2. NOT USED. Asbestos-Cement Pipe. Joints shall be installed in accordance with AWWA C603.

7.4.3. **Polyvinyl Chloride Pipe.**

7.4.3.1. Threaded joints shall be made by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. The joint shall be tightened with strap wrenches which will not damage the pipe and fittings. The joint shall be tightened no more than two threads past hand-tight.

7.4.3.2. The ends of pipe for push-on joints shall be beveled to facilitate assembly. Pipe shall be marked to indicate when the pipe is fully seated. The gasket shall be lubricated to prevent displacement. Care shall be exercised to insure that the gasket remains in proper position in the bell or coupling while making the joint.

7.4.3.3. Solvent-weld joints shall comply with the manufacturer's instructions.

7.4.4. **Polyethylene Pipe.** Heat fusion joints shall be made in compliance with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time. Flanged and mechanical joints shall be made in compliance with the manufacturer's instructions.

7.4.5. **Polypropylene Pipe.** Heat fusion joints shall be made in compliance with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time.

7.4.6. **Reinforced Thermosetting Resin Pipe.** Elastomeric gasket joints shall comply with the manufacturer's instructions.

7.4.7. **Reinforced Plastic Mortar Pipe.** Elastomeric gasket joints shall conform to the manufacturer's recommendations.

7.5. **VALVES.** Prior to installation, valves shall be cleaned of all foreign matter and inspected for damage. Valves shall be fully opened and closed

to insure that all parts are properly operating. Valves shall be installed with the stem in the vertical position. [Valves shall be installed in valve vaults as indicated.]

7.6. NOT USED. VALVE BOXES. Valve boxes shall be installed over each outside valve, unless otherwise indicated. Valve boxes shall be centered over the valve. Fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides or to undisturbed trench face, if less than 4 feet.

7.7. NOT USED. VALVE VAULTS. Valve vaults shall be installed as indicated.

7.8. NOT USED. DRAIN LINES. Drain lines shall be installed where indicated. The drain line shall consist of a tee in the main line with a 4-inch diameter branch, a 4-inch diameter elbow, and a 4-inch plug valve.

#(N)#

7.9. NOT USED. THRUST BLOCKS. Plugs, caps, tees, and bends deflecting 22-1/2 degrees or more, either horizontally or vertically, on force mains 6 inches in diameter or larger shall be provided with thrust blocking, tie rods, or bolts and clamps. Thrust blocking shall be constructed of concrete having a compression strength of not less than 3,000 psi after 28 days. Thrust blocks shall be installed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust block shall be placed directly against undisturbed earth. The sides of the thrust block not subject to thrust may be poured against forms. The bearing area of each thrust block shall be as shown on the drawings. The blocking shall be placed so that the fitting joint will be accessible for repair. Steel rods, clamps and bolts shall be protected by galvanizing or coating with bituminous paint.

7.10. NOT USED. BONDED JOINTS. For ferrous piping, a metallic bond shall be provided at each joint, including joints made with flexible couplings, calking or rubber gaskets, of ferrous-metallic piping to effect continuous conductivity. The bond shall be of the thermal weld type. Test leads shall be provided in accordance #(d)#
with the details shown on the drawings. Test leads shall be placed at intervals not exceeding 300 feet, on pipe casings, and where the pipe crosses within 6 inches of any other metal pipe (provide 2 test leads, one each pipe). Test leads will not be required within 300 feet of a riser pipe or any other place where the pipe may be readily accessible. The Contractor shall provide a plan showing dimensioned location of all test leads. Test leads and bond connections shall be made with the exothermic weld process, insulated with coal tar base mastic and protected with a weld shield or a plastic weld cap.

8. **HYDROSTATIC TESTS.** The pipeline shall be subjected to both a pressure test and a leakage test. [The method proposed for disposal of waste water from hydrostatic tests shall be approved by the Contracting Officer.]

8.1. **PRESSURE TEST.** After the pipe has been installed, joints completed, thrust blocks have been in place for at lest 5 days, and the trench has been partially backfilled, leaving the joints exposed for examination, the pipe shall be filled with water in a manner to expel all air. The pipeline shall be subjected to a test pressure of 100 psi or 150 percent of the working pressure, whichever is greater, for a period of at least 1 hour. Each valve shall be opened and closed several times during the test. The exposed pipe, joints, fitting, and valves shall be examined for leaks. Visible leaks shall be stopped or the defective pipe, fitting, joints, or valve shall be replaced.

8.2. LEAKAGE TEST.

8.2.1. The leakage test may be conducted subsequent to or concurrently with the pressure test.

8.2.2. The amount of water permitted as leakage for the line shall be placed in a sealed container attached to the supply side of the test pump. No other source of supply will be permitted to be applied to the pump or line under test. The water shall be pumped into the line by the test pump as required to maintain the specified test pressure as described for pressure test for a 2-hour period. Exhaustion of the supply or the inability to maintain the required pressure will be considered test failure.

8.2.3. Leakage considered acceptable shall be less than the number of gallons per hour as determined by the following formula:

L = ND P/K Where:

L = Allowable leakage in gallons per hour.

N = Number of joints in length of pipeline tested.

D = Nominal diameter of the pipe in inches.

P = Square root of the test pressure in psig.

K = 4000 for asbestos - cement pipe.

K = 7400 for other pipe materials.

8.2.4. At the conclusion of the test, the amount of water remaining in the container shall be measured and the results recorded in the test report.

8.3. RETESTING. If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be reconducted until the results of the tests are within specified allowances without additional cost to the Government.

ZERO ACCIDENTS

SECTION 02910
MONITORING WELLS

INDEX

1. APPLICABLE PUBLICATIONS
2. SCOPE
3. QUALITY CONTROL
4. DOCUMENTATION
5. SUBMITTALS
6. MATERIALS
7. INSTALLATION
8. PROTECTION OF EXISTING FACILITIES
9. LOCATION SURVEY

1. APPLICABLE PUBLICATIONS. The following publications of these 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.

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

A 185-85	Steel Welded Wire Fabric, Plain for Concrete Reinforcement
C 94-89	Standard Specification for Ready Mix Concrete
C 150-86	Standard Specification for Portland Cement
D 1586-84	Standard Method for Penetration Test and Split-Barrel Sampling of Soils
D 1889-81	Standard Test Methods for Turbidity of Water
D 2487-85	Standard Test Method for Classification of Soils for Engineering Purposes
D 2488-84	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
F 480-81	Specifications for Thermoplastic Water Well Casing Pipe and Couplings Made in Standard Dimension Ratios

2. SCOPE. The work provided for herein consists of furnishing all plant, labor, fuels, lubricants, electric energy, materials, and equipment, and performing all operations required to construct monitoring wells as indicated on the drawings and as specified herein.

3. QUALITY CONTROL. The Contractor shall establish and maintain quality control for all monitor well construction to assure compliance with contract requirements. The Contractor shall maintain records of his quality control for construction, including but not limited to the items listed in paragraph: Submittals.

4. DOCUMENTATION. For each monitoring well installed, the documents outlined below shall be completed.

4.1. Geologic Logs. Geologic Logs shall be prepared by a qualified hydrogeologist present on-site during all well drilling and installation activities. Formation sampling shall be performed as necessary to provide the information specified below. The log scale shall be 1-inch equals 1-foot.

Copies of the logs shall be submitted as a Category II (Approval) submittal within 10 working days after completion of the boring and well installation program. Information provided on the logs shall include, but not be limited to, the following:

4.1.1. Name of the project and site.

4.1.2. Boring identification number.

4.1.3. Location of boring (coordinates).

4.1.4. Type of drill rig and name of drilling firm.

4.1.5. Date(s) borings were drilled.

4.1.6. Reference elevation for all depth measurements.

4.1.7. Name of driller and name and signature of hydrogeologist preparing log.

4.1.8. Nominal hole diameter and depth at which hole diameter changes.

4.1.9. Total depth of boring.

4.1.10. Method of drilling, including sampling methods and sample depths. Also include a description of drill fluids and fluid additives used, if any.

4.1.11. Depth of each change of stratum.

4.1.12. Description of the material of which each stratum is composed, according to the Unified Soil Classification System and ASTM D 2488, or standard rock nomenclature, as necessary.

4.1.13. Depth of any observed fractures or weathered zones in overburden.

4.1.14. Depth and quantity of drill fluid loss or lost circulation.

4.1.15. Depth to water and date measured.

4.1.16. Chemical analysis of any drill water used.

4.2. Installation Diagrams. An installation diagram shall be completed for each monitoring well installed. The scale of the diagram shall be 1-inch equals 1-foot. The diagram shall be prepared by the hydrogeologist present during well installation operations. Submission of the diagram shall be a Category II (Approval) submittal within 10 working days of the completion of the well installation program. The well will not be accepted by the Contracting Officer's Representative before the geologic logs and installation diagrams are received. The diagram shall illustrate the as-built condition of the well and include, but not be limited to, the following items:

4.2.1. Name of the project and site.

4.2.2. Well identification number.

4.2.3. Name of driller and name and signature of hydrogeologist preparing diagram.

4.2.4. Date(s) of well installation.

4.2.5. Description of material from which the well is constructed, including casing and screen material, diameter and schedule of casing and screen, and joint type (threaded, coupled, etc.).

4.2.6. Total depth of well.

4.2.7. Nominal hole diameter.

4.2.8. Depth to top and bottom of screen, filter pack, and any tailpipe installed in the well.

4.2.9. Depth to top and bottom of any seals installed in the well boring (grout or bentonite).

4.2.10. Type of cement and bentonite used, mix ratios of grout, and quantities used.

4.2.11. Elevations of key features of the well, such as top of well casing, top and bottom of protective casing, ground surface, bottom of well screen, top and bottom of filter pack, and top and bottom of seal(s).

4.2.12. Other pertinent construction details, such as gradation and depth of filter pack, quantities of filter pack installed, slot size and percent open area of screen, and manufacturer of screen.

4.2.13. Well location by coordinates. A plan sheet shall also be included showing the coordinate system used and the location of each well. A plan sheet is not required for each well installation diagram; multiple wells may be shown on the same sheet.

4.2.14. A brief stratigraphic log showing major changes in lithology and the depths to those changes.

4.2.15. Static water level upon completion of the well.

4.3. Well Development Record. A well development form shall be prepared and completed for each monitoring well installed. The form shall be prepared under the supervision of the hydrogeologist present during well installation operations. Submission of the form shall be a Category II (Approval) submittal within 10 working days of the completion of development. Information provided on the well development record shall include, but not be limited to, the following:

4.3.1. Date, time, and elevation of water level in the well, before development, name of project and site, well identification number, and date of development.

4.3.2. Method used for development.

4.3.3. Time spent developing the well.

4.3.4. Volume of water removed.

4.3.5. Volume of water added to the well (if any).

4.3.6. Volume of sediment removed.

4.3.7. Source of any water added to the well and chemical analysis of added water.

4.3.8. Clarity of water before, during, and after development, stated in nephelometric turbidity units according to ASTM D 1889.

4.3.9. Total depth of well after development.

4.3.10. Readings of pH, specific conductance, and temperature taken before, during, and after development.

4.3.11. Name of individual developing well.

4.4. Field Notebook. A field notebook shall be kept by the hydrogeologist present during well installation operations. Information shall include, but not be limited to, the following:

4.4.1. Date and personnel present.

4.4.2. Visitors to the site.

4.4.3. Activities performed.

4.4.4. Quantities

4.4.5. Weather conditions.

4.4.6. Any problems encountered.

5. SUBMITTALS. In accordance with SECTION: Special Clauses, the Contractor shall submit the following items:

5.1. Category I.

5.1.1. Drilling and Installation Plan. A plan describing the drilling methods and procedures to be used for monitoring well installation shall be submitted. The plan must either be prepared by, or approved and signed by, a hydrogeologist before submittal. The plan shall include, but not be limited to:

5.1.1.1. Description of well drilling and installation procedures, including placement of filter pack and seal materials.

5.1.1.2. Description of well construction materials, including well screen, riser pipe, tailpiece, filter pack, bentonite, and cement.

5.1.1.3. A description of quality control procedures to be used for placement of filter pack and all seals in the boring, including depth measurements. Also include example forms to be used for written drill logs, installation diagrams of wells, well development records.

5.1.1.4. Description of grouting and surface completion procedures.

5.1.1.5. A list of applicable publications, such as ASTM and/or API standards.

5.1.1.6. Description of well development method(s) to be used.

5.1.2. Gradation analysis of filter pack (Paragraph 6.3).

5.1.3. Chemical analysis of drilling water (Paragraph 7.3).

5.2. Category II (Approval).

5.2.1. Monitoring well geologic logs (Paragraph 4.1).

5.2.2. Monitoring well installation diagrams (Paragraph 4.2).

5.2.3. Monitoring well development record (Paragraph 4.3).

5.2.4. Catalog data on well casing, well screen, bentonite, cement, protective covers, and sampling equipment (Paragraph 6.7).

5.2.5. Field notebook (includes details of daily activities, geologic log and well installation/construction log).

6. MATERIALS.

6.1. Well Casing. Piping material used in construction of monitoring wells shall consist of 4-inch diameter, flush-joint, threaded, polyvinyl chloride (PVC) plastic. All pipe shall be new. Pipe shall meet the requirements of ASTM F 480-81. The minimum wall thickness shall be Schedule 40. Threaded ends shall have a chemically inert O-ring on the male end of the pipe. Solvent cement or glue is not permitted for use in joining pipe. Teflon tape is acceptable for use on pipe joints. A vented top cap that threads or slips onto the well casing shall be provided.

6.2. Well Screen. All well screens shall consist of 4-inch diameter, new, Schedule 40, continuous slot, wire wound PVC. A No. 10 (0.10 in) screen slot size shall be used. Screen lengths for individual monitoring wells are identified in the project drawings. the screen shall be joined to the well casing by a flush-threaded joint. Solvent cement or glue is not permitted for joining the screen to the well casing. Teflon tape is acceptable for use on joints. The bottom of the screen shall be sealed watertight by a flush-threaded PVC end cap or tail pipe with cap.

6.3. Filter Pack. Filter pack material shall consist of rounded to subrounded #1 siliceous washed sand of the gradation below and composed of hard, tough, and durable particles free from adherent coatings. Organic matter, soft, friable, thin, or elongate particles are not permissible. No more than 5 percent

by weight of calcareous material is permitted. A gradation analysis of the filter pack shall be a Category I submittal.

U.S. Standard Sieve No.	% Passing
16	100
20	80-100
30	60-98
40	35-75
70	0-10
140	0-2

6.4. Well Seal and Grout. A well seal shall be placed immediately above the filter pack to prevent contamination of the filter pack by grout. If the seal is installed in unsaturated conditions in the boring, it shall consist of a 40-mesh granular sodium bentonite. If the seal is installed in saturated conditions, it shall consist of 1/2-inch diameter sodium bentonite pellets. The bentonite seal shall be allowed to hydrate prior to placement of grout. Grout shall consist of a mixture of 94 pounds of Type II Portland cement, 3 pounds of powdered bentonite and a maximum 8 gallons of water. Cement shall meet the requirements of ASTM C 150.

6.5. Concrete for well pads. The concrete for the well pads as shown on the drawings shall consist of Ready Mix Concrete with maximum 3/4-inch aggregate in accordance with ASTM C 94-89. The concrete shall have 3,000 psi 28-day strength.

6.6. Welded Wire Fabric. Welded wire fabric used in the well pads shall be 4x4 mesh and conform to ASTM 185.

6.7. Protective Covers. Steel lockable protective casing of 8-inch diameter shall be cemented in place around each monitor well. Wall thickness of the steel casing shall be 0.250 inches. All protective casing shall be provided with keyed locks. All locks shall be keyed alike. One set of two keys shall be provided to the Contracting Officer's Representative.

6.8. Sampling Equipment. Teflon bailers shall be dedicated to each monitoring well constructed. Bailers shall be stored inside the well casing a minimum of 2 feet above ground water when not in use. Bailers shall be a minimum of 3 feet in length. Rope used to raise and lower the bailer shall be polyethylene or polypropylene and shall also be dedicated to the well.

6.9. Catalog Data Submittal. Catalog data for all well screens, casing, bentonite, cement, protective casings, and sampling equipment shall be submitted as a Category II (Information) submittal.

7. INSTALLATION.

7.1. Drilling Method. Borings for monitoring well installation except for wells placed in extraction trenches shall be drilled by the hollow stem auger method. The drilling method must prevent the collapse of formation material against or within 2 inches of the well screen and casing during installation of the well. The inside diameter of the augers shall be at least 6-1/4 inches. Grease or oil on rod, casing, or auger joints is not permitted; however, Teflon tape or vegetable oil are acceptable. The drill rig shall be free from leaks of fuel, hydraulic fluid, or oil which may contaminate the working area. Sufficient sampling of geologic formations shall be performed to allow completion

of the documents described in paragraphs 4.1 and 4.2 of this specification. Continuous samples shall be taken according to ASTM D 1586. No samples are required for the shallow well in well pairs. The specific method of drilling, equipment, and precautions to be used to prevent contamination of the work area shall be detailed in the Drilling and Installation Plan described in paragraph 5.1.1. of this specification.

7.2. Decontamination. The drill rig, drill rods, augers, and all other associated equipment shall be cleaned with high-pressure steam prior to drilling at each location. Decontamination shall be performed at a central decontamination station. All screen and well casing shall be steam-cleaned immediately prior to installation in the well. Factory sealed (plastic wrapped) screen and well casing can be substituted for preinstallation cleaning.

7.3. Water Source. If well drilling/installation requires the use of water, the water source shall be sampled and tested for the constituents specified in SECTION: CHEMICAL DATA MANAGEMENT prior to use at the site. Results of the chemical analysis shall be a Category I submittal. The Contractor shall be responsible for obtaining the water from the source and transporting it to the site. The water sample shall be obtained from the container (tank) used in transporting the water to the site.

7.4. Well Depth. Estimated depths of individual borings are shown in the design drawings.

7.5. Well Installation. Monitoring wells shall consist of specified screen and well casing, screen, and caps shall be new, clean, and in good condition. The well shall be placed in the hole in such a manner as to avoid jarring impacts and to ensure the assembly is not damaged. The well shall be implaced while the hollow stem auger or temporary casing (depending on the drilling method used) is still in place in the boring. The well shall be centered in the hollow stem auger using centralizers placed at the bottom and top of screen.

7.6. Filter Pack Placement. The lowermost 6 inches of filter pack may be placed in the boring prior to installation of the well casing and may serve as a base on which to rest the casing. The filter pack shall be tremied into place, from the bottom of the borehole up, in such a manner as to ensure uniform placement around the screen. The hollow stem auger or temporary casing shall be withdrawn from the boring as the filter pack is placed. The level of the filter pack shall not fall below the bottom of the auger or casing during placement of the filter pack. Any water added to the sand during the tremie operation shall meet the requirements of paragraph: WATER SOURCE of this specification. All filter pack material shall be protected from contamination prior to placement by either storing it in plastic-lined bags in a location protected from the weather. All filter pack materials shall be transported to the well site in a manner that prevents contamination by other soils, oil and grease, and other chemicals.

7.7. Well Alignment. All wells shall be set straight and true to line. After placement of the filter pack, well alignment shall be tested by passing a 5-foot long section of pipe, 1/2-inch less in diameter than the inner diameter of the well riser pipe, to the bottom of the well. The pipe shall move freely through the entire length of the well riser and screen. The results of this test shall be recorded on the Well Installation Diagram. If the pipe does not pass freely, the well will not be accepted. If not accepted, the well shall be removed from the boring and filter pack drilled out. The well shall then be

reinstalled according to this specification. The pipe section used to test well alignment shall be decontaminated with steam prior to each test.

7.8. Well Drill Cuttings. Well cuttings produced during drilling operations will be considered contaminated. Cuttings will be secured in 55-gallon approved steel drums. The _____ will be responsible for the ultimate disposal of well drill cuttings.

7.9. Well Development. The wells shall be developed immediately after placement of the filter pack and before placement of the seals. Well development shall be conducted by alternatively surging and building each well and shall include surging of all screened sections of the well. Surging shall be performed by use of a surge block of minimum 3-inch outside diameter. The borehole above the filter pack shall be maintained in a stable condition throughout all development operations. Additional filter pack material shall be added to the boring, if necessary, to bring the filter pack up to a distance of 2 feet above the top of screen. During the development process, the level of filter pack shall be maintained a minimum of 1 foot above the top of screen elevation. Development criteria include pH, specific conductance, and temperature readings (within ±0.2 pH, +5 percent specific conductance, and +1 degree C temperature), and ground water is free of sediment. Ground water generated during well development shall be collected in approved drums or tanks and shall be disposed of by _____.

7.10. Bentonite Seal and Grout Placement. A bentonite seal shall be placed above the filter pack. Prior to placement of the seal, the Contractor shall verify that the filter pack extends a minimum of 2 feet above the top of screen elevation in the well after development. If it does not, sufficient filter pack material shall be added to bring the pack to the specified level. If the seal is installed in unsaturated conditions in the boring, it shall consist of a mixture of 40-mesh granular sodium bentonite and filter pack material. The mixture shall be in the ration of 50 percent bentonite and 50 percent filter pack. The filter pack shall meet the requirements specified in paragraph: FILTER PACK of this specification. The mixture shall be placed by tremie pipe in 1 foot lifts. After implacement, each lift will be hydrated for a period of 15 minutes using water meeting the requirements of paragraph: WATER SOURCE of this specification. If the seal is installed in saturated conditions, it shall consist of 1/2-inch diameter sodium bentonite pellets. Bentonite pellets shall be allowed to hydrate a minimum of 2 hours prior to commencement of grouting. The hole shall then be grouted to within 5 feet of the ground surface with a neat cement grout. Grout shall be as described in paragraph: WELL SEAL AND GROUT of this specification. The grout shall be placed by tremie pipe, submerged in the grout at all times. The tremie pipe shall be constructed so as to direct flow of grout to the sides rather than downward. The tremie pipe may be raised as the grout is placed as long as the discharge end remains submerged in the grout.

7.11. Surface Completion. Monitoring wells shall be completed at the surface with a protective steel casing meeting the requirements of paragraph: PROTECTIVE COVERS of this specification. A concrete seal shall be installed in the annulus of the borehole. Placement of the concrete seal shall commence within a maximum of 2 hours of completion of grouting of the borehole. The concrete surface seal shall be sloped to provide positive drainage away from the protective casing. The inside of the protective casing shall be filled with mortar to a point slightly above the exterior concrete pad. A hole shall be

drilled through the protective steel casing immediately above the mortar (placed inside the casing) to allow drainage of the protective casing. Protective casings shall be locked with keyed-alike locks.

8. PROTECTION OF EXISTING FACILITIES. The Contractor shall protect and maintain existing structures, survey monuments and all existing monitoring wells from damage from equipment and vehicular traffic. Any damage shall be repaired by the Contractor at his expense. Any monitoring wells requiring replacement due to Contractor negligence shall be installed according to these specifications.

9. LOCATION SURVEY. Each monitor well shall be surveyed to within plus or minus one foot to determine its map coordinates using the Universal Transverse Mercator or State Planar grid. Elevations of the natural ground surface, top of the concrete pad, and the highest point on the rim of the uncapped well casing (not protective casing) for each monitor well shall be surveyed to within 0.01 foot using the National Geodetic Vertical datum of 1929.

10. LOCATION SURVEY. Each monitor well shall be surveyed to within plus or minus one foot to determine its map coordinates using the universal transverse mercator or state planar grid. Elevations of the natural ground surface, top of the concrete pad, and the highest project on the rim of the uncapped well casing (not protective casing) for each monitor well shall be surveyed to within 0.01 foot using the National Geodetic Vertical datum of 1929.

ZERO ACCIDENTS

SECTION 02920
PIEZOMETERS

INDEX

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5. SUBMITTALS
6. MATERIALS
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1. APPLICABLE PUBLICATIONS. The following publications of these 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.

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

C 150-86	Standard Specification for Portland Cement
C 1586-84	Standard Method for Penetration Test and Split Barrel Sampling of Soils
D-1889-81	Standard Test Methods for Turbidity of Water
D 2487-85	Standard Test Method for Classification of Soils for Engineering Purposes
D 2488-84	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
F 480-81	Specifications for Thermoplastic Water Well Casing Pipe and Couplings Made in Standard Dimension Ratios

2. SCOPE. The work provided for herein consists of furnishing all plant, labor, fuels, lubricants, electric energy, materials, and equipment, and performing all operations required to construct piezometers as indicated on the drawings and as specified herein.

3. QUALITY CONTROL. The Contractor shall establish and maintain quality control for all piezometer construction to assure compliance with contract requirements. The Contractor shall maintain records of his quality control for construction, including but not limited to the items listed in paragraph 5, SUBMITTALS.

4. DOCUMENTATION. For each piezometer installed, the documents outlined below shall be completed.

4.1. Geologic Logs. Geologic logs shall be prepared by a qualified hydrogeologist present on-site during all well drilling and installation activities. Formation sampling shall be performed as necessary to provide the information specified below. The log scale shall be 1-inch equals 1-foot. Copies of the logs shall be submitted as a Category II (Approval) submittal within 10 working days after completion of the boring and well installation program. Information provided on the logs shall include, but not be limited to, the following:

4.1.1. Name of the project and site.

4.1.2. Boring identification number.

4.1.3. Location of boring (coordinates).

4.1.4. Type of drill rig and name of drilling firm.

4.1.5. Date(s) borings were drilled.

4.1.6. Reference elevation for all depth measurements.

4.1.7. Name of driller and name and signature of hydrogeologist preparing log.

4.1.8. Nominal hole diameter and depth at which hole diameter changes.

4.1.9. Total depth of boring.

4.1.10. Method of drilling, including sampling methods and sample depths. Also include a description of drill fluids and fluid additives used, if any.

4.1.11. Depth of each change of stratum

4.1.12. Description of the material of which each stratum is composed, according to the Unified Soil Classification System and ASTM D 2488, or standard rock nomenclature, as necessary.

4.1.13. Depth of any observed fractures or weathered zones in overburden.

4.1.14. Depth to water and date measured.

4.1.15. Chemical analysis of any drill water used.

4.2. **Installation Diagrams.** An installation diagram shall be completed for each piezometer installed. The scale of the diagram shall be 1-inch equals 1-foot. The diagram shall be prepared by the hydrogeologist present during piezometer installation operations. Submission of the diagram shall be a Category II (Approval) submittal within 10 working days of the completion of the installation program. The piezometer will not be accepted by the Contracting Officer's Representative before the geologic logs and installation diagrams are received. The diagram shall illustrate the as-built condition of the piezometer and include, but not be limited to the following items:

4.2.1. Name of the project and site.

4.2.2. Piezometer identification number.

4.2.3. Name of driller and name and signature of hydrogeologist preparing diagram.

4.2.4. Dates(s) of piezometer installation.

4.2.5. Description of material from which the piezometer is constructed including casing and screen material, diameter and schedule of casing and screen, and joint type (threaded, coupled, etc.).

4.2.6. Total depth of piezometer.

4.2.7. Nominal hole diameter.

4.2.8. Depth to top and bottom of screen, filter pack, and any tailpipe installed in the piezometer.

4.2.9. Depth to top and bottom of any seals installed in the piezometer boring (grout or bentonite).

4.2.10. Type of cement and bentonite used, mix ratios of grout and quantities used.

4.2.11. Elevations of key features of the piezometer, such as top of piezometer casing, top and bottom of protective casing, ground surface, bottom of borehole, top and bottom of screen, top and bottom of filter pack and top and bottom of seal(s).

4.2.12. Other pertinent construction details, such as gradation and depth of filter pack, quantities of filter pack installed, slot size and percent open area of screen, and manufacturer of screen.

4.2.13. Piezometer location by coordinates. A plan sheet shall also be included showing the coordinate system used and the location of each piezometer. A plan sheet is not required for each piezometer installation diagram, multiple piezometers may be shown on the same sheet.

4.2.14. A brief stratigraphic log showing major changes in lithology and the depths to those changes.

4.2.15. Static water level upon completion of the piezometer.

4.3. **Piezometer Development Record.** A piezometer development form shall be prepared and completed for each piezometer installed. The form shall be prepared under the supervision of the hydrogeologist present during piezometer installation operations. Submission of the form shall be a Category II (Approval) submittal within 10 working days of the completion of development. Information provided on the piezometer development record shall include, but not be limited to, the following:

4.3.1. Date, time, and elevation of water level in the piezometer before development, name of project and site, piezometer identification number and date of development.

4.3.2. Method used for development.

4.3.3. Time spent developing the piezometer.

4.3.4. Volume of water removed.

4.3.5. Volume of water added to the piezometer (if any).

4.3.6. Volume of sediment removed.

4.3.7. Source of any water added to the piezometer and chemical analysis of added water.

4.3.8. Clarity of water before, during, and after development, stated in nephelometric turbidity units according to ASTM D 1889.

4.3.9. Total depth of piezometer after development.

4.3.10. Readings of pH, specific conductance, and temperature taken before, during, and after development.

4.3.11. Name of individual developing piezometer.

4.4. **Field Notebook.** A field notebook shall be kept by the hydrogeologist during piezometer installation operations. Information shall include, but not limited to the following:

4.4.1. Date and personnel present.

4.4.2. Visitors to the site.

4.4.3. Activities performed.

4.4.4. Quantities.

4.4.5. Weather conditions.

4.4.6. Any problems encountered.

5. **SUBMITTALS.** In accordance with SECTION: SPECIAL CLAUSES, the Contractor shall submit the following items:

5.1. Category I.

5.1.1. **Drilling and Installation Plan.** A plan describing the drilling methods and procedures to be used for piezometer installation shall be submitted. The plan must either be prepared by, or approved and signed by, a hydrogeologist before submittal. The plan shall include, but not be limited to:

5.1.1.1. Description of piezometer drilling and installation procedures, including placement of filter pack and seal materials.

5.1.1.2. Description of piezometer construction materials, including screen, riser pipe, filter pack, bentonite, and cement.

5.1.1.3. A description of quality control procedures to be used for placement of filter pack and all seals in the boring, including depth measurements. Also include example forms to be used for written drill logs, installation diagrams of piezometers, piezometer development records.

5.1.1.4. Description of grouting and surface completion procedures.

5.1.1.5. A list of applicable publications, such as ASTM and/or API standards.

5.1.1.6. Description of piezometer development method(s) to be used.

5.1.2. Gradation analysis of filter pack.

5.1.3. Chemical analysis of drilling water.

5.2. **Category II (Approval).**

5.2.1. Piezometer geologic logs.

5.2.2. Piezometer installation diagrams.

5.2.3. Piezometer development record.

5.2.4. Catalog data on piezometer casing, piezometer screen, bentonite, cement, protective covers, and sampling equipment.

5.2.5. Field notebook (includes details of daily activities, geologic log, and piezometer installation/construction log).

6. MATERIALS.

6.1. **Well Casing.** Piping material used in construction of piezometers shall consist of 2-inch diameter, flush-joint, threaded, polyvinyl chloride (PVC) plastic. All pipe shall be new. Pipe shall meet the requirements of ASTM F 480-81. The minimum wall thickness shall be Schedule 40. Threaded ends shall have a chemically inert 0-ring on the male end of the pipe. Solvent cement or glue is not permitted for use in joining pipe. Teflon tape is acceptable for use on pipe joints. A vented top cap that threads or slips onto the piezometer casing shall be provided.

6.2. **Piezometer Screen.** All piezometer screens shall consist of 4-inch diameter, new, Schedule 40, continuous slot, wire wound, PVC. A No. 10 (0.010 in) screen slot size shall be used. Screen lengths for individual piezometers are identified in the project drawings. The screen shall be joined to the piezometer casing by a flush-threaded joint. Solvent cement or glue is not permitted for joining the screen to the piezometer casing. Teflon tape is acceptable for use on joints. The bottom of the screen shall be sealed watertight by a flush-threaded PVC end cap.

6.3. **Filter Pack.** Filter pack material shall consist of rounded to subrounded siliceous washed sand of the gradation below and composed of hard, tough, and durable particles free from adherent coatings. Organic matter, soft, friable, thin, or elongate particles are not permissible. No more than 5 percent by weight of calcareous material is permitted. A gradation analysis of the filter pack shall be a Category I submittal.

U.S. Standard Sieve No.	Percent Passing
16	100
20	80-100
30	60-98
40	35-75
70	0-10
140	0-2

6.4. **Piezometer Seal and Grout.** A piezometer seal shall be placed immediately above the filter pack to prevent contamination of the filter pack by grout. If the seal is installed in unsaturated conditions in the boring, it shall consist of a 40-mesh granular sodium bentonite. If the seal is installed in saturated conditions, it shall consist of 1/2-inch diameter sodium bentonite pellets. The bentonite seal shall be allowed to hydrate prior to placement of grout. Grout shall consist of a mixture of 94 pounds of Type II Portland cement, 3 pounds of powdered bentonite and a maximum 8 gallons of water. Cement shall meet the requirements of ASTM C 150.

6.5. **Protective Blanket.** A 6-inch thick coarse gravel (3/4" to 3" particle size) blanket shall be placed so as to extend radially at least 3 feet from the protective casing. Prior to the placement of the gravel blanket, any depression existing around the piezometer borehole shall be backfilled with clay to the level of the surrounding ground surface.

6.6. **Protective Covers.** Steel lockable protective casing of 6-inch diameter shall be cemented in place around each piezometer. Wall thickness of the steel casing shall be 0.250 inches. All protective casing shall be provided with keyed locks. All locks shall be keyed alike. One set of two keys shall be provided to the Contracting Officer's Representative.

6.7. **Catalog Data Submittal.** Catalog data for all piezometer screens, casing, bentonite, cement, protective casings, and sampling equipment shall be submitted as a Category II (Information) submittal.

7. INSTALLATION.

7.1. **Drilling Method.** Borings for piezometer installation shall be drilled by the hollow stem auger method. The drilling method must prevent the collapse of formation material against, or within 2 inches of, the piezometer screen casing during installation of the piezometer. The inside diameter of the augers shall be at least 4-inches. Grease or oil on rod, casing, or auger joints is not permitted; however, Teflon tape or vegetable oil are acceptable. The drill rig shall be free from leaks of fuel, hydraulic fluid, or oil which may contaminate the working area. Sufficient sampling of geologic formations shall be performed to allow completion of the documents described in paragraphs 4.1 and 4.2 of this specification. Continuous samples shall be taken according to ASTM D 1586. The specific method of drilling, equipment, and precautions to be used to prevent contamination of the work area shall be detailed in the Drilling and Installation Plan described in paragraph 5.1.1. of this specification.

7.2. **Decontamination.** The drill rig, drill rods, augers and all other associated equipment shall be cleaned with high-pressure steam prior to drilling at each location. Decontamination shall be performed at a central decontamination station. All screen and piezometer casings shall be steam-cleaned immediately prior to installation in the piezometer. Factory sealed

(plastic wrapped) screen and piezometer casings can be substituted for preinstallation cleaning.

7.3. **Water Source.** If piezometer drilling/installation requires the use of water, the water source shall be sampled and tested for the constituents specified in SECTION: CHEMICAL DATA MANAGEMENT prior to use at the site. Results of the chemical analysis shall be a Category I submittal. The Contractor shall be responsible for obtaining the water from the source and transporting it to the site. The water sample shall be obtained from the container (tank) used in transporting the water to the site.

7.4. **Piezometers.** Estimated depths of individual borings are shown in the design drawings.

7.5. **Piezometer Installation.** Piezometers shall consist of specified screen and casing, with bottom plug and top cap securely attached. All casing, screen, and caps shall be new, clean, and in good condition. The piezometer shall be placed in the hole in such a manner as to avoid jarring impacts and to ensure the assembly is not damaged. The piezometer shall be emplaced while the hollow stem auger is still in place in the boring. The piezometer shall be centered in the hollow stem auger using centralizers placed at the bottom and top of screen.

7.6. **Filter Pack Placement.** The lowermost 6 inches of filter pack may be placed in the boring prior to the installation of the piezometer and may serve as a base on which to rest the casing. The filter pack shall be tremied into place, from the bottom of the borehole up, in such a manner as to ensure uniform placement around the screen. The hollow stem auger shall be withdrawn from the boring as the filter pack is placed. The level of the filter pack shall not fall below the bottom of the auger during placement of the filter pack. Any water added to the sand during the tremie operations shall meet the requirements of paragraph: WATER SOURCE of this specification. All filter pack material shall be protected from contamination prior to placement by either storing it in plastic-lined bags in a location protected from the weather. All filter pack materials shall be transported to the piezometer site in a manner that prevents contamination by other soils, oil and grease, and other chemicals.

7.7. **Piezometer Drill Cuttings.** Piezometer cuttings produced during drilling operations will be considered contaminated. Cuttings will be secured in 55-gallon approved steel drums. The Rocky Mountain Arsenal will be responsible for the ultimate disposal of well drill cuttings.

7.8. **Piezometer Development.** The piezometers shall be developed immediately after placement of the filter pack and before placement of the seals. Piezometer development shall be conducted by alternately surging and bailing each piezometer and shall include surging of all screened sections of the piezometer. Surging shall be performed by use of a surge block. The borehole above the filter pack shall be maintained in a stable condition throughout all development operations. Additional filter pack material shall be added to the boring, if necessary, to bring the filter pack up to a distance of 2 feet above the top of screen. During the development process, the level of filter pack shall be maintained a minimum of 1 foot above the top of screen elevation. Ground water generated during well development shall be collected in approved drums or tanks and shall be disposed by the Rocky Mountain Arsenal.

7.9. **Bentonite Seal and Grout Placement.** A bentonite seal shall be placed above the filter pack. Prior to placement of the seal, the Contractor shall verify that the filter pack extends a minimum of 2 feet above the top of screen elevation in the piezometer after development. If it does not, sufficient filter

pack material shall be added to bring the pack to the specified level. If the seal is installed in unsaturated conditions in the boring, it shall consist of a mixture of 40-mesh granular sodium bentonite and filter pack material. The mixture shall be in the ratio of 50 percent bentonite and 50 percent filter pack. The filter pack shall meet the requirements specified in paragraph: FILTER PACK of this specification. The mixture shall be placed by tremie pipe in 1 foot lifts. After emplacement, each lift will be hydrated for a period of 15 minutes using water meeting the requirements of paragraph: WATER SOURCE of this specification. If the seal is installed in saturated conditions, it shall consist of 1/2-inch diameter sodium bentonite pellets. Bentonite pellets shall be allowed to hydrate a minimum of 2 hours prior to commencement of grouting. The hole shall then be grouted to within 5 feet of the ground surface with a neat cement grout. Grout shall be as described in paragraph: PIEZOMETER SEAL AND GROUT of this specification. The grout shall be placed by tremie pipe, submerged in grout at all times. The tremie pipe shall be constructed so as to direct flow of grout to the sides rather than downward. The tremie pipe may be raised as the grout is placed as long as the discharge end remains submerged in the grout.

7.10. **Surface Completion.** Piezometers shall be completed at the surface with a protective steel casing meeting the requirements of paragraph: PROTECTIVE COVERS of this specification. A concrete seal shall be installed in the annulus of the borehole. Placement of the concrete seal shall commence within a maximum of 2 hours of completion of grouting of the borehole. The protective blanket shall be sloped to provide positive drainage away from the protective casing. The inside of the protective casing shall be filled with mortar to a point slightly above the exterior protective blanket. A hole shall be drilled through the protective steel casing immediately above the mortar (placed inside the casing) to allow drainage of the protective casing. Protective casings shall be locked with keyed-alike locks.

8. **PROTECTION OF EXISTING FACILITIES.** The Contractor shall protect and maintain existing structures, survey monuments, and all existing monitoring wells from damage from equipment and vehicular traffic. Any damage shall be repaired by the Contractor at his expense. Any monitoring wells requiring replacement due to Contractor negligence shall be installed according to these specifications.

9. **LOCATION SURVEY.** Each piezometer shall be surveyed to within plus or minus one foot to determine its map coordinates using the Universal Transverse Mercator or State Plane Grid. Elevations of the natural ground surface, top of the protective blanket and the highest point on the rim of the uncapped piezometer casing (not protective casing) for each piezometer shall be surveyed to within 0.01 foot using the National Geodetic Vertical datum of 1929.

ZERO ACCIDENTS

SECTION 05600
METAL SHEET PILING

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9. REMOVALS
10. MEASUREMENT AND PAYMENT

1. **SCOPE.** The work covered by this section consists of furnishing all plant, equipment, labor and materials and performing all operations in connection with the installation of metal sheet piling in accordance with these specifications and applicable drawings.

2. **NOT USED.**

3. **APPLICABLE PUBLICATIONS.** The following publications listed below and 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) SPECIFICATIONS.**

A 328-84 Steel Sheet Piling

3.2. **AMERICAN WELDING SOCIETY (AWS) PUBLICATION.**

D 1.1-86 Structural Welding Code - Steel

4. **QUALITY ASSURANCE.**

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. Testing of sheet piling for mechanical properties shall be performed after the completion of all rolling and forming operations.

4.2. **WELDING.** Welding Operators and Welders shall be qualified in accordance with AWS D1.1. All materials used for welding and workmanship for welding shall be in accordance with AWS D1.1.

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 submittals to the Contracting Officer for approval as required. Submittals not satisfactory to the Contracting Officer will be rejected.

5.1. **EQUIPMENT DESCRIPTIONS.** Complete descriptions of sheet piling driving equipment including hammers, extractors, protection caps and other installation appurtenances shall be submitted for approval prior to commencement of work.

5.2. **SHOP DRAWINGS.** Shop drawings for sheet piling including fabricated sections shall show complete piling dimensions and details, driving sequence and location of installed piling. Shop drawings shall include details and dimensions of templates and other temporary guide structures for installing 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, section properties, heat analysis number, chemical composition, mechanical properties and mill identification mark.

5.4. **NOT USED.**

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 of installed piling.

6. **DELIVERY, STORAGE AND HANDLING.** Materials delivered to the site shall be new and undamaged 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. 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.

7. **MATERIALS.**

7.1. **METAL SHEET PILING.** Sheet piling shall be hot-rolled steel sections conforming to ASTM A 328. The interlocks of sheet piling shall be free-sliding, provide a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed. Fabricated sections shall conform to the requirements herein and the piling manufacturer's recommendations for fabricated sections. Fabricated corners, tees, wyes and cross pieces shall be fabricated of piling sections with a minimum web thickness of 3/8 inch. Sheet piling shall be provided with standard pulling holes.

7.1.1. The following table lists section properties of the specified sheet piling.

HOT-ROLLED STEEL SECTION

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)
PZ22	0.375	18.1	22.0	40.3

7.2. **APPURTENANT METAL MATERIALS.** Metal plates, shapes, bolts, nuts and other appurtenant fabrication and installation materials shall conform to manufacturer's standards and to the requirements specified in the respective sheet piling standards.

8. **INSTALLATION.**

8.1. **PILING DRIVING EQUIPMENT.**

8.1.1. **Driving Hammers.** Hammer shall be vibratory type. The eccentric movement of the vibratory hammer shall be between 1740 and 3470 in-lb. as recommended by the manufacturer for the piling weights and subsurface materials to be encountered.

8.2. **PLACING AND DRIVING.**

8.2.1. **Placing.** Pilings shall be carefully located as shown on the drawings or directed by the Contracting Officer. Pilings shall be placed plumb with out-of-plumbness not exceeding 1/8 inch per foot of length and true to line. Temporary templates, 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. 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.** 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 shall be taken in the sustained use of vibratory hammers when a hard driving condition is encountered to avoid interlock-melt or damages. The sheet piles will be driven one foot into the bedrock surface, or until refusal. Any further driving of piles shall be stopped when the penetration rate due to vibratory loading is one foot or less per minute, which is defined as the refusal point. The use of vibratory hammers should be discontinued at this point. The boring logs along the sheet pile alignment show bedrock at a depth of 9 to 14.5 feet, generally 9 feet on the south boundary increasing to 14.5 feet on the north boundary. Sheet piles shall be located 10 feet away from the design limits of vitrification. Pilings damaged during driving or driven out of interlock shall be removed and replaced at the Contractor's expense. Pilings shall be driven without the aid of a water jet. 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 pilings shall be driven to the required depth and tapered pilings shall be provided and driven to interlock with the out-of-plumb 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 shall 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. If the piling next to the one being driven tends to follow below final elevation it may be pinned to the next adjacent piling. If obstructions restrict driving a piling to the specified penetration the obstructions shall be removed or penetrated with a chisel beam. 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. Pilings shall not be driven within 100 feet of concrete less than 7 days old.

8.3. **CUTTING OFF AND SPLICING.** Pilings driven to refusal or to the point required 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. 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 shall become the property of the Contractor and shall be removed from the site. The Contractor shall cut holes in pilings for bolts or rods as required by the sheet pile manufacturer. 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 in steel piling shall be drilled or may be burned and reamed by approved methods which will not damage the surrounding metal. Holes other than bolt holes shall be reasonably smooth and the proper size for rods and other items to be inserted.

8.4. **INSPECTION OF DRIVEN PILING.** The Contractor shall inspect the interlocked joints of driven pilings extending above ground. Pilings found to be out of interlock shall be removed and replaced at the Contractor's expense.

8.5. **PULLING AND REDRIVING.** The Contractor shall pull selected pilings after driving to determine the condition of the underground portions of pilings when directed by the Contracting Officer. 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 is impaired shall be removed and replaced at the Contractor's expense. Pilings pulled and found to be in satisfactory condition shall be redriven when directed by the Contracting Officer.

8.5.1. **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 piling interlocks and adjacent construction. If the Contracting Officer determines that adjacent permanent construction has been damaged during pulling, the Contractor will be required to repair this construction 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 proper care not being exercised during pulling.

9. REMOVAL.

9.1. **SHEET PILE REMOVAL.** The sheet piles will not be removed under this contract, but will be removed by others in the future.

10. **MEASUREMENT AND PAYMENT.** Measurement and payment for Steel Sheet Pile shall be made at the contract unit price per square foot. Such costs shall include all cost of installing the steel sheet pile wall as shown on the drawings. Measurement for the sheet pile shall be based on the area in square feet measured

in a vertical plane through the centerline of the sheet pile cutoff wall from the top of the finished cutoff wall to the bottom of the sheet piles.

ZERO ACCIDENTS

SECTION 11303
GUIDE-MOUNTED SEWAGE LIFT LIFT STATION

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#(N)#

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, INC. (ANSI) STANDARDS.**

A21.51-1981 & Erratum	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids
B16.1-1975	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800

1.2. **AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS.**

A 120-84	Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses
A 153-82	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
C 478-87	Precast Reinforced Concrete Manhole Sections
C 890-78 (R 1985)	Minimum Structural Design Loading for Monolithic on Sectional Precast Concrete Water and Wastewater Structures

1.3. **AMERICAN WATER WORKS ASSOCIATION (AWWA) STANDARD.**

C 207-86	Steel Pipe Flanges for Waterwork Service - Sizes 4 In. Through 144 In.

1.4. **ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA) STANDARDS.**

STD 9-1978	Load Ratings and Fatigue Life for Ball Bearings
STD 11-1978	Load Ratings and Fatigue Life for Roller Bearings

1.5. **HYDRAULIC INSTITUTE (HI) PUBLICATION.**

Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps (14th Edition, 1983)

1.6. **MANUFACTURER'S STANDARDIZATION SOCIETY OF VALVE AND FITTINGS INDUSTRY (MSS) PUBLICATION.**

SP-78	Cast Iron Plug Valves, Flanged, and Threaded Ends (1977)

1.7. **NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) STANDARD.**
MG-1-1978 Motors and Generators
Incl Rev 1 thru 8

1.8. **NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) PUBLICATION.**
No. 70-1987 National Electrical Code

2. **GENERAL.** This section includes guide-mounted submersible sump sewage pumps, motors, controls, guide rails and supports, piping, valve chamber pump chamber and accessories.

2.1. **STANDARD PRODUCTS.** Material and equipment to be provided shall be the standard catalog product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate material and equipment that have been in satisfactory use at least 2 years prior to bid opening.

2.2. **NAMEPLATES.** Each major component of equipment shall have the manufacturer's name, address, and catalog or model number on a plate securely attached to the item of equipment.

2.3. **VERIFICATION OF DIMENSIONS.** The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

2.4. **FACTORY TESTS.** Pumps shall be tested by the manufacturer or a nationally recognized testing agency in compliance with Hydraulic Institute Standards. Where two or more identical pumps are specified, only one representative pump shall be tested. Certified test results shall be submitted to the Contracting Officer.

#(N)#

3. **SUBMITTALS.** In accordance with SECTION: SPECIAL CLAUSES, the Contractor shall submit for approval, items as listed in the following categories:

3.1. **CATEGORY I.**
Valves and Piping (Para. 4)
Sewage Pumps (Para. 6)
Motor Controls (Para. 6.3)
Motors (Para. 7.6)
Station Structure (Para. 8.2)
Access Covers (Para. 8.3)
Pump Characteristic Curves (Para. 12)
Wiring Diagrams (Para. 13.2.4)

3.2. **CATEGORY II.**
[Field Test Results] (Para. 2.4)
Spare parts data (Para. 13.1)

3.2.1. **For Approval.**
Operating and Maintenance Instructions (Para. 13.2)

4. **MATERIALS AND EQUIPMENT.** The following materials and equipment shall conform to the respective publications and other requirements specified below.

4.1. **CHECK VALVES.**

4.1.1. **Check Valves** shall be installed in pump discharge line. and shall be suitable for handling domestic sewage. Valve shall permit free flow of sewage forward and provide a positive check against backflow. Body shall be iron with a removable cover for inspection and removal of the gate assembly. Gate, gate seat, gate studs and nuts shall be bronze or other suitable alloy.

4.1.2. **Ball Check Valves**, suitable for handling domestic sewage, are acceptable for installation in pump discharge lines 2 inches and smaller when recommended by the pump manufacturer. The valve shall be the non-slam type designed to permit free flow of sewage forward and a positive check against backflow. Valve shall have a cast-iron body with a renewable rubber seat. Ball shall be stainless steel unless otherwise indicated. All screws, nuts, and bolts shall be of stainless steel or other corrosion-resistant materials.

4.2. NOT USED. PLUG VALVES shall conform to MSS SP-78 and to the following:

Type - Nonlubricated
Pattern - Regular
Plug - Resilient facing resistant to hydrocarbons. Hycar or Buna N
Operator - Lever with position indicator
Exposed Bolts and Nuts - Zinc plated or stainless steel

4.3. **PIPE.**

4.3.1. NOT USED. Ductile Iron. ANSI A21.51, thickness class 53 with ANSI B16.1 class 125 flanges.

4.3.2. **Steel Pipe.** ASTM A 120, standard weight. Steel pipe shall not be installed in contact with earth.

4.3.3. **Plastic Pipe.** Plastic pipe shall not be installed within the pump chamber or the valve chamber. PVCPlastic pipe installed outside between the pump chamber and valve chamber shall conform to specification SECTION: FORCE MAINS, SEWER.

4.4. **JOINTS.**

4.4.1. NOT USED. Ductile Iron. Joints and fittings shall conform to ANSI B16.1, class 125.

4.4.2. **Steel.** Flanges shall conform to AWWA C207, Class D.

5. **ELECTRICAL WORK.** Motors, manual or automatic motor control equipment and protective or signal devices required for operation specified herein and any wiring required therefor, but not shown on the electrical plans, shall be provided under this section in accordance with SECTION: ELECTRICAL WORK, INTERIOR. All wiring and disconnect switches installed within the pump basin shall be suitable for class I, division I locations.

6. SEWAGE **SUMP PUMP.**

6.1. **GENERAL.**

6.1.1. Guide-Mounted **Submersible** Sump **Pumps.** The pumps shall be of the nonclogging centrifugal type, designed to pump sewage. Each pump, when operating under conditions of the specified capacities and heads, shall be as near the peak efficiency as practicable.

6.1.2. NOT USED. Guide-Mounted Submersible Grinder Pumps. Pumps shall be of the centrifugal type with an integrally built-in grinder unit and submersible motor. Each pump, when operating under conditions of the specified capacities and head, shall be as near the peak efficiency as practicable.

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6.2. **PUMP CHARACTERISTICS.** Pump number[s] _____ [located in _____] shall have the following operating characteristics:

6.2.1. **Pump Service.** Contaminated groundwater.

6.2.2. **Design Operating Point.** 48 to 58 feet head, 22 gpm flow, _____ percent efficiency.

6.2.3. **Maximum Operating Point.** 48 to 58 feet head, 24 gpm flow.

6.2.4. **Minimum Operating Point.** 48 to 58 feet head, 19 gpm flow.

6.2.5. **Impeller Type.** Gray Iron No. 30, Cast Iron, or Bronze.

6.2.6. **Maximum Sphere Size.** [2-1/2-inch] [3-inch] [4-inch] [3/4-inch] diameter.

6.2.7. **Operating Speed.** 3450 or 3600 rpm.

6.2.8. **Motor Type.** speed: 3450 or 3600 rpm; Electrical Characteristics: 208 V a.c., 1 phase, [60] [ ] Hz.

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6.3. CONTROLS.

6.3.1. **Controller.** The pump controller shall be mounted in a [NEMA] [general-purpose sheet-metal enclosures] [watertight cast-metal enclosure [explosion-proof enclosures for class I, division] at the location indicated on the drawings]. [The controls shall automatically alternate the pumps in operation.] [The controls shall be suitable for the sequence of pump operations, which can be alternated by manual setting, as follows:]

6.3.2. **Floats.** Sealed float-type mercury switches shall be provided to control sump levels and provide an alarm signal. Mercury switches shall be sealed in an inert synthetic casing suspended in the sump [and held in place as detailed on the drawings]. [Float shall be weighted to hold it in place.] Three Two floats shall be provided for level control and one for alarm control. The float switches shall be part of an intrinsically safe system (circuit), listed for use in a Class I, Division I, Group D location.

6.3.3. **Alarm.** An alarm light and audible alarm in a weatherproof enclosure shall be provided at the control box actuated by a high liquid level in the pump chamber. The audible alarm shall be equipped with a silencing switch with automatic reset. [The alarm light provided shall also be actuated by the moisture probe in the pump seal chamber.]

6.3.4. **Operation.** On a rising liquid level, the lead pump shall be started when the liquid level reaches float number 2. When the liquid level reaches float number 3, the lag pump shall start and operate in conjunction with the lead pump. BothThe pump shall operate until the liquid level falls to float number 1 (lowest). When the liquid level reaches float number 3, the alarm light and bell shall be actuated, indicating a high liquid level. Float switch number 1 shall stop pump operation. A mechanical or electrical automatic alternator shall be provided to transpose the starting sequence of the lead pump.

[6.3.5. **Starting Delay.** When a standby electric generator is provided, a time delay shall be provided in the pump controller to allow a 30-second delay between successive pump starts.]

6.3.6. NOT USED. Elapsed Time Meter. An elapsed time meter shall be used for each pump. This meter shall measure hours in 1/10's of hours.

7. PUMP CONSTRUCTION.

7.1. PUMP CASING.

7.1.1. Pump casing shall be constructed of [cast iron] [semisteel] or [gray-iron]. The casing shall be of uniform quality and free from blow holes, porosity, hard spots, shrinkage cracks, and other injurious defects. The casing shall be capable of withstanding operating pressures 50 percent greater than the maximum operating pressures. The volute shall have smooth passages which provide unobstructed flow through the pump.

7.1.2. Exterior surfaces of the casing in contact with water sewage shall be protected by a sewagecorrosion-resistant coating. All exposed nuts and bolts shall be stainless steel.

7.2. **IMPELLER.** The impeller shall be of [cast, gray or ductile iron], [or bronze], [_____] and shall be of the [single] [double] [shrouded] open or semi-open non-clogging design to minimize clogging of solids., fibrous materials, heavy sludge, or other materials found in sewage. The impeller shall be statically, dynamically, and hydraulically balanced. The impeller shall be securely keyed to the shaft with a locking arrangement whereby the impeller cannot be loosened by torque from either forward or reverse direction. [A wear ring will be installed at the pump inlet to protect against impeller wear. Wear rings shall be constructed of _____ and be designed for ease of maintenance].

7.3. **PUMP SHAFT.** The pump shaft shall be of [high grade alloy steel] [stainless steel] [_____] and shall be of adequate size and strength to transmit the full driver horsepower with a liberal safety factor.

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7.4. **SEALS.** A tandem mechanical shaft seal system running in an oil bath shall be provided. Seals shall be of carbon, tungsten carbide, or ceramic, [_____] with each interface held in contact by its own spring system. Conventional mechanical seals which require a constant pressure differential to effect sealing will not be allowed.

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7.5. **BEARINGS.** Pump bearings shall be ball or roller type designed to handle all thrust loads in either direction. Pumps depending only on hydraulic balance end thrust will not be acceptable. Bearings shall have an AFBMA L-10 life of _____ hours minimum, as specified in AFBMA STD 9 or STD 11.

7.6. **MOTOR.** The pump motor shall have Class F insulation, NEMA B design, in accordance with NEMA MG-1, and shall be watertight. The motor shall be oil filled or shall be air filled with a water jacket which encircles the stator housing. A moisture probe capable of detecting water that intrudes beyond the lower mechanical seal of the seal chamber shall be provided. If moisture enters the seal chamber, the probe shall activate the alarm light in the control panel.

7.7. **POWER CABLE.**

7.7.1. The power cable shall comply with NFPA No. 70, Type SO, and shall be of standard construction for submersible pump applications.

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7.7.2. The power cable shall enter the pump through a heavy-duty entry assembly provided with an internal grommet assembly to prevent leakage. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board which shall isolate the motor interior from foreign material gaining access through the pump top. [Epoxies, silicones, or other secondary sealing systems are not acceptable.]

7.8. NOT USED. SEALING FLANGE. Each pump shall be equipped with a sliding guide bracket which will mate to the pump discharge elbow when the pump is lowered into position. Connection shall be made in such a manner to provide a leakless seal without the use of bolts and nuts and without personnel entering the pump pit.

7.9. NOT USED. GRINDER ASSEMBLY. The grinder assembly shall consist of a hardened stainless steel renewable cutter ring and cutter impeller. The assembly shall be designed to shear and reduce all materials normally found in domestic sewage such as wood, plastic, and rags into a fine slurry. The slurry

shall be capable of passing through _____-inch diameter piping system including check and [plug] valves.

8. MISCELLANEOUS.

8.1. NOT USED. RAIL-MOUNTED SYSTEMS.

8.1.1. NOT USED. Rail System for Non-Clog Sewage Pumps. Rail-mounted installation systems shall consist of galvanized guide rails, a sliding bracket, and a discharge connection elbow. Guide rails shall be of the size and type standard with the manufacturer and shall not support any portion of the weight of the pump. Guide rails shall be anchored at the top and bottom of the basin with intermediate supports provided if wet well depth exceeds 12 feet. The sliding guide bracket shall be an integral part of the pump unit. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection and service without entering the pump chamber.

8.1.2. NOT USED. Rail Mounted System for Grinder Pumps. Rail mounted installation systems shall consist of galvanized guide rails, a sliding bracket and a sealing flange. Guide rails shall be of the size and type standard with the manufacturer and shall not support any portion of the weight of the pump. Guide rails shall be anchored at the top and bottom of the basin with intermediate supports provided if wet well depth exceeds 12 feet. The sliding guide bracket shall be an integral part of the pump unit. The sealing flange shall be permanently installed in the wet well along with the discharge piping. The check valve shall be located between the pump discharge and the sealing flange such that the check valve is removed with the grinder pump as an assembly. The pump shall be automatically connected to the sealing flange when lowered into place and shall be easily removed for inspection and service without entering the pump chamber.

8.2. **Lifting Chain.** Lifting chain to raise and lower the pump through the limits indicated shall be provided. The chain shall be galvanized and shall be capable of supporting the pump.

8.3. **PUMP AND VALVE CHAMBERS.**

8.3.1. **Polyethylene.** Pump chamber shall be constructed of 36 inch I.D. corrugated polyethylene pipe. The pipe shall be of the length required to meet the required chamber depth indicated on the drawings. The pipe and fittings used to construct the pump chamber shall be made of polyethylene compounds which meet or exceed the requirements of Type III, Category 4 or 5, Grade P33 or P34, Class C per ASTM D-1248 with the applicable requirements defined in ASTM D-1248. Joints shall be made with split couplings, corrugated to match the pipe corrugations, and shall engage a minimum of 4 corrugations with neoprene gaskets to provide a soil tight joint. The pipe shall be provided with a 6-inch fitting for connection to the 6-inch collection drain at the location which will meet the collection drain invert indicated on the drawings. The bottom of the pump chamber shall be water tight and shall consist of a 36-inch diameter pipe cap welded to the pipe. The top of the pump chamber shall consist of a lockable cover which can be removed for maintenance purposes.

8.3.2.. **Installation.** The pump chamber and collection piping shall be installed as one unit. All piping connections shall be made above ground including the connection to the pump chamber. The piping and pump chamber shall be lowered as one unit into the collection trench, through a bio-slurry. This operation may require a crane to guide the pump chamber into proper position.

Concrete. Pump chamber shall be constructed of precast manhole sections conforming to ASTM C 478. Valve chambers may be of precast concrete manhole sections conforming to ASTM C 478, precast concrete designed in accordance with ASTM C 890, or poured-in-place concrete as detailed on the drawings with 3,000 psi concrete. The top and bottom slabs shall be constructed as detailed on the drawings. Concrete shall conform to the SECTION: CONCRETE.

8.3.3. NOT USED. Fiberglass. The [grinder] pumps shall be installed in a _____-inch diameter fiberglass reinforced polyester resin tank with a depth below the inlet invert of _____ inches. The pump chambers shall have a minimum nominal wall thickness of 3/16 inch and a minimum operating capacity of _____ gallons. [An] [A cast-iron] inlet hub comparable with the connecting gravity sewer diameter and material shall be furnished and installed where previously indicated herein. The inlet hub shall be securely fastened to the tank with stainless steel bolts and nuts. The inlet connection shall be leak tight. [The basin covers shall be constructed of fiberglass reinforced polyester stiffened with steel angle sections molded integrally in the covers to resist deflection.] [The basin shall be provided with 1/4-inch-thick steel covers factory coated with epoxy paint and a field applied bituminous coating.] The cover shall be rated to withstand a 150 pounds per square foot live load. The fiberglass pump chamber shall be placed on a concrete hold down pad large enough to resist buoyant forces [commonly encountered in the area] [in accordance with the borings located on the drawings].

8.4. NOT USED. ACCESS FRAMES AND DOORS. Access doors and curb frames shall be provided complete with interior snap lock, removable key wrench, cast steel hinges, and locking bar. Doors shall lock in the open 90 Degrees position. Doors shall be of aluminum plate construction with nonslip diamond pattern rated for a live load of 150 pounds per square foot. Bituminous coating shall be applied to the exterior of the frame.

8.5. **LABELS.** All switches, lights, horns, controls, etc., shall be clearly identified with permanent labels or tags. The labels shall be plastic or metal and shall be permanently attached.

9. **MISCELLANEOUS METAL.** Bolts, nuts, anchors, washers, and all other types of supports necessary for the installation of the equipment shall be furnished and shall be of steel galvanized according to ASTM A 153.

10. **SPECIAL TOOLS** necessary for the proper operation and maintenance of the equipment, including one pressure gun for each type of grease required, shall be furnished in a hardwood or metal container.

11. **ACCEPTANCE TESTS.** The Contractor shall furnish the manufacturer's report of pump capacity determined by shop tests and make such tests as may be necessary to verify the pump capacity. Tests shall assure that all equipment, including the pump, have been installed in accordance with the specifications.

12. **PUMP CHARACTERISTIC CURVES,** properly identified and prepared by the pump manufacturer showing capacities, heads, efficiencies, and brake horsepower throughout the entire range of the pump, shall be furnished.

13. **OPERATING AND MAINTENANCE INSTRUCTIONS AND SPARE-PARTS DATA.**

13.1. **SPARE-PARTS DATA.** The Contractor shall furnish spare-parts data for each different item of materials and equipment specified. The data shall include

a complete list of parts and supplies, with current unit prices and source of supply.

13.2. **OPERATING AND MAINTENANCE INSTRUCTIONS.**

13.2.1. Operating instructions outlining the step-by-step procedures required for system start-up and operation shall be furnished. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.

13.2.2. Maintenance instructions listing routine maintenance procedures and possible breakdowns and repairs shall be furnished. The instructions shall include simplified diagrams for the system as installed.

13.2.3. Contractor shall conduct a training course for operating staff as designated by the Contracting Officer. The training period, for a total of __4___ hours of normal working time, shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the Operating and Maintenance Instructions.

13.2.4. Framed instructions, under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Proposed diagrams, instructions, and other sheets shall be submitted prior to posting. The framed instructions shall be posted before acceptance testing of the systems.

ZERO ACCIDENTS

#(2)#

SECTION 16401
ELECTRICAL DISTRIBUTION SYSTEM, AERIAL

INDEX

1. APPLICABLE PUBLICATIONS
2. GENERAL REQUIREMENTS
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10. CONNECTIONS TO UTILITY LINES
11. CONNECTIONS BETWEEN MEDIUM-VOLTAGE AERIAL AND UNDERGROUND SYSTEMS
12. GROUNDING
13. TESTS

#(30)#
Attachments: Std. Dwg. 40-06-17, Sh. ___, ___, ___, ___, and ___.
Std. Dwg. 40-06-04, Sh. ___, ___, ___, ___, and ___.
Attachments: REA Drawings: VB1, VB2, VB7, E12, F4-1S, VG10, M5-10, M5-14, M40-12.

PART 1 - GENERAL

#(6.30)#
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.).**

L-C-530C	Coating, Pipe, Thermoplastic Resin
L-P-1035A	Plastic Molding Material, Vinyl Chloride Polymer and Vinyl Chloride-Vinyl Acetate Copolymer, Rigid
L-T-1512A	Tape, Pressure Sensitive Adhesive, Pipe Wrapping
FF-P-101F	Padlocks

1.2. **U.S. DEPARTMENT OF AGRICULTURE, RURAL ELECTRIFICATION ADMINISTRATION (REA) SPECIFICATION.**

Spec. No. DT-5B: PE-16 (1972) (Reissued Dec 1975)	Wood Crossarms, (Solid and Laminated), Transmission Timbers, and Pole Keys

1.3. **AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI) STANDARDS.**

C2-199087	National Electrical Safety Code (NESC)
C8.35-1975	Weather-Resistant Polyolefin-Covered Wire and Cable
C29.1-1982	Electrical Power Insulators
C29.2-1983	Insulators -- Wet-Process Porcelain and Toughened Glass -- Suspension Type
C29.3-1980	Wet-Process Porcelain Insulators (Spool Type)

C29.4-1984	Wet-Process Porcelain Insulators (Strain Type)
C29.5-1984	Wet-Process Porcelain Insulators (Low- and Medium-Voltage Pin Types)
C29.6-1984	Wet-Process Porcelain Insulators -- (High-Voltage Pin Type)
C29.7-1983	Wet-Process Porcelain Insulators- High-Voltage Line-Post Type
C57.12.20-1981	Requirements for Overhead-Type Distribution Transformers, 500 kVA and Smaller: High-Voltage 67,000 Volts and Below; Low-Voltage, 15,000 Volts and Below
C62.1-1981	Surge Arresters for AC Power Circuits
C62.2-1981	Guide for Application of Valve-Type Surge Arresters for Alternating-Current Systems
C78.380-1984	Method for the Designation of High-Intensity Discharge Lamps
C80.1-1983	Rigid Steel Conduit -- Zinc Coated
C80.4-1963	Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
C82.4-1985	Ballasts for High-Intensity Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
C135.1-1979	Galvanized Steel Bolts and Nuts for Overhead Line Construction
C135.2-1979	Threaded Galvanized Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction
C135.4-1979	Galvanized Ferrous Eyebolts and Nuts for Overhead Line Construction
C135.14-1979	Staples with Rolled or Slash Points for Overhead Line Construction
C135.17-1979	Galvanized Ferrous Bolt-Type Insulator Pins with Lead Threads for Overhead Line Construction
C135.22-1979	Galvanized Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction
C135.30-1979	Galvanized Ferrous Ground Rods for Overhead or Underground Line Construction
C135.33-1980	Galvanized Ferrous Crossarm Gain for Overhead Line Construction
C136.2-1985	Roadway Lighting - Luminaires - Voltage Classification
C136.3-1984	Luminaire Attachments
C136.6-1984	For Roadway Lighting Equipment-Metal Heads and Reflector Assemblies, Mechanical and Optical Interchangeability
C136.9-1984	For Roadway Lighting Equipment-Socket Supports for Use in Metal Heads, Mechanical Interchangeability
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
	C136.13-1979	Metal Brackets for Wood Poles Used in Roadway Lighting
	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
	05.1-1979	Specifications and Dimensions for Wood Poles

1.4. **AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS.**

A 123-84	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153-82 (R 1987)	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 475-78 (R 1984)	Zinc-Coated Steel Wire Strand
A 575-86a	Steel Bars, Carbon, Merchant Quality, M-Grades
A 576-87a	Steel Bars, Carbon, Hot-Wrought, Special Quality
B 1-85	Hard-Drawn Copper Wire
B 8-81	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
B 117-85	Salt Spray (Fog) Testing
B 228-88	Concentric-Lay-Stranded Copper-Clad Steel Conductors
B 231-85	Concentric-Lay-Stranded Aluminum 1350 Conductors
B 232-81	Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
B 399-81	Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
B 416-88	Concentric-Lay-Stranded Aluminum-Clad Steel Conductors
D 923-86	Sampling Electrical Insulating Liquids
D 3304-77 (R 1983)	Analysis of Environmental Materials for Polychlorinated Biphenyls

1.5. **AMERICAN WATER WORKS ASSOCIATION (AWWA) STANDARD.**

C 203-78	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot Applied

1.6. **AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA) STANDARDS.**

C4-87	Poles--Preservative Treatment by Pressure Processes
C25-85	Sawn Crossarms--Preservative Treatment by Pressure Processes
P1-78 (Revised)	Standard for Coal Tar Creosote for Land and Fresh Water Use

	P8-87	Oil-Borne Preservatives
	P9-87	Standard for Solvents for Organic Preservative Systems

1.7. NOT USED. ILLUMINATION ENGINEERING SOCIETY (IES) RECOMMENDED PRACTICE.

RP-8-1983	Roadway Lighting

1.8. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE) STANDARDS.

No. 18-1980	Shunt Power Capacitors
No. 24-1984	Characteristics and Dimensions for Outdoor Apparatus Bushings
No. 142-1982	Recommended Practice for Grounding of Industrial and Commercial Power Systems
No. 404-1977	Power Cable Joints

1.9. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) PUBLICATIONS.

CC 3-1973 (R 1978, R 1983)	Connectors for Use Between Aluminum or Aluminum-Copper Overhead Conductors
FA-1-1973 (R 1979)	Outdoor Floodlighting Equipment
FB 1-1983	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
HV 1-1978 Incl. Rev. 1 thru 3	High-Voltage Insulators
LA 1-1976 (R 1980)	Surge Arresters
PH 1-1960 (R 1972, 1977)	Spool Type Secondary Racks
PH 10-1977	Galvanized Ferrous Washers
PH 11-1979	Galvanized Ferrous Guy Attachments, Wrap and Formed Guy Hooks, Guy Strain Plates and Pole Eye Plates
PH 20-1979	Galvanized Ferrous Insulator Clevises
PH 31-1977	Galvanized Ferrous Single and Double Upset Spool Insulator Bolts
PH 38-1977	Galvanized Ferrous Washerhead Bolts and Washer Nuts
RN 1-1980	Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
SG 2-1981	High-Voltage Fuses
SG 2.1-1979	Distribution Fuse Links
SG 6-1974 (R 1979) Incl. Rev. 1	Power Switching Equipment
SG 13-1983	Automatic Circuit Reclosers, Automatic Line Sectionalizers and Oil-Filled Capacitor Switches for Alternating-Current Systems
TR 1-1980 Incl. Rev. 1 & 2	Transformers, Regulators and Reactors

WC 5-1973 (R 1979) Incl. Rev. 1 thru 11	Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
WC 7-1982 Incl. Rev. 1	Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
WC 8-1976 Incl. Rev. 1 thru 9	Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

1.10. **NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) PUBLICATION.**

No. 70-199087 National Electrical Code (NEC)

1.11. **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. thru Oct 10, 1983; Errata Aug 29, 1986)
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 514	Electrical Outlet Boxes and Fittings (May 14, 1979, 6th Ed., Rev. thru Jun 1, 1982)
UL 1242	Intermediate Metal Conduit (Oct 10, 1983, 1st Ed.; Rev. thru Apr 10, 1986)

2. **GENERAL REQUIREMENTS.** Items of the same classification shall be identical including equipment, assemblies, parts, and components.

#(4.8)#

2.1. **CODE COMPLIANCE.** The installation shall comply with the requirements and recommendations of NFPA No. 70 (National Electrical Code) and ANSI C2 (National Electrical Safety Code) for [heavy] [medium] [light] loading districts, Grade B construction, and no reduction in clearance shall be made.

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. Transformer nameplates shall be permanently marked with a statement to the effect that the transformer dielectric to be supplied is nonpolychlorinated biphenyl classified with less

than 50 parts per million (ppm) polychlorinated biphenyl (PCB) content. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 50 ppm PCB content. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the 50 ppm PCB content or transformers without certification will be considered as PCB insulated and will not be acceptable. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 923 and have tests performed per ASTM D 3304 at an EPA-approved testing facility to obtain this certification. Transformers with test results indicating PCB levels exceeding 50 ppm shall be replaced or decontaminated in accordance with approved EPA procedures to achieve the acceptable levels, and the certification specified shall be submitted and approved prior to acceptance of the transformer and approved dielectric. It is not permissible to dilute contaminated dielectric in an attempt to lower the level of contamination. The PCB contaminated dielectric must be marked as PCB and transported to and incinerated by an approved EPA waste disposal facility and the Contractor shall furnish certification of proper disposal.

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 153, and A 123.

2.4.3. NOT USED. Luminaires fabricated from ferrous metals, unless hot-dip galvanized or of porcelain enamel finish, shall be factory finished with a weather-resistant finish that will withstand 200 hours exposure to the salt spray test specified in ASTM B 117. Finish color shall be the manufacturer's standard, unless otherwise indicated.

2.4.4. **Steel Conduit.** Conduits installed underground or under slabs-on-grade shall be field-wrapped with 0.010-inch-thick pressure-sensitive plastic tape applied with a 50-percent overlap, or shall have a factory-applied plastic epoxy resin or coal-tar coating system. Zinc coating may be omitted from steel conduit which has a factory-applied epoxy-resin coating system.

#(4,9)#

2.5. **UNUSUAL SERVICE CONDITIONS.** Items furnished under this section shall be specifically suitable for the following unusual service conditions:

2.5.1. NOT USED. Fungus Control: _____

2.5.2. **Altitude.** 5265 feet above mean sea level.

2.5.3. **Ambient Temperature.** minus 20 degrees F.

2.5.4. **Other:** _____

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.

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3. **SUBMITTALS.**

3.1. **SUBMITTAL PROCEDURES.** Shop drawings shall be submitted in accordance with the overall requirements detailed in the SECTION: SPECIAL CLAUSES and the overall requirements of this section. Documents shall consist of a complete list of equipment and materials, manufacturer's descriptive and technical

literature, brochures, catalog cuts, performance data, diagrams, and other material as appropriate. As a minimum, the following must be submitted:

3.1.1. **Category I.**

Drawings and data on the following components:

Automatic Circuit Reclosers (par 4.1, 8.6)
Pole Top Switches (par 8.4.1)
Surge (Lightning) Arrestors (par 4.22; 8.2)
Nonstandard Luminaires including Mounting Provisions (Fixtures not listed in Series 40-06-04) (par 4.16.1, 4.16.2, 9)
[Lighting Controls and Accessories (including control diagrams as applicable) (par 4.16.3, 9.4)]
Capacitor Equipment (par 4.2, 8.5)
[Optional Pole Equipment Mounts (par 7)]

Sag and Tension Tables Initial - Primary Line (par 6.2, 13.4)
Protective Coordination Study (Par 3.6.4)
Supplementary Contractor's Drawings, as applicable (par 3.7)
[Operation and Maintenance Instructions (par 3.4)]

3.1.2. **Category II.** (For Information Only)

Drawings and data on the following components:

Standard Luminaires (listed in Series 40-06-04)
(par 4.16.1, 4.16.2, 9)
Down Guys, Anchors, and Related Hardware (par 4.13, 4.14.2, 6.2.6, 7.10, 7.11)
PCB Certification (par 2.3)
List of Equipment and Materials (par 3.3)

3.2. **PROOF OF COMPLIANCE.** Where materials or equipment are specified to conform to the standards or publications, and requirements of Federal Specifications, ANSI, ASTM, AWPA, AWWA, IEEE, IES, NEMA, NFPA, REA, or UL, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of, or listing in the Electrical Construction Materials Directory of UL or the manufacturer's certification or published catalog specification data statement that the items comply with applicable specifications, standards publications, and with the manufacturer's standards will be acceptable evidence of such compliance.

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, and the name of the manufacturer of each such item.

3.4. NOT USED. INSTRUCTION MANUALS. Instruction manuals shall be furnished following the completion of factory tests and shall include assembly, instal- lation, 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 and 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.

3.5. **MANUFACTURER'S CERTIFICATIONS.**

3.5.1. **Certificates of Compliance.** Certificates shall be prepared by the manufacturer 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 manufacturer performs routine 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 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 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.

3.6.3. NOT USED. Certification of the Qualifications of Medium-Voltage Cable Installers. The Contractor shall submit a certification, to and for the approval of the Contracting Officer, that contains the names and qualifications of persons recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that persons recommended to perform actual splicing and terminations have been adequately trained in the proper techniques and have had at least 3 recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, persons recommended by the Contractor may be required to perform a dummy or practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types. The certifications shall be prepared in conformance with paragraph: CERTIFICATES OF COMPLIANCE in the SPECIAL CLAUSES, and shall be accompanied by satisfactory proof of the training and experience of persons recommended by the Contractor as cable installers.

3.6.4. NOT USED. Protective Coordination Study. The Contractor shall prepare and submit a complete protective coordination study within 30 calendar days following the complete approval of circuit protective devices, including circuit breakers, fuses, thermal overloads, and protective relays.

3.7. **SUPPLEMENTARY CONTRACTOR'S DRAWINGS.** If the submittal data required above is not sufficient to demonstrate compliance with applicable contract requirements, the Contractor shall prepare and submit additional drawings as required to supplement the contract drawings, manufacturer's data and drawings, and Contractor's data. Drawings shall be dimensioned or scaled to show the relative arrangement and mounting details of the equipment or equipment assemblies.

PART 2 - PRODUCTS AND EXECUTION

4. **MATERIALS AND COMPONENTS.** Materials and equipment shall conform to the following requirements:

4.1. NOT USED. AUTOMATIC CIRCUIT RECLOSERS. NEMA SG 13.

4.2. NOT USED. CAPACITORS. IEEE No. 18.

4.3. **BARE CONDUCTORS.**

4.3.1. **Aluminum-Composition Conductors.** All-aluminum-conductors, (AAC), alloy No. 1350-H19, per ASTM B 231. All-aluminum-alloy-conductors (AAAC), alloy No. 6201-T81, per ASTM B 399. Aluminum-conductor-steel-reinforced (ACSR) per ASTM B 232.

4.3.2. **Copper Conductors.** ASTM B 1 and B 8 as appropriate to the conductor size, hard-drawn temper.

4.4. **INSULATED CONDUCTORS.**

#(4.10)#

4.4.1. **Low-Voltage Cables.** Low-voltage cables shall be of the neutral-supported secondary and service drop type conforming to the requirements of NEMA WC 5 for thermoplastic insulation and NEMA WC 7 for the cross-linked-thermosetting-polyethylene insulation. [Line wires may be of the weather-resistant polyolefin-covered type conforming to ANSI C8.35.]

4.4.2. **Messenger-Supported Medium-Voltage Cables.** Messenger-supported medium-voltage cables shall be of the preassembled three-conductor type conforming to the construction requirements of NEMA WC 8. Insulation shall be either cross-linked-thermosetting-polyethylene conforming to NEMA WC 7 or ethylene-propylene-rubber conforming to NEMA WC 8.

4.5. **CONDUIT AND FITTINGS, STEEL.**

4.5.1. **Conduit, Intermediate Metal.** UL 242.

4.5.2. **Conduit, Rigid.** ANSI C80.1 and UL 6.

4.5.3. **Conduit Outlets and Fittings.** ANSI C80.4, NEMA FB 1, and UL 514.

4.6. **CONDUIT COATINGS.**

4.6.1. **Plastic.** Fed. Spec. L-C-530, type I or L-P-1035; composition, type, class, and grade suitable for the purpose, thickness as required or the type I system of Fed. Spec. L-C-530 or NEMA Standard RN1, type 40.

4.6.2. **Epoxy System.** Fed. Spec. L-C-530, type II.

4.6.3. **Coal-Tar System.** Primer and enamel conforming to AWWA C203. The thickness of the dry coating system shall not be less than 1/16 inch at any point.

4.6.4. **Pipe-Wrapping Plastic Tape.** Fed. Spec. L-T-1512, type I.

4.7. **CONNECTORS AND SPLICES.** Connectors and splices shall be of copper alloys for copper conductors, shall be of aluminum alloys for aluminum-composition conductors, and shall be of a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors.

4.7.1. **For Bare Conductors.** NEMA CC 3 for aluminum-composition and aluminum-composition to copper.

4.7.2. **For Insulated Aerial Low-Voltage Cable.** NEMA CC 3 and UL 486B for aluminum-composition and aluminum-composition to copper, and UL 486A for copper to copper.

4.8. **CROSSARM ASSEMBLIES.**

4.8.1. **Crossarms.** REA Spec. No. DT-5B:PE-16 solid wood, distribution type, except cross-sectional area with pressure treatment conforming to AWPA C25, and a 1/4-inch, 45 degree chamber on all top edges. Cross-sectional area minimum dimensions shall be 4-1/4 inches in height by 3-1/4 inches in depth in accordance with ANSI C2 for Grade B construction.

4.8.2. **Crossarm Gains.** ANSI C135.33.

4.9. **FUSES, MEDIUM-VOLTAGE.** NEMA SG 2 and SG 2.1.

4.10. **FUSE CUTOUTS, PRIMARY.** NEMA SG 2.

4.11. **GROUNDING AND BONDING.** Equipment, UL 467. Wire, ASTM B 8, softdrawn copper.

4.12. NOT USED. GROUP-OPERATED LOAD INTERRUPTER SWITCHES. NEMA SG 6.

#(4,8)#

4.13. **GUY STRANDS.** [Aluminum-clad steel, ASTM B 416] [Copper-clad steel, ASTM B 228] [or] [zZinc-coated steel, ASTM A 475].

4.14. **INSULATORS.** NEMA HV 1 for general requirements.

4.14.1. **Line Insulators.** Low-voltage lines, ANSI C29.2 and C29.3. Medium-voltage lines; ANSI C29.2, C29.5, C29.6, and C29.7.

4.14.2. **Strain Insulators for Guy Wires.** ANSI C29.4 for porcelain or equivalent fiberglass.

4.14.3. **Tests.** ANSI C29.1.

#(4,8)#

4.15. NOT USED. 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 #(d)#
[120] [208] [240] [277] [480] [volts] [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] [minus 22] [minus 40] degrees F. and above.

#(4,11)#

4.15.1. **High-Pressure Sodium Lamps.** ANSI C78.380, designations [S50VA-250,] [S66MN-200,] [S55SC-150,] [S54SB-100,] [or] [S62ME-70,] [as #(d)#
indicated on the plans] installed where indicated.

#(4,11)#

4.15.2. **Mercury Vapor Lamps.** ANSI C78.380, designations [H33GL- #(d)#
400,] [H37KC-250,] [H39KC-175,] [or] [H38JA-100,] [as indicated on the plans] installed where indicated. Lamps shall be of the deluxe-white type.

#(4,11)#

4.15.3. **Metal Halide Lamps.** ANSI C78.380, designations [M59PK- #(d)#
400,] [M58PH-250,] [or] [M57PF-175,] [as indicated on the plans] installed where indicated. Lamps shall be of the phosphor-coated type.

4.16. NOT USED. LUMINAIRE COMPONENTS, ROADWAY LIGHTING.

4.16.1. **Luminaires.** Attachments, ANSI C136.3. Classification, ANSI C136.2. Field identification marking, ANSI C136.15. Interchangeability, ANSI C136.6 for metal heads and reflectors, ANSI C136.9 for sockets. Luminaires, side-mounted, ANSI C136.14. Sockets, ANSI C136.11.

4.16.2. **Metal Brackets.** ANSI C136.13, for use with wood poles.

4.16.3. **Photo-Control Devices.** ANSI C136.10.

4.17. NOT USED. LUMINAIRES, FLOODLIGHTING. NEMA FA 1.

4.18. **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)#

4.19. NOT USED. PADLOCKS. Padlocks shall conform to Fed. Spec. FF-P-101, type _____, size _____.

4.20. **POLES.**

4.20.1. NOT USED. Steel Poles. NEMA TT 1.

4.20.2. **Wood Poles.** ANSI 05.1, completely pressure treated in accordance with AWPA C4, with creosote conforming to AWPA P1 or with oilborne preservatives and petroleum conforming to AWPA P8 and P9, respectively. Species listed in ANSI 05.1 for which a preservative treatment is not specified in AWPA C4 shall not be used, except that northern white cedar, if treated as specified for western red cedar, and western fir if treated as specified for Douglas fir, may be used.

#(10)#

4.21. **POLE LINE HARDWARE.** Zinc-Coated, ANSI C135.1, C135.2, C135.4, C135.14, C135.17, C135.22, and C135.33; NEMA [PH 1,] PH 10, PH 11, PH 20, PH 31, and PH 38; and steel hardware material, ASTM A 575 and A 576.

4.22. **SURGE ARRESTERS.** NEMA LA 1, zinc-oxide type and suitable for outdoor installations, ANSI C62.1 and C62.2.

4.23. **TRANSFORMERS.** NEMA TR 1 for general requirements and ANSI C57.12.20 for specific requirements for overhead transformers.

5. **GENERAL INSTALLATION REQUIREMENTS.** Circuits installed in conduits or underground and splices and terminations for medium-voltage cable shall conform to the requirements of SECTION: ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Secondary circuits installed in conduit on poles shall conform to the requirements of SECTION: ELECTRICAL WORK, INTERIOR.

#(4,12)#

6. **CONDUCTORS.** Conductor sizes indicated are based on the electrical and physical properties provided by [hard-drawn copper conductors (CU)] [all aluminum conductors (AAC)] [all-aluminum-alloy conductors (AAAC)] [aluminum-conductors-steel-reinforced (ACSR)]. Where other conductor materials as specified below are used, such conductors shall provide equivalent ampacity and adequate strength for the specified loading conditions.

6.1. **TYPES.**

6.1.1. **Bare Medium-Voltage Lines.** Conductors shall be hard-drawn-copper, CU; all-aluminum-conductor, AAC; all-aluminum-alloy-conductor, AAAC, or aluminum-conductor-steel-reinforced, ACSR. Conductor types shall not be mixed on any project, unless specifically permitted. Conductors larger than No. 2 AWG shall be stranded. Minimum conductor size shall be No. 6 AWG CU or conductors of equivalent strength.

#(4)#

6.1.2. NOT USED. [Insulated Medium-Voltage Lines. Cables shall be of the preassembled-messenger-supported type, have a rated circuit voltage of [5 kV] [15 kV], [25 kV], a 133 percent insulation level, and a Type III cable construction. Conductors shall be annealed copper or 1350 alloy aluminum. Messengers may be zinc-coated steel, aluminum-clad-steel, copper-clad-steel, or composite-copper and copper-clad steel. #(4,10)#]

6.1.3. **Low-Voltage Lines.** Neutral-supported secondary and service drop cables shall be insulated copper with bare hard-drawn-copper or copper-clad steel neutrals or insulated aluminum with bare aluminum (AA-8000 Series Alloy) or ACSR neutrals. [Line wires installed on secondary racks may be provided in lieu of neutral-supported cable for pole line circuits where necessary clearances are available.]

6.2. **INSTALLATION.** Conductors shall be installed in accordance with manufacturer's approved tables of sags and tensions or equivalent industry references acceptable to the Contracting Officer. Required clearances shall be maintained.

6.2.1. **Line Conductors.** Proper care shall be taken in handling and stringing conductors to avoid abrasions, sharp bends, cuts, kinks, or any possibility of damage to insulation or conductors. Conductors shall be paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Bend radius for any insulated conductor shall be at no time less than the applicable NEMA specification recommendation. Conductors shall not be drawn over rough or rocky ground, nor around sharp bends. When installed by machine power, conductors shall be drawn from a mounted reel through adequate stringing sheaves in approximately straight lines clear of obstructions.

6.2.2. **Miscellaneous Installations.** In vertical risers on poles, cables shall be protected by conduit secured at intervals not exceeding 10 feet and within 12 inches of each side of any bend or termination. Drip loops shall be formed on conductors at entrances to buildings, cabinets, or conduits.

6.2.3. **Supports.** Connectors, supports, clamps, and ties shall be designed for the particular purpose, shall be of the proper material and size, and shall be installed in accordance with standard practice.

6.2.4. **Splices and Connectors.** Splices and connectors shall be mechanically and electrically secure under tension and shall be of the nonbolted compression type. The tensile strength of any splice shall be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and shall not adversely affect conductors. Aluminum-composition conductors shall be wire brushed and an oxide inhibitor applied before making a compression connection. Connectors which are factory-filled with an inhibitor are acceptable. Inhibitors and compression tools shall be of types recommended by the connector manufacturer. Primary line apparatus taps shall be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors shall be of the solderless pressure type. Noninsulated connectors shall be smoothly taped to provide a water-proof insulation equivalent to the original insulation when installed on insulated conductors.

6.2.5. **Conductor-to-Insulator Attachments.** Conductors shall be properly attached to insulators. For insulators requiring conductor tie-wire attachments, tie-wire sizes shall be as indicated in Table I.

TABLE I. TIE WIRE REQUIREMENTS

CONDUCTOR Copper AWG	TIE WIRE Soft-Drawn Copper AWG
6	8
4 and 2	6
1 through 3/0	4
4/0 and larger	2
AAC, AAAC, or ACSR AWG	AWG
Any size	6 AAAC or 4 AAC

6.2.6. **Armor Rods.** Armor rods shall be provided for AAC, AAAC, and ACSR conductors. Armor rods shall be installed at supports, except that armor rods will not be required at primary dead-end assemblies if aluminum or aluminum-lined zinc-coated steel clamps are used. Lengths and methods of fastening armor rods shall be in accordance with the manufacturer's recommendations. For span lengths of less than 200 feet, flat aluminum armor rods may be used. Flat armor rods, not less than 0.03 by 0.25 inch shall be used on No. 1 AWG AAC and AAAC and smaller conductors and on No. 5 AWG ACSR and smaller conductors. On larger sizes, flat armor rods shall be not less than 0.05 by 0.30 inch. For span lengths of 200 feet or more, preformed round armor rods shall be used.

#(4,13)#

6.2.7. Tree Trimming. Where lines pass through trees, trees shall be trimmed at least 8 feet clear on both sides horizontally and below for medium-voltage lines, and 4 feet clear on both sides horizontally and below for other lines, and no branch shall overhang horizontal clearances. [Where trees are indicated to be removed to provide a cleared right-of-way, clearing is specified in SECTION: CLEARING AND GRUBBING FOR ROADS, RAILROADS, AIRFIELDS AND STRUCTURES (EXCLUSIVE OF RESERVOIRS).]

6.3. CONNECTIONS TO AERIAL BUILDING SERVICES. Service-entrance conduits with termination fittings and conductors within the building, including sufficient slack for connection to aerial service cables, shall conform to the requirements of SECTION: ELECTRICAL WORK, INTERIOR. Aerial services shall be attached to buildings approximately at the point indicated and shall be connected to the service entrance conductors. Supports at buildings shall be adequate to withstand required pulls, but in no case shall supports be rated less than 1,000 pounds.

#(4,8,14)#

7. **POLE LINES.** Joint-use electric/roadway-lighting poles for overhead electric and communication lines shall be [wood] [steel] poles utilizing [armless] [crossarm] construction. [Cluster-mounted] [Cross-arm mounted] banked single-phase transformer installations shall be provided. [Crossarm construction shall be provided for support of other equipment, except where direct-pole mounting is indicated.] [Pole equipment mounts rather than crossarm equipment mounts may be utilized, if shop drawings are submitted and approved.]

#(4,15)#

7.1. **PROVISION FOR COMMUNICATION SERVICES.** Provision for communication services is required on pole-line construction, except where specifically noted otherwise. A vertical pole space of not less than [2] [_____] feet shall be reserved at indicated locations.

#(4,16)#

7.2. **CLEARANCES.** Poles shall be of lengths and [classes] [strengths] indicated, except where longer poles are necessary to maintain required clearances. Where conditions require poles longer than indicated, the Contractor will be reimbursed in accordance with the requirements of CONTRACT CLAUSES.

7.3. **WOOD POLES.** Wood poles shall have pole markings located approximately 10 feet from pole butts, except that other locations standard with the pole manufacturer will be acceptable. Poles shall be machine trimmed by turning smooth full length, and shall be roofed, gained, and bored prior to pressure treatment. Where poles are not provided with factory-cut gains, metal gain plates shall be provided.

7.4. NOT USED. STEEL POLES. Steel poles shall provide adequate strength for the indicated loading conditions. Poles shall have tapered tubular members, either round in cross-section or polygonal. Pole shafts shall be one piece. Poles shall be welded construction; no bolts, rivets, or other means of fastening are permitted, except as specifically indicated or approved. Pole markings shall be approximately 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, length, and a loading tree. Attachment requirements shall be provided as indicated, including grounding provisions. Climbing facilities are not required. Bases shall be of the anchor-bolt-mounted type. Poles shall be hot-dip galvanized in accordance with ASTM A 123 and shall not be painted. Required NEMA TT 1 design calculations shall be made by a registered engineer.

7.5. **STORAGE AND HANDLING OF POLES.** Wood poles held in storage for more than 2 weeks shall be stored in accordance with ANSI 05.1. Handling of wood poles shall be in accordance with ANSI 05.1, except that pointed tools capable of producing indentations more than 1 inch in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

#(4,17)#

7.5.1. **Wood Pole Setting.** Wood poles shall be set straight and firm. In normal firm ground, minimum pole-setting depths shall be as listed in Table II. In rocky or swampy ground, pole-setting depths shall be decreased or increased [as shown] [respectively in accordance with the local utility's published standards and as approved]. In swampy or soft ground, a bog shoe shall be used where support for a pole is required. Poles in straight runs shall be in a straight line. Curved poles shall be placed with curvatures in the direction of the pole line. Poles shall be set to maintain as even a grade as practicable. When the average ground run is level, consecutive poles shall not vary more than 5 feet in height. When the ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece shall be sawed off the top and roofed. If any pole is shortened after treatment, the shortened end of the pole shall be given an application of hot preservative. Where poles are set on hilly terrain, along edges of cuts or embankments, or where soil may be washed out, special precautions shall be taken to ensure durable pole foundations, and the setting depth shall be measured from the lower side of the pole. Holes shall be dug large enough to permit proper use of tampers to the full depth of a hole. Earth shall be placed into a hole in 6-inch maximum layers, then thoroughly tamped before the next layer is placed. Surplus earth shall be placed around a pole in a conical shape and packed tightly to drain water away from poles.

TABLE II. MINIMUM POLE-SETTING DEPTH
(Feet and Inches)

Length Overall (Feet)	Straight Lines	Curves, Corners, and Points of Extra Strain	Length Overall (Feet)	Straight Lines	Curves, Corners, and Points of Extra Strain
20	5-0	5-0	65	8-6	9-0
25	5-6	5-6	70	9-0	9-6
30	5-6	5-6	75	9-6	10-0
35	6-0	6-0	80	10-0	10-6
40	6-0	6-6	85	10-6	11-0
45	6-6	7-0	90	11-0	11-6
50	7-0	7-6	95	11-6	12-0
55	7-6	8-0	100	12-0	12-6
60	8-0	8-6			

7.5.2. NOT USED. Steel Pole Setting. Concrete foundations with conduit 90 degree sweep shall have anchor bolts accurately set in foundations using a template supplied by the pole manufacturer. Concrete work and grouting is specified in SECTION: CONCRETE FOR BUILDING CONSTRUCTION. When concrete has cured, base plates shall be leveled and grouted in place. Pole anchor bases shall then be set on base plates, leveled plumb on foundations, and secured with the holding nuts. A channel of one inch square or one inch radius cross section shall be provided in the top of each pole base, or grout, to allow moisture drainage off the metal pole.
#(16,d)#

7.6. NOT USED. ARMLESS CONSTRUCTION. Configurations shall conform to the indicated details. Pole mounting brackets for line-post insulators and eye bolts for suspension insulators shall be as shown, and shall be installed so as to provide not less than the required climbing space. Brackets shall be attached to poles with a minimum of two bolts. Brackets may be either provided integrally as part of an insulator or attached to an insulator with a suitable stud. Bracket mounting surface shall be suitable for the shape of a pole. Brackets for wood poles shall have wood gripping members. Horizontal offset brackets shall have a 5-degree uplift angle. Pole top brackets shall conform to ANSI C135.22, except for modifications necessary to provide support for a line-post insulator. Brackets shall provide a strength exceeding that of the required insulator strength, but in no case less than a 2800 pounds cantilever strength.

7.7. **CROSSARM CONSTRUCTION.** Crossarms shall be 8 feet in length, except that 10-foot crossarms shall be used for crossarm-mounted banked single-phase transformers or elsewhere as indicated. Crossarms shall be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling shall be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling shall provide required climbing space and wire clearances. Crossarms shall be straight and free of twists to within 1/10-inch per foot of length. Bend or twist shall be in one direction only.
#(4,18)#

7.7.1. **Mounting.** Crossarms shall be bolted to poles with 5/8-inch through-bolts with square washers at each end. Bolts shall extend not less

than 1/8 inch nor more than 2 inches beyond nuts. On single cross-arm construction, the bolt head shall be installed on the crossarm side of the pole. Metal crossarm braces shall be provided on crossarms. Flat braces [may be provided for 8-foot crossarms and] shall be 1/4 inch by 1-1/4 inches, not less than 28 inches in length. Flat braces shall be bolted to arms with 3/8-inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 1/2-inch by 4-inch lag screws after crossarms are leveled and alined. Angle braces [are required for 10-foot crossarms and] shall be 60-inch span by 18-inch drop formed in one piece from 1-1/2 inch by 1-1/2 inch by 3/16-inch angle. Angle braces shall be bolted to crossarms with 1/2-inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 5/8-inch through-bolts. Double crossarms shall be securely held in position by means of 5/8-inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

7.7.2. **Line Arms and Buck Arms.** Line arms and buck arms shall be set at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms shall bisect angles of turns of less than 45 degrees. Dead-end assemblies shall be used for turns where shown. Buck-arms shall be installed, as shown, at corners and junction poles. Double crossarms shall be provided at ends of joint use or conflict sections, at dead-ends, and at angles and corners as indicated, to provide adequate vertical and longitudinal strength. Double crossarms shall be provided at each line-crossing structure, where lines not attached to the same pole cross each other, and elsewhere as shown.

7.7.3. **Equipment Arms.** Equipment arms shall be set parallel or at right angles to lines as required to provide climbing space. Equipment arms shall be located below line construction to provide necessary wire and equipment clearances.

7.8. NOT USED. MESSENGER-SUPPORT CABLES.

#(4,19)#

7.8.1. Medium-Voltage Cables. Medium-voltage cable messengers shall be attached to poles with clamps providing a strength exceeding the required messenger strength and with not less than 5/8-inch through-bolts. Messengers shall be dead-ended, grounded, and [storm and] line-guyed at corners and dead-ends, and at intervals not exceeding 1000 feet along straight runs.

#(4,10)#

7.8.2. **Low-Voltage Cables.** Low-voltage cable neutrals shall be supported on clevis fittings using spool insulators; except that where required to provide adequate strength, dead-end clevis fittings and suspension insulators shall be provided. Dead-end construction shall provide a strength exceeding the rated breaking strength of the neutral messenger. Clevis attachments shall be provided with not less than 5/8-inch through-bolts. [Secondary racks may be used when installed on wood poles and where the span length does not exceed 200 feet. Secondary racks shall be two-, three-, or four-wire as required, complete with spool insulators. Racks shall meet strength and deflection requirements of NEMA PH 1 for heavy-duty steel racks, and shall be either galvanized steel or aluminum alloy. Tops of insulator saddles shall be rounded and smooth to avoid damage to conductor insulation. Each insulator shall be held in place with a 5/8-inch button-head bolt equipped with a nonferrous cotter pin, or equivalent, at the bottom. Racks for dead-ending four No. 4/0 AWG or four larger conductors shall be attached to poles with three 5/8-inch through-bolts. Other secondary racks shall be attached to poles with at least two 5/8-inch through-bolts.

Minimum vertical spacing between conductors shall not be less than 8 inches.]

7.9. **INSULATORS.** Suspension insulators shall be used at corners and angles, at dead-ends, and wherever line insulators do not provide adequate strength. Mechanical strength of suspension insulators and hardware shall exceed the rated breaking strength of the conductor attached thereto.
#(4,8,20)#

7.9.1. **Medium-Voltage Line Insulators.** Medium-voltage line insulators shall have ratings not lower than the ANSI classes indicated in Table III. Horizontal line-post insulators shall be used for armless construction and shall have the same mechanical and electrical ratings as vertical line-post insulators for the ANSI class indicated, but shall be modified to be suitable for horizontal installation. Where line-post insulators are used for angles greater than 15 degrees, clamp-top fittings shall be provided as well as for other locations shown. Conductor clamps for use with clamp-top, line-post insulators shall be hot-dip galvanized malleable iron for copper conductors and aluminum alloy for aluminum-composition conductors. [Either line-post or pin insulators may be used for crossarm construction. Pin insulators for use on voltages in excess of 6000 volts phase-to-phase shall be radio-interference-freed or else line-post insulators shall be used.]

TABLE III. MINIMUM ANSI RATING OF MEDIUM-VOLTAGE INSULATORS BY CLASS

Voltage Level	Line-Post	Pin	Suspension
Up to 5 kV	57-1 or 11	55-3	One 52-1
	57-1 or 11	55-5	Two 52-1
6 kV to 15kV	57-1 or 11	55-5	Two 52-2
	57-2 or 12	56-3	Two 52-3 or 4
16 kV to 25 kV	57-2 or 12	56-3	Two 52-3 or 4
	57-3 or 13	56-4	Three 52-3 or 4
26 kV to 35 kV	57-3 or 13	56-4	Three 52-3 or 4
	57-4 or 14	56-5	Four 52-3 or 4

#(4,10,20)#

7.9.2. NOT USED. Low-Voltage Line Insulators. Spool insulators for use on low-voltage lines shall be mounted on clevis attachments [or secondary racks] and shall be not smaller than Class [53-2] [53-3]. For No. 4/0 AWG and larger conductors, Class [53-4] [53-5] shall be used. Suspension insulators on clevis attachments used at dead-ends shall be not smaller than Class 52-1.
#(4,20)#

7.9.3. **Guy Wire Insulators.** Strain insulators for use in insulated guy assemblies shall have a mechanical strength exceeding the rated breaking strength of the guy attached thereto. Insulators shall be not smaller than Class [54-1] [54-2] for lines up to 5 kV, not smaller than Class [54-2] [54-3] for lines of 6 kV to 15 kV, not smaller than Class [54-4] [54-4 with two in tandem] for lines of 16 kV to 25 kV, and not smaller than Class [54-4 with two in tandem] [54-4 with three in tandem] for lines of 26 kV to 35 kV.
#(8)#

7.9.4. **Series Lighting Insulators.** Pin insulators shall be Class 55-5; line-post insulators shall be Class 57-1 or 57-11.

7.10. **GUY ASSEMBLIES.**
#(4,8)#

7.10.1. **Construction.** Guy assemblies, including insulators and attachments, shall provide a strength exceeding the required guy strength. Thimbles or thimble-eyes shall be provided on anchor rods and eye-bolt guy attachments to protect the strands. A half-round yellow polyvinyl, fiberglass, or other suitable plastic guy marker, not less than 8 feet in length, shall be provided where shown or required at the anchor end of each guy, securely clamped to the guy or anchor at the bottom and top of the marker. Holding capacities for down guys shall be based on a lead angle [of 45 degrees] [as indicated]. When field conditions prevent [specified] [indicated] lead angles, anchors shall be placed in other locations as approved and guy strengths increased by the ratio of the sine of the lead angle [specified] [indicated] to the sine of the lead angle provided, except that lead angles shall be not less than 15 degrees. Guy strand shall be [3] [7] strand. Guy material shall be [Class [30 HS] [30 EHS] copper-clad steel], [Class [A] [B] [C] zinc-coated-steel [utilities] [high-strength] [extra-high-strength] grade] [or] [aluminum-clad-steel-strand], with a minimum breaking strength not less than [6,000 pounds] 11,500[____ pounds] [as shown], except where two or more guys are used to provide the required strength. Guy rods shall be not less than [7] [8] feet in length by [5/8] [3/4] [1] inch in diameter.
#(4,21)#

7.10.2. **Installation.** Guys shall be provided where shown, with loads and strengths as indicated, and elsewhere as required wherever conductor tensions are not balanced, as at angles, corners, and dead-ends. Where a single guy will not provide the required strength, two or more guys shall be provided. Where guys are wrapped around poles, at least two guy hooks shall be provided and pole shims shall be provided where guy tension exceeds 6000 pounds. Guy clamps 6 inches in length with three 5/8-inch bolts, or offset-type guy clamps, or approved guy grips shall be provided at each guy terminal. [Guy-strain insulators shall be provided in each guy for wood poles.] Multiple-helix screw anchors shall be provided in marshy ground; rock anchors shall be of an expanding type, except that power installed screw anchors of equivalent holding power are acceptable.
#(4,8,22)#

7.11. **HARDWARE.** Pole-line hardware shall be hot-dip galvanized steel [, except anchor rods of the copper-molten welded-to-steel type with nonferrous corrosion-resistant fittings shall be used]. Suitable washers shall be installed under boltheads and nuts on wood surfaces and elsewhere as required. Washers used on through-bolts and double-arming bolts shall be approximately 2-1/4 inches square and 3/16-inch thick. The diameter of holes in washers shall be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage-bolts shall be of the proper size to fit over square shanks of bolts. Eye bolts, bolt eyes, eyenuts, strain-load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to adequately support and protect poles, brackets, crossarms, guy wires, and insulators.

#(4,23)#

8. **APPARATUS.** Apparatus shall be grounded as specified in paragraph GROUNDING. [The creep or leakage distance of outdoor bushings and insulators shall be not less than the distance required for [one BIL level] [two BIL levels] higher than that required by IEEE No. 24 for bushings and NEMA SG 6 for outdoor apparatus insulators.]

#(4,8,24)#

8.1. **FUSE CUTOUTS AND FUSES.** Primary-fuse cutouts shall be of the [load-break] [nonload-break] [enclosed] [open] type construction [rated [5.2] [7.8] [15] [27] [38] kV and of the [normal] [heavy] [extra-heavy] [ultra-heavy]-duty type] [ratings and types indicated]. Open-link cut-outs are not acceptable. Fuses shall be either indicating or dropout type. Fuse ratings shall be equal to approximately 150 percent of transformer full-load ratings, 100 percent of cable ratings for aerial to underground transitions which serve more than one transformer, or shall be as indicated. Fuse cutouts shall be equipped with mounting brackets suitable for the indicated installations.

#(4,8,23)#

8.2. **SURGE ARRESTERS.** Surge arresters shall be provided for protection of aerial-to-underground transitions, automatic circuit reclosers, capacitor equipment, group-operated load-interrupter switches, transformers and other #(d)# indicated equipment. Arresters shall be [distribution-valve] [intermediate-valve] class rated [as shown] [6] [9] [10] [12] [18] [21] [27] [30] kV]. Arresters for use at elevations in excess of 6,000 feet above mean sea level shall be specifically rated for that purpose. Arresters shall be equipped with mounting brackets suitable for the indicated installations.

8.3. **OVERHEAD DISTRIBUTION TRANSFORMERS.** Overhead distribution transformers shall be of the two-winding per phase, outdoor, oil-immersed type, single-phase or three-phase as indicated. Transformers shall be provided with necessary auxiliary mounting devices suitable for the indicated installation.

#(4,8)#

8.3.1. **Requirements.** Transformers shall have [four 2-1/2 percent] [two 2-1/2 percent] [two 5 percent] rated kVA high-voltage taps [above] [and] [below] rated primary voltage. [Transformer tanks shall be given a rust-inhibiting treatment and shall have a standard gray finish.] [Transformers shall be provided with either a factory-applied corrosion-resistant finish which shall withstand 200 hours exposure to the salt spray test specified in ASTM B 117 or a stainless steel case.] Transformer installations shall include one primary fuse cutout and one surge arrester for each ungrounded phase conductor. Self-protected transformers are not acceptable.

8.3.2. **Installation.** Transformers shall be carefully installed so as not to scratch finishes or damage bushings. After installation, surfaces shall be inspected and scratches touched up with a finish furnished by the transformer manufacturer for this purpose.

8.4. NOT USED. GROUP-OPERATED LOAD INTERRUPTER SWITCHES. Group-operated load interrupter switches shall be of the outdoor, manually-operated, three-pole, single-throw type with either tilting or rotating insulators and equipped with interrupters capable of interrupting currents equal to a switch's continuous current rating. Each switch shall be suitably preassembled for the indicated configuration and mounting. Moving contacts shall be of the high-pressure, limited area type, designed to ensure continuous satisfactory contact. Switches shall be fused or nonfused as indicated.

#(4,25)#

8.4.1. **Fused Switches.** Fused switches shall be provided with integral power fuses of the dropout type. Fuse ratings shall be equal to approximately 150 percent of transformer full-load ratings, 100 percent of cable

ratings for aerial to underground transitions which serve more than one transformer, or shall be as indicated. Each switch shall have a continuous current rating [of 400 amperes rms] [of 600 amperes rms] [as shown], a momentary asymmetrical current rating [of 20 kA rms] [of 40 kA rms] [as shown] and shall be rated for the voltage of the system in which it is installed.
#(4,25)#

8.4.2. **Nonfused Switches.** Each switch shall have a continuous current rating [of 100 amperes rms] [of 200 amperes rms] [of 400 amperes rms] of 600 amperes rms] [as shown], a momentary asymmetrical current rating [of 20 kA rms] [of 40 kA rms] [as shown], and shall be rated for the voltage of the system in which it is installed.

8.4.3. **Operating Mechanism.** Switches shall be complete with necessary operating mechanisms, handles, and other items required for manual operation from the ground. Operating handles shall be located approximately 3 feet 6 inches above finished grade, shall be insulated and grounded, and each handle shall be provided with a padlock arranged to lock the switch in both the open and the closed position. Insulation of switches shall include both insulated interphase rod sections and insulated vertical shafts.
#(4,8,27)#

8.5. NOT USED. CAPACITOR EQUIPMENT. Capacitor equipment shall be of the three-phase, grounded-wye, outdoor type rated for continuous operation [and automatically switched]. Equipment shall be suitable for mounting on a single pole. Polychlorinated biphenyl (PCB) shall not be used as the dielectric. Equipment
#(d)#
shall be adequately rated for the system voltage. The indicated kvars shall be automatically switched by [single-step [time switch] [voltage] [current] [kilovar] control.] [multiple-step [voltage] [kilovar] control providing the
#(d)#
indicated number of steps and switching the indicated kvar.] [Necessary transformers shall be provided for sensing circuit variations and for low-voltage control. Oil-immersed switches shall be provided for automatic switching of capacitors] [, and shall be electrically separate from ungrounded capacitor enclosures and metal frames]. Installations shall include one primary fuse cutout and one surge arrester for each ungrounded phase conductor. Fuse link ratings shall be in accordance with the manufacturer's recommendations. Capacitor equipment, except for [low-voltage control and] primary fuse cutouts, shall be subassembled and coordinated by one manufacturer. Units, including metal pole-mounting supports and hardware, shall be shipped in complete sections ready for connection at the site. [Low-voltage equipment shall be socket or cabinet type, mounted on the pole approximately 4 feet above grade, shall be connected with the necessary wiring in conduit to capacitor equipment, and shall be provided with secondary arrester protection against switching surges when recommended by the manufacturer.]
#(4,8,27)#

8.6. NOT USED. AUTOMATIC CIRCUIT RECLOSURES. Automatic circuit reclosures shall be outdoor oil or vacuum type, complete with devices, attachments, and accessories required for installation and operation and shall be suitable for mounting on a single pole. Each recloser shall have continuous current minimum tripping current, interrupting current, and making current ratings and reclosure times #(d)#
as indicated and shall be rated for the voltage and phase of the system in which it is installed. Three-phase lockout shall be provided on three-phase circuits.

Reclosers shall include provisions for a sequence of not less than three automatic reclosing operations unless otherwise noted, followed by lockout if the circuit fault persists, and for manual opening, closing, and lockout by use of a hookstick. Operating sequence shall be adjustable for 1, 2, 3, and 4 operations to lockout and for combinations of instantaneous operations followed by time delay openings to secure coordination with other reclosers and fuses in the medium-voltage distribution system. Reclosers shall automatically reset within a definite time interval after a successful reclosure and shall be supplied with devices needed to provide the necessary operating power. Hydraulically-controlled reclosers shall be provided with tank drains and sampling valves. Surge arrester protection shall be provided. [Reclosers shall be equipped with [ground fault tripping] [and] [three-phase current metering] equipment.]

9. NOT USED.LIGHTING.

#(4,8)#

9.1. **FLOODLIGHTS.** Floodlights shall be of the enclosed [Class HD, heavy-duty] [Class GP, general-purpose] type having adjustable support brackets suitable for required mountings. Mountings and brackets shall be as indicated. Floodlights 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. The optical assemblies must generate beam spreads corresponding to the specific NEMA [horizontal and

#(d)#

vertical] type[s] designated on the plans and defined in NEMA publication FA-1.

9.2. **ROADWAY LIGHTING.**

9.2.1. **Luminaires.** 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, 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. 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. The optical assemblies must generate light distribution patterns corresponding to the specific IES illumina-

#(d)#

tion Type[s] designated on the plans and defined in IES publication RP-8.

#(4,8)#

9.2.2. **Brackets.** Brackets on wood poles shall be galvanized-steel pipe or equivalent aluminum secured to poles with through-bolts and lag screws as required for load support. Brackets on metal poles shall be not less than [1-1/4 inch] [2 inch] and of the same type of metal as the pole. Brackets shall correctly position luminaires not less than [4] [6] [8] [10] [12] [the indicated number of] feet from poles, at not less than the mounting heights indicated, but in no case less than 24 feet above any roadway. Slip-fitter brackets shall be coordinated with the luminaires provided, and brackets used with one type of luminaire shall be identical.

#(4,d)#

[9.3. **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.]

#(4,28)#

[9.4. **PHOTO-CONTROL.** Luminaries 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 twistlock assembly.]

#(29)#

10. **CONNECTIONS TO UTILITY LINES.** The Contractor shall coordinate the work with the Contracting Officer and shall provide for final connections to the arsenal's utility's electric lines.

#(4,5)#

11. NOT USED. CONNECTIONS BETWEEN MEDIUM-VOLTAGE AERIAL AND UNDERGROUND SYSTEMS. Where indicated, connections between medium-voltage aerial and underground systems shall be made as shown. Poles, brackets, crossarms, insulators, wire, surge arresters, primary-fuse cutouts, hardware, molding, [conduit,] grounding, and guying shall be provided under this section of the specifications and connected to the underground service. [Conduit, cable, and cable terminations are specified in SECTION: ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.]

12. **GROUNDING.** Equipment, neutral, and surge arrester ground systems shall be installed at poles where indicated.

12.1. **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 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.

#(4,8)#

12.1.1. **Ground Rods.** Ground rods shall be of [copper-clad steel] [galvanized ferrous composition conforming to ANSI C135.30], not less than 3/4 inch in diameter by 8 feet in length, and shall be driven into the ground until tops of rods are approximately 1 foot below finished grade. Where the specified ground resistance cannot be met with the indicated number of ground rods, additional grounds rods, longer ground rods, or deep-driven sectional rods shall be installed and connected until the specified resistance is obtained, expect 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.

12.1.2. **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.

12.2. **NEUTRAL GROUNDING.** Neutral conductors shall be grounded where indicated. Ground wire sizes, not otherwise indicated, shall have a current-carrying capacity of at least 20 percent of the largest neutral conductor to which a ground wire is connected, but in no case smaller than No. 6 AWG. Each connection to earth shall consist of a ground wire connected to a ground rod driven into the ground approximately 3 feet out from the base of the pole. Ground wires on wood poles shall be protected by half-round wood, plastic, or fiber molding from a point 18 inches above the ground line up the length of the pole. Rigid or intermediate steel conduit shall protect ground wires on poles from a point 14 inches above grade to a point.6 inches below grade. Conduits shall be terminated with a grounding bushing at each end, and the ground wire shall be connected to each bushing. Conduits shall be held in place by two, two-hole, galvanized, rigid conduit straps spaced approximately 9 inches apart. Moldings shall be stapled to wood poles at intervals not exceeding 2 feet, with one staple not more than 3 inches from each end of the molding. Single-point serrated staples of a type suitable for use with the molding shall be used for stapling molding to wood poles. When not covered by molding, ground wires shall be stapled to wood poles at intervals not exceeding 2 feet. On metal poles, a preformed galvanized steel strap, 5/8-inch wide by 22-gage minimum by length as required, secured by a preformed locking method standard with the manufacturer, shall be used to support a ground wire installation on the pole and spaced at intervals not exceeding 5 feet with one band not more than 3 inches from each end of the vertical ground wire. Bends greater than 45 degrees in ground wire connections to ground rods are not permitted.

#(16)#

12.3. **EQUIPMENT GROUNDING.** Equipment such as luminaires, medium-voltage cable terminations and messengers, metal poles, operating mechanisms of pole top switches, transformer, capacitor, and recloser frames (cases) and other noncurrent-carrying metal items shall be grounded as required. Ground wire sizes, not otherwise indicated, shall be not smaller than No. 6 AWG. Connections to earth shall be made in the same manner as required for secondary neutral grounding. Equipment or devices operating at less than 750 volts such as luminaires) may be connected to secondary neutral grounds. Equipment operating at more than 750 volts (such as transformers or group-operated load interrupter switches) shall be provided with grounds separate from secondary neutral grounds, but both grounds shall be bonded together below grade at the ground rods. Metal poles shall be grounded at each pole and these grounds shall not be interconnected with any other grounds.

12.4. **SURGE ARRESTER GROUNDING.** Surge arresters shall be grounded. Ground resistance for intermediate-class arresters shall be not more than 10 ohms and for distribution-class arresters shall be not more than 25 ohms. Ground wire connections shall be not less than No. 4 AWG for distribution arresters and No. 1/0 AWG for intermediate arresters. Connections to earth shall be made in the same manner as for secondary neutral conductors but run to a ground rod separate from the secondary neutral ground rod. Surge arrester grounds may use the same ground wires provided for equipment operating at more than 750 volts. Surge arrester and secondary neutral grounds shall be separate from and independent of each other but both grounds shall be bonded together below grade at the ground rods.

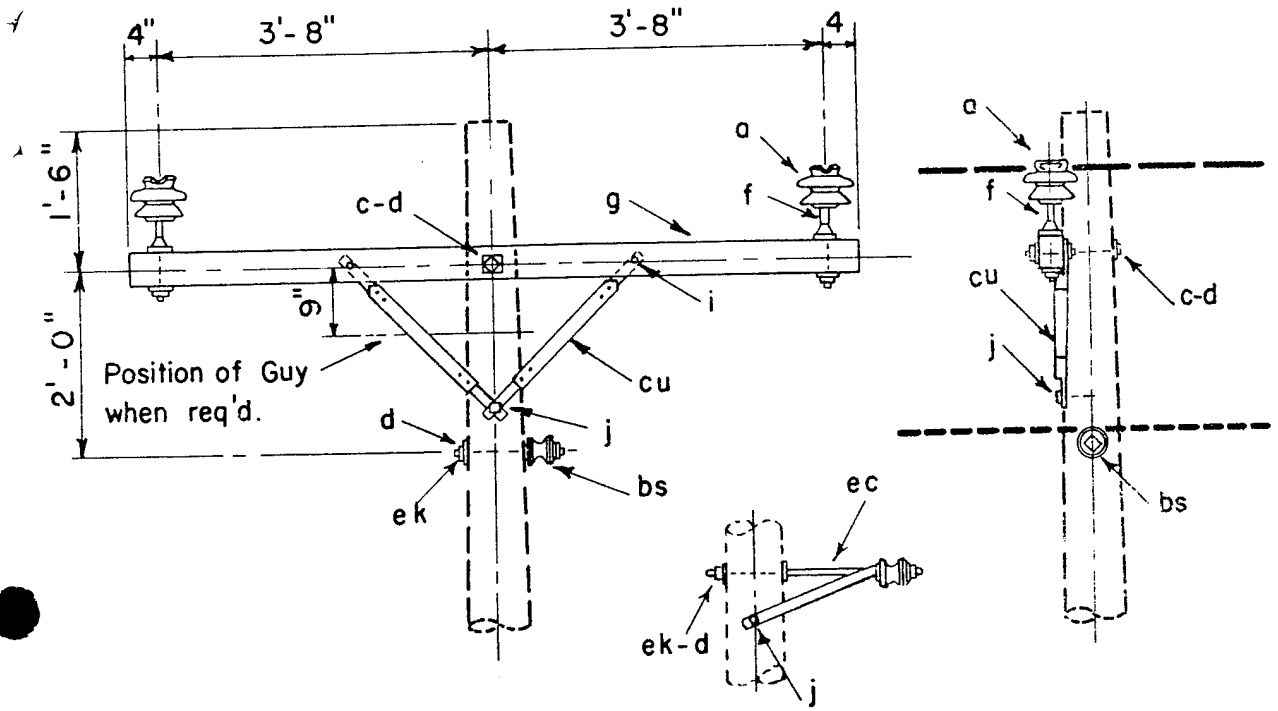
13. **TESTS.**

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. The Contractor shall submit in writing to the Contracting Officer upon completion of the project, the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system, as well as the resistance and soil conditions at the time the measurements were made. 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 [24] [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.

13.3. NOT USED. MEDIUM-VOLTAGE PREASSEMBLED CABLE TEST. After installation, [prior to connection to an existing system,] and before the operating test, the medium-voltage preassembled cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable at the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The method, voltage, length of time, and other characteristics of the test shall be in accordance with NEMA WC 7 or WC 8 for the particular type of cable installed, and shall not exceed the recommendations of IEEE No. 404 for cable joints unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed by the Contracting Officer.

13.4. **SAG AND TENSION TEST.** The Contracting Officer shall be given prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits and reserves the right to witness the procedures used for ascertaining that initial stringing sags and tensions are in compliance with requirements for the applicable loading district and cable weight.



Specify VBIA for
offset neutral assembly

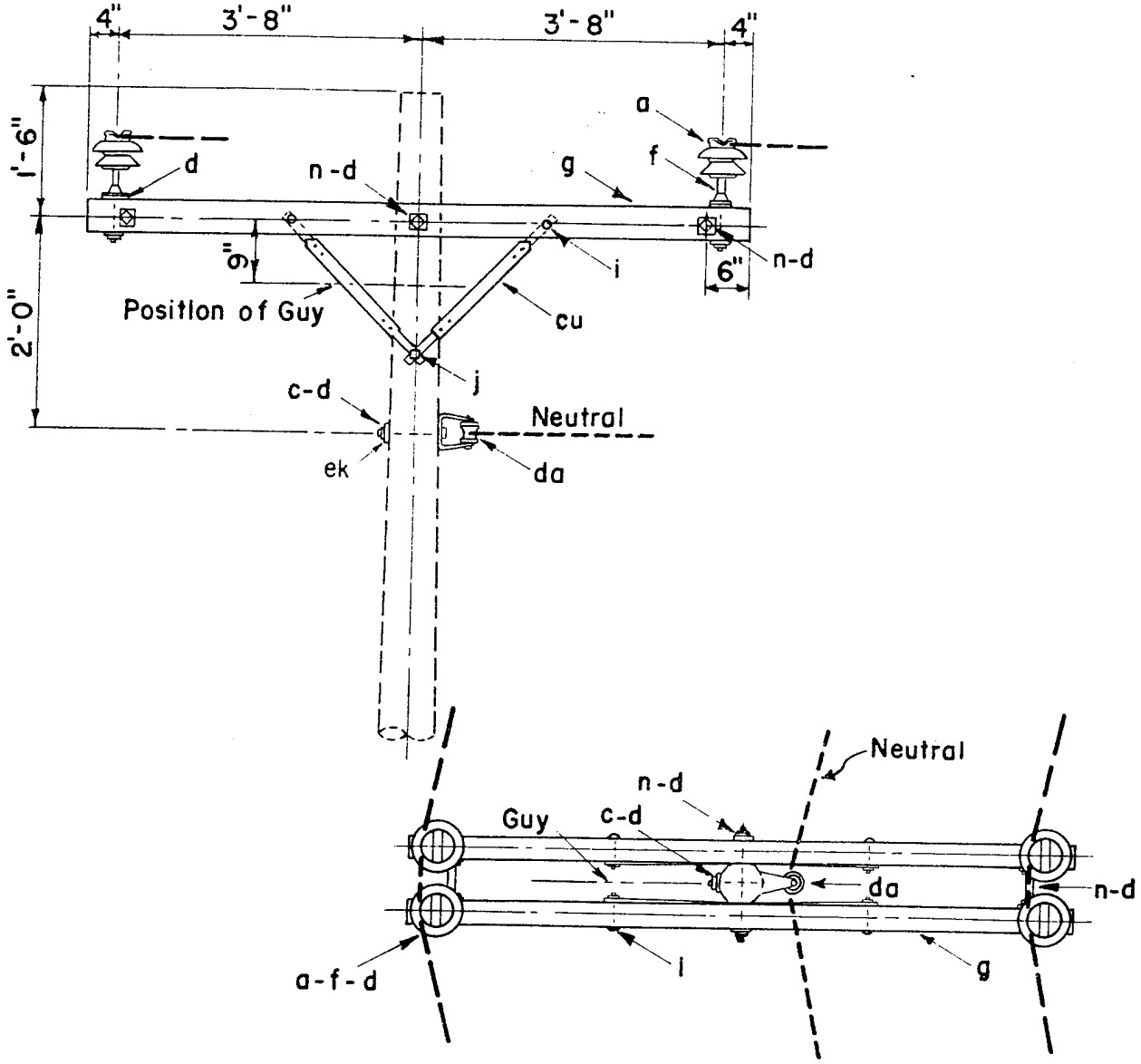
ITEM	NO.	MATERIAL
a	2	Insulator, pin type
c	1	Bolt, machine, 5/8" x req'd. length
d	3	Washer, square 2 1/4"
f	2	Pin, crossarm, steel, 5/8" x 14"
g	1	Crossarm, 3 1/2" x 4 1/2" x 8'-0"
j	3	Screw, lag, 1/2" x 4" (VBIA only)
k		Locknuts

ITEM	NO.	MATERIAL
cu	2	Brace, wood, 28"
i	2	Bolt, carriage, 3/8" x 4 1/2"
j	1	Screw, lag, 1/2" x 4" (VBI only)
bs	1	Bolt, single upset, insulated (VBI only)
ec	1	Bracket, offset, neutral (VBIA only)

14.4/24.9 KV, TWO PHASE CROSSARM CONSTRUCTION, 0° TO 5° ANGLE SINGLE PRIMARY SUPPORT

Jan. 1, 1963

VBI, VBIA

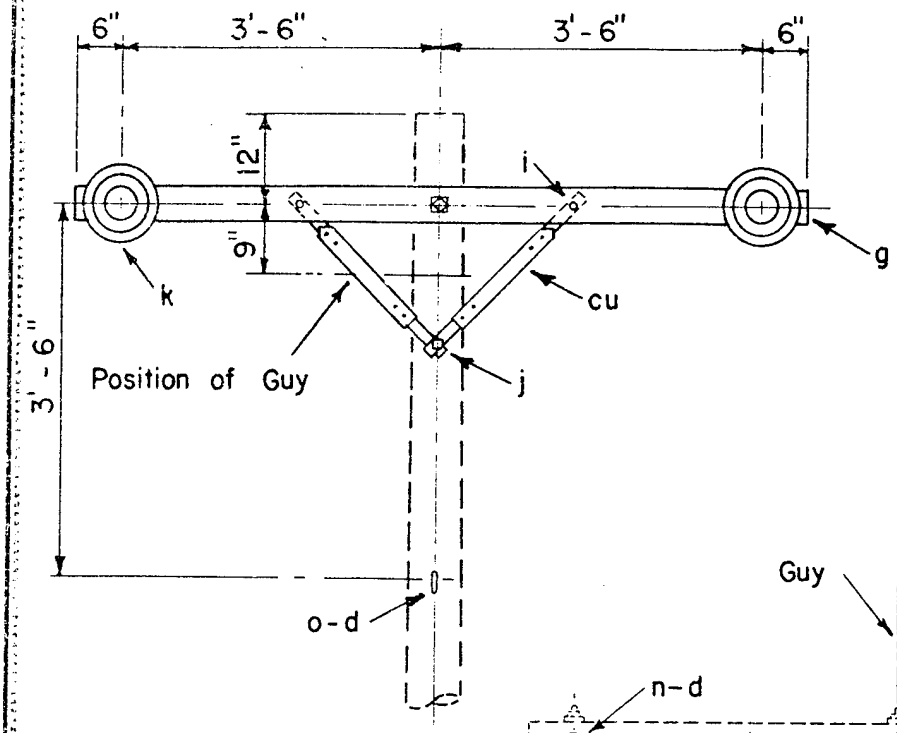


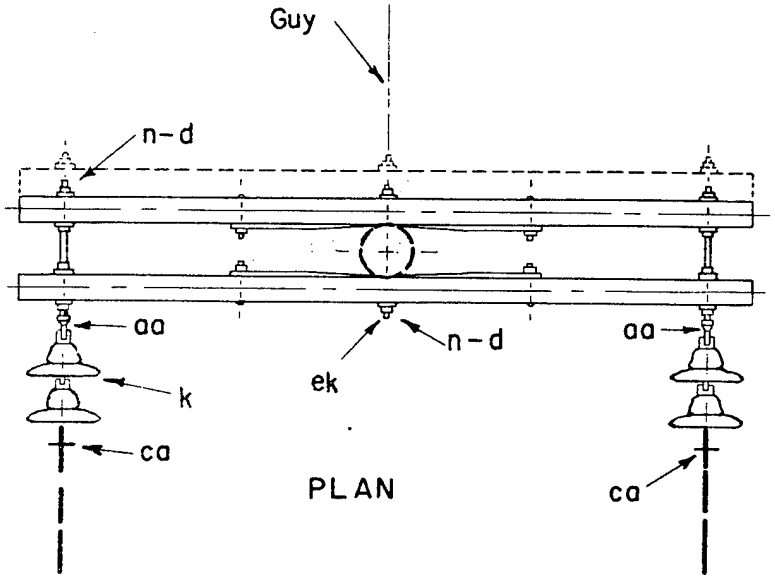
ITEM	NO.	MATERIAL		ITEM	NO.	MATERIAL	
a	4	Insulator, pin type		cu	4	Brace, wood, 28"	
c	1	Bolt, machine, 5/8" x reqd length		i	4	Bolt, carriage, 3/8" x 4 1/2"	
d	11	Washer, square 2 1/4"		j	2	Screw, lag, 1/2" x 4"	
d	4	Washer, 3"x3"x1/4", 13/16" hole		n	3	Bolt, double arming, 5/8" x req'd length	
f	4	Pin, crossarm, steel, 5/8" x 14"		da	1	Bracket, insulated	
g	2	Crossarm, 3 1/2" x 4 1/2" x 8'-0"		ek		Locknuts	

14.4/24.9 KV. TWO PHASE CROSSARM CONSTR.- DOUBLE PRIMARY SUPPORT MAX. TRANSVERSE LOADING 750 LBS./PIN (5° TO 30° MAX. ANGLE)

Jan. i, 1963

VB2





PLAN

Notes:

1. See drawing VE5-1 for crossarm loading limitations.

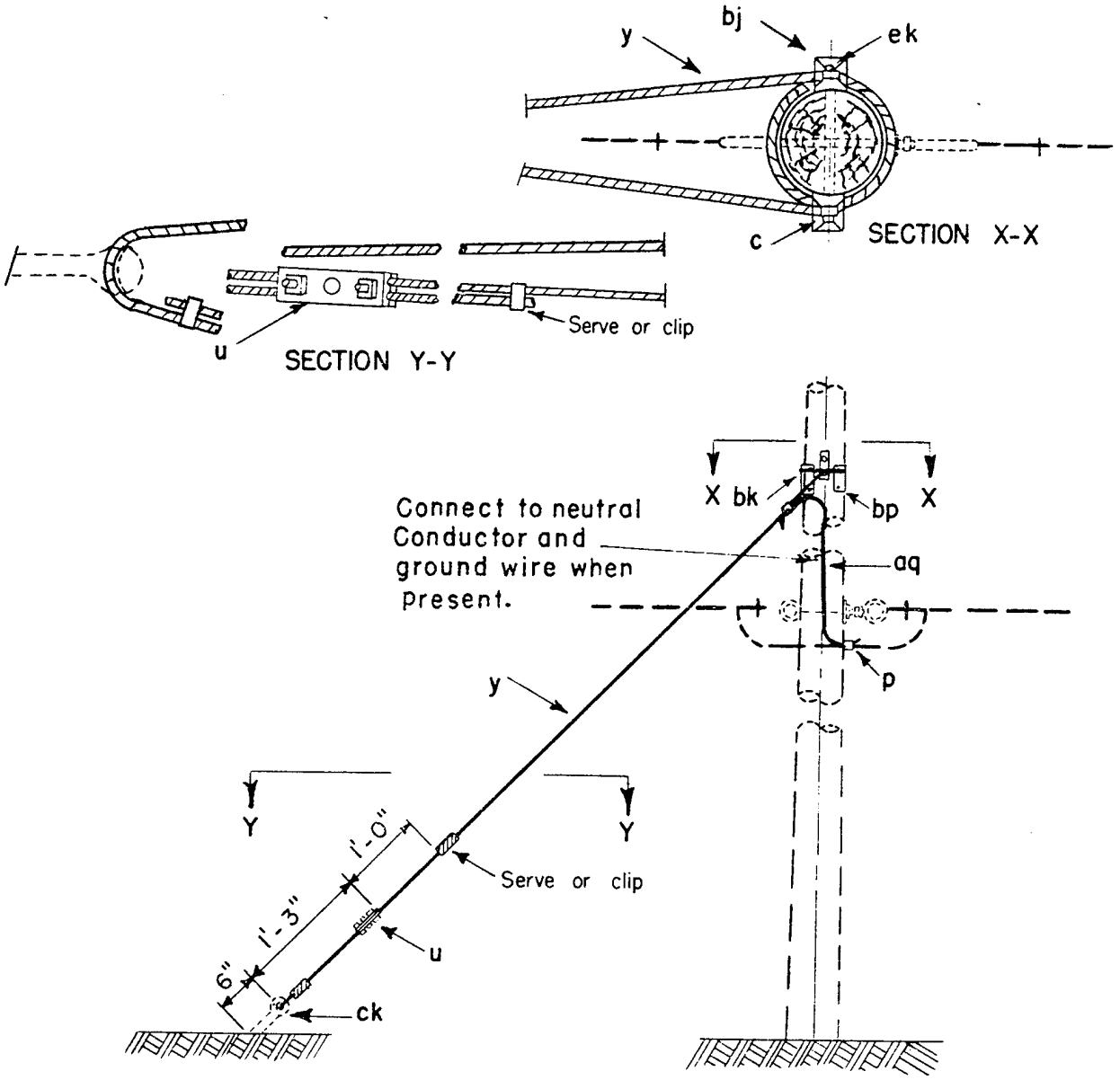
2. Designate as VB7-1 for assembly with three crossarms.

ITEM	NO.	MATERIAL	ITEM	NO.	MATERIAL
			n	3	Bolt, double arming, 5/8"x req'd. length
d	11	Washer, square, 2 1/4"	o	1	Bolt, eye, 5/8" x req'd. length
g	2	Crossarm, 3 1/2" x 4 1/2" x 8'-0"	aa	2	Nut, eye, 5/8"
cu	4	Brace, wood, 28"	ca	2	Deadend assembly, primary
i	4	Bolt, carriage, 3/8"x 4 1/2"	cc	1	Deadend assembly, neutral
j	2	Screw, lag, 1/2"x 4	ek		Locknuts
k	4	Insulator, suspension, 10"			

14.4/24.9 KV, TWO PHASE CROSSARM CONSTRUCTION-DEADEND (SINGLE)

Jan. 1, 1963

VB7, VB7-1



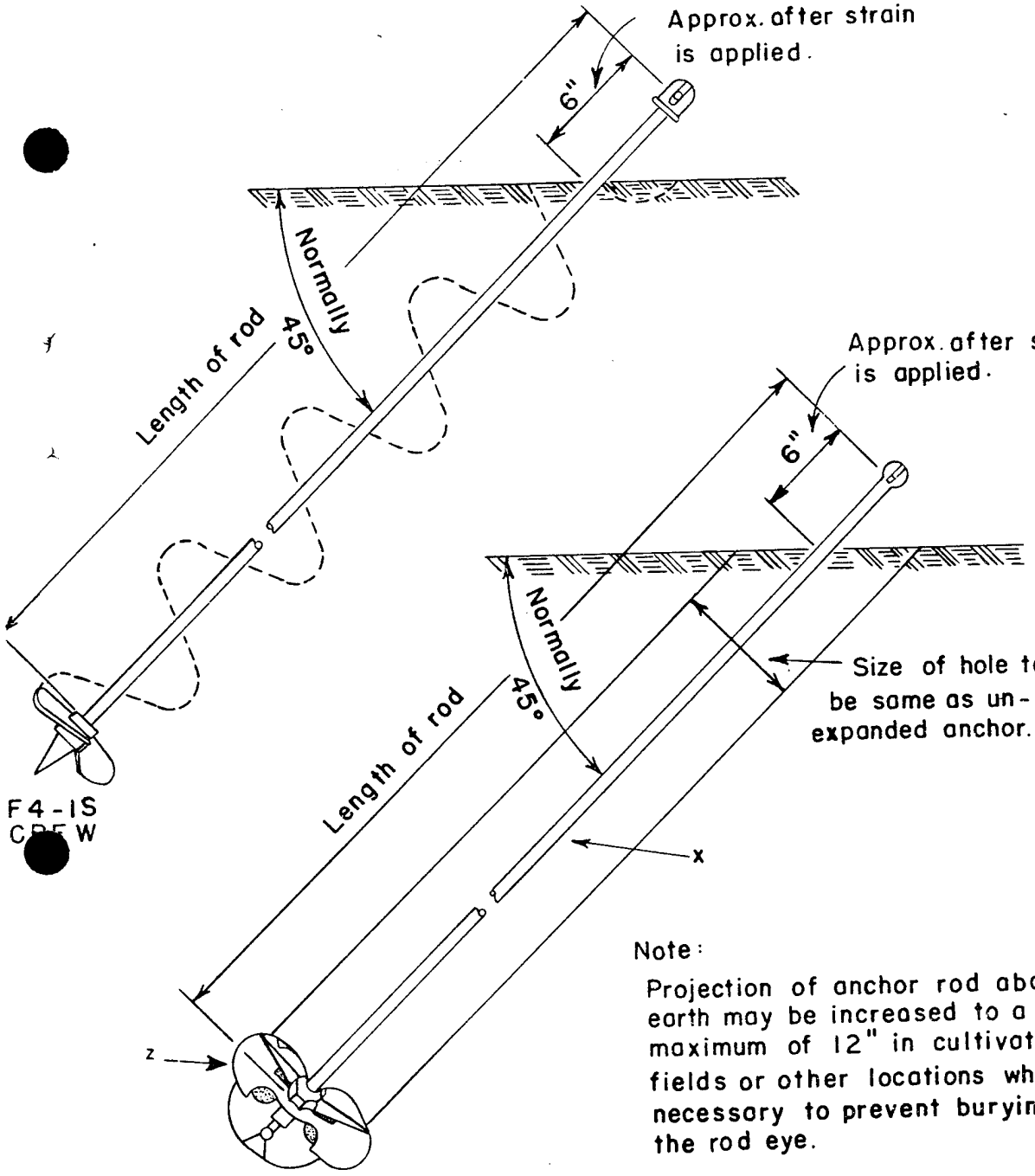
		ASSEMBLY UNIT			
		E11 1/4" GUY WIRE	E12 3/8" GUY WIRE		
ITEM	MATERIAL	No. REQ'D.	No. REQ'D.		
c	Bolt, machine, 5/8" x req'd. length	1	1		
u	Clamp, guy	1- Light Duty	1- Heavy Duty		
y	Guy wire, S.M., 7 strand	Req'd. Length	Req'd. Length		
ck	Clamp, anchor rod bonding	1	1		
bj	Guy hook, J	2	2		
bk	Guy plate, 4" x 8", 14 guage	2	2		
bp	Nail, 8 penny, galv.	8	8		
aq	Jumper, # 6 S.D. copper or equivalent				
p	Connectors, as req'd.				
ek	Locknuts				

7.2/12.5 KV

SINGLE LOOP GUY, WRAPPED TYPE

Jan 1, 1962

E11, E12



F4-1E
EXPANDING

Note:
Projection of anchor rod above earth may be increased to a maximum of 12" in cultivated fields or other locations where necessary to prevent burying the rod eye.

ITEM	MATERIAL	ASSEMBLY UNIT F4-1S NO.	F4-1S	F4-1E NO.	F4-1E				
	Rod, anchor, thimble type eye			1	5/8" x 6'-0"				
	Anchor, service	1		1					
	Holding power		2500#		2500#				

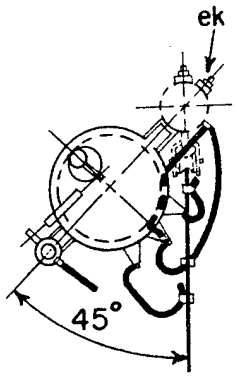
SERVICE ANCHOR ASSEMBLY

Jan 1, 1962

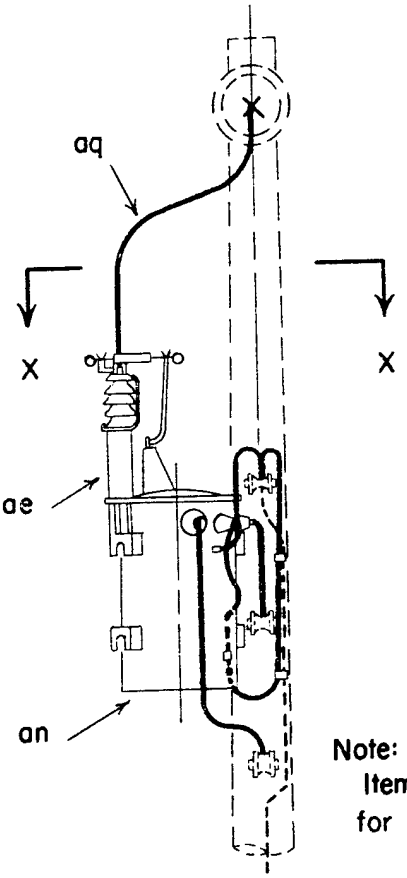
F4-1

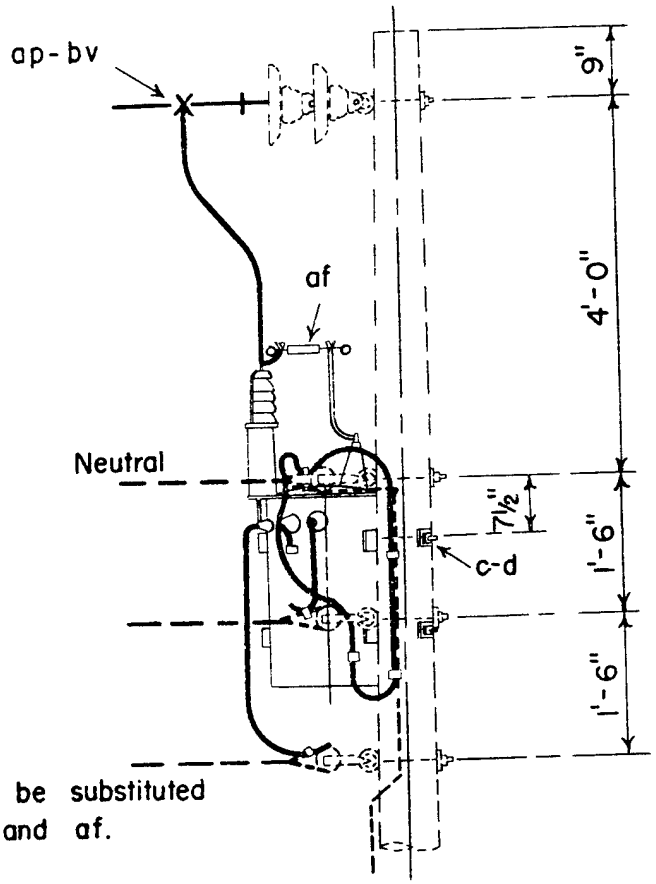
Notes:

1. Designate VG10 for conventional transformer with tank mounted cutout and arrester, VG66 for transformer with double gaps and internal fuse, VG106 for self protected transformer.
2. See guide drawings for details of transformer secondary and service connections.



SECTION X-X





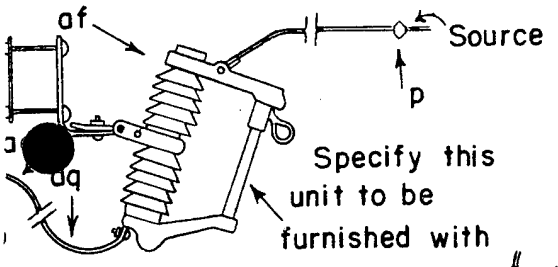
Note:
Item ax may be substituted for items ae and af.

ITEM	NO.	MATERIAL		ITEM	NO.	MATERIAL	
c	2	Bolt, machine, 5/8" x req'd. length		an	1	Transformer	
d	2	Washer, square, 2 1/4"		ap	1	Clamp, hot line, tap assembly	
p		Connectors, as required		aq		Jumpers, stranded, as required	
ae	1	Lightning arrester (VG10 only)		bv	1	Rods, armor	
af	1	Cutout, fuse, open link (VG10 only)		ek		Locknuts	

14.4/24.9 KV.
SINGLE PHASE TRANSFORMER
AT DEADEND

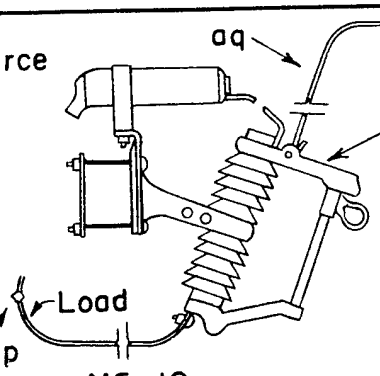
Jan. 1, 1963

VG10, VG66, VG106

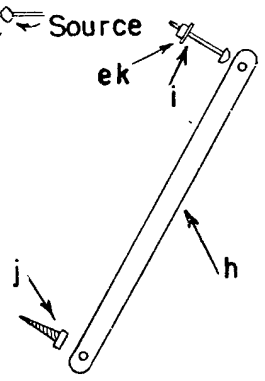


M5-9

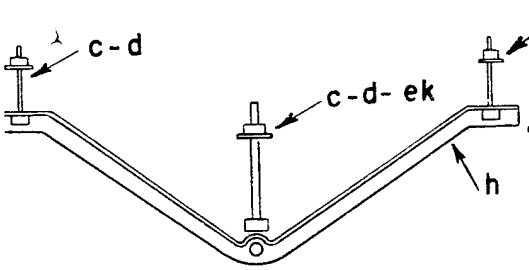
Specify this unit to be furnished with fuse tube or switch blade.



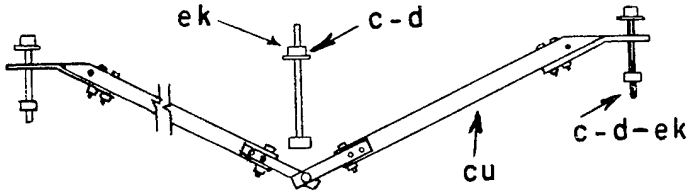
M5-10



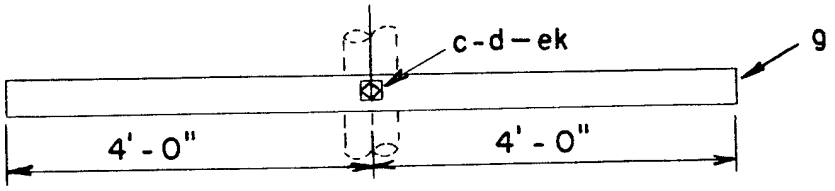
M5-11



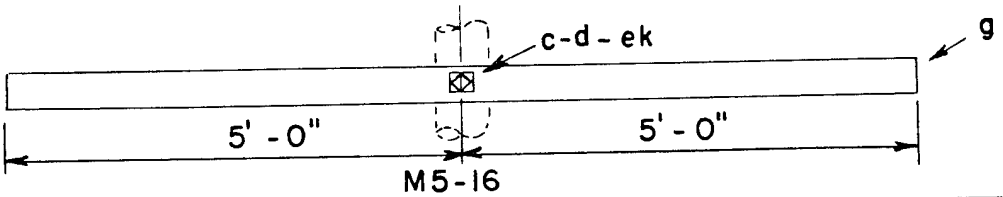
M5-12



M5-13



M5-14, M5-15



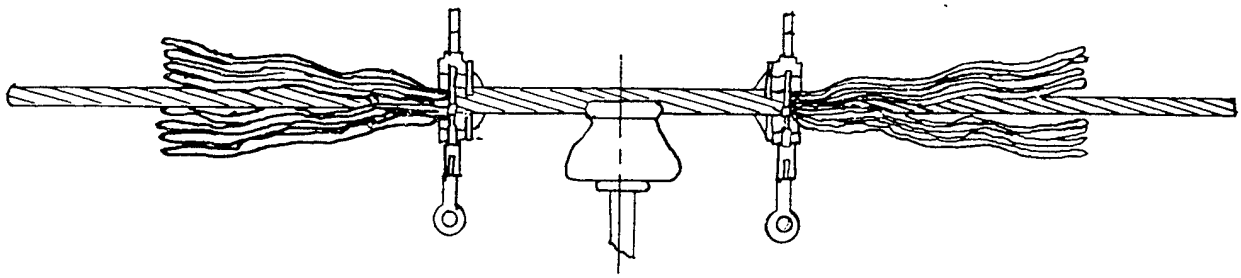
M5-16

M	MATERIAL	NUMBER REQUIRED							
		M5-9	M5-10	M5-11	M5-12	M5-13	M5-14	M5-15	M5-16
	Bolt, machine, 5/8" x req'd length				1	1	1	1	
	Bolt, machine, 1/2" x req'd length				2	2			
	Washer, 2 1/4" x 2 1/4" x 3/16", 13/16" hole				1	1	2	2	2
	Washer, round, 1 3/8" dia., 9/16" hole				2	2			
	Crossarm, 3 1/2" x 4 1/2" x 8'-0"						1		
	Crossarm, 3 3/4" x 4 3/4" x 10'-0"								1
	Brace, flat, 1 1/4" x 1/4" x 28"			1					
	Brace, angle, 1 1/2" x 1 1/2" x 3/16", 60" span				1				
	Bolt, carriage, 3/8" x 4 1/2"			1					
	Screw, lag, 1/2" x 4"			1					
	Connector	2	2						
	Cutout, single-shot	1							
	Jumper	2	2						
	Cutout and arrester combination		1						
	Brace, wood, 60" span					1			
	Locknuts			1	3	3	1	1	1
	Crossarm, 3 3/4" x 4 3/4" x 8'-0"							1	

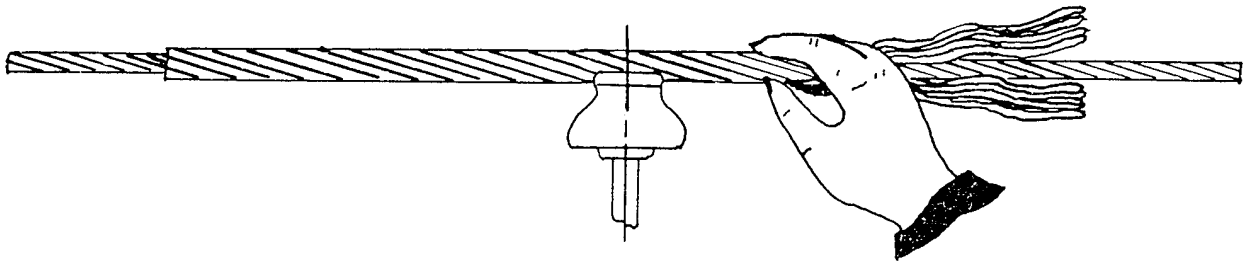
MISCELLANEOUS PRIMARY ASSEMBLIES

Jan 1, 1962

M5-9 TO 16



For tool application, insert half the reinforcements in one cavity and the other half in the other cavity of the open wrenches, keeping the ends even. Hook wrenches over the conductor and close jaws. Space wrenches approximately one reinforcement pitch apart and twist them in the same direction as the lay of the conductor. Wind each wrench to the end of the reinforcements and remove.



For hand application, hold one or more reinforcements against the conductor with midpoint at the insulator, and rotate in same direction as the lay of the conductor, for three or four inches each side of center. In like manner apply remaining reinforcements to center section. After all have been started, complete the application by a rotary outward wiping motion of the hand. Make certain that the ends snap into place in proper order.

PREFORMED ALUMINUM ALLOY ARMOR RODS

A.C.S.R.	LENGTH SINGLE SUPPORT	LENGTH DOUBLE SUPPORT	NO. PER SET	WIRE DIAM. (IN.)	DIAM. PLUS RODS	A.C.S.R.	LENGTH SINGLE SUPPORT	LENGTH DOUBLE SUPPORT	NO. PER SET	WIRE DIAM. (IN.)	DIAM. PLUS RODS
4/0(6x1)	60"	72"	11	.182	.927	2 (7x1)	44"	56"	9	.146	.613
3/0(6x1)	56"	68"	11	.167	.836	2 (6x1)	44"	56"	9	.146	.604
2/0(6x1)	54"	66"	10	.167	.781	4 (7x1)	40"	52"	7	.146	.545
1/0(6 x1)	52"	64"	9	.167	.732	4(6x1)	40"	52"	7	.146	.538
1(6x1)	48"	60"	9	.146	.643						

PREFORMED ARMOR RODS
A.C.S.R. CONDUCTORS

Jan 1, 1962

M40-12

ZERO ACCIDENTS

SECTION 16415
ELECTRICAL WORK, INTERIOR

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29. REPAIR OF EXISTING WORK
30. TESTS
31. SPARE PARTS

#(N)#
Attachments: Std. Dwg. 40-06-04, Sheets ____, ____, ____, ____, ____, and ____,
Std. Dwg. 40-15-01, Sheet 2

#(N)#

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.).**

J-C-30A & Am-1	Cable and Wire, Electrical (Power, Fixed Installation)
L-C-530C	Coating, Pipe, Thermoplastic Resin
L-P-387A & Am-1 & Int. Am-2	Plastic Sheet, Laminated, Thermosetting (For Designation Plates)
L-P-1035A	Plastic Molding Material, Vinyl Chloride Polymer and Vinyl Chloride-Vinyl Acetate

	Copolymer, Rigid
L-T-001512A (GSA-FSS)	Tape, Pressure-Sensitive Adhesive, Pipe Wrapping
W-B-30A & Am-2	Ballast, Fluorescent Lamp (Non-Polychlorinated Biphenyl Type)
W-C-375B/GEN	Circuit Breakers, Molded Case; Branch Circuit and Service
W-C-586C	Conduit Outlet Boxes, Bodies, and Entrance Caps, Electrical: Cast Metal
W-C-596F/GEN & Suppl. 1	Connector, Electrical, Power, General Specification for
W-C-1094A	Conduit and Conduit Fittings, Plastic, Rigid
#(N)#	
W-F-406C	Fittings for Cable, Power, Electrical and Conduit, Metal, Flexible
W-F-408C & Am-1	Fittings for Conduit, Metal, Rigid (Thick-Wall and Thin-Wall (EMT) Type)
W-F-414E & Int. Am-1	Fixture, Lighting (Fluorescent, Alternating-Current, Pendant Mounting)
W-F-1234A	Fixture, Lighting (Fluorescent Lamp, Industrial)
W-F-1662A & Int. Am-2	Fixture, Lighting (Fluorescent, Alternating-Current, Recessed and Surface Ceiling)
W-F-1814A/GEN & Suppl. 1	Fuse, Cartridge, High Interrupting Capacity
W-J-800E	Junction Box; Extension, Junction Box; Cover, Junction Box (Steel, Cadmium, or Zinc-Coated)
W-L-101H & Suppl. 1	Lamp, Incandescent, (Electric, Large Tungsten-Filament) (General Specification)
W-L-00116D	Lamps, Fluorescent (General Specification)
W-L-142a & Int. Am-4	Lampholder, Adapter and Shadeholder, Medium-Screw-Shell, 125, 250, and 600 Volts
W-L-305D & Int. Am-1	Light Set, General Illumination (Emergency or Auxiliary)
W-P-115b	Panel, Power Distribution
W-S-610D	Splice Conductor
W-S-865c & Int Am-2	Switch, Box, (Enclosed), Surface-Mounted
CC-M-1807A	Motors, Alternating Current, Fractional and Integral Horsepower (500 HP and Smaller)
GG-I-446E	Illuminator, X-Ray Film
HH-I-553C & Am-1	Insulation Tape, Electrical, (Rubber, Natural and Synthetic)
HH-I-595C	Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic
WW-C-00540c & Int. Am-1	Conduit, Metal, Rigid: and Coupling, Elbow, and Nipple, Electrical Conduit: Aluminum
WW-C-566C	Conduit, Metal, Flexible

1.2. **AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI) STANDARDS.**

C2-1987	National Electrical Safety Code
C12.1-1988	Code for Electricity Metering
C12.4-1984	Mechanical Demand Registers

C12.10-1978	Watthour Meters
C12.11-1987	Instrument Transformers for Revenue Metering, 10 KV BIL Through 350 KV (0.6 KV NSV through 69 KV NSV)
C37.13-1981	Low-Voltage AC Power Circuit Breakers Used in Enclosures
C39.1-1981	Electrical Analog Indicating Instruments
C57.13-1978	Requirements for Instrument Transformers
C78.380-1984	Method for the Designation of High-Intensity-Discharge Lamps
C82.4-1985	High-Intensity-Discharge Lamp Ballasts (Multiple Supply Type)
C97.1-1972	Low-Voltage Cartridge Fuses 600 Volts or Less

1.3. **AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATION.**

D 69-85	Friction Tape

1.4. **AMERICAN WATER WORKS ASSOCIATION (AWWA) STANDARD.**

C 203-78	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines--Enamel and Tape--Hot-Applied

1.5. **INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE) STANDARDS.**

No. 18-1980	Shunt Power Capacitors
No. 142-1982	Recommended Practice for Grounding of Industrial and Commercial Power Systems

1.6. **NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) STANDARDS.**

BU 1-1983 Incl. Rev. 1	Busways
ICS 1-1978 Incl. Rev. 1 thru 4 (R 1983)	General Standards for Industrial Control and Systems
ICS 2-1983 Incl. Rev. 1 thru 3	Industrial Control Devices, Controllers and Assemblies
ICS 3-1983	Industrial Systems
ICS 4-1983	Terminal Blocks for Industrial Control Equipment and Systems
ICS 6-1983 Incl. Rev. 1 (R 1983)	Enclosures for Industrial Controls and Systems
MG 1-1987	Motors and Generators
MG 10-1983	Energy Management Guide for Selection on Use of Polyphase Motors
PB 2-1984	Deadfront Distribution Switchboards
RN 1-1986	Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
SG 3-1981	Low-Voltage Power Circuit Breakers
SG 5-1981	Power Switchgear Assemblies
TC 2-1983	Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
VE 1-1984	Cable Tray Systems

Incl. Rev. 1	
WD 1-1983	See Fed. Spec. W-C-596

1.7. **NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) PUBLICATIONS.**

No. 70-1990	National Electrical Code ("NEC")
No. 101-1988	Code for Safety to Life From Fire in Buildings and Structures ("Life Safety Code")

1.8. **UNDERWRITERS LABORATORIES, INC. (UL) PUBLICATIONS.**

Building Materials Directory (Jan 1988 with Quarterly Supplements)

UL 5	Surface Metal Raceways and Fittings (May 28, 1985, 10th Ed.)
UL 20	General-Use Snap Switches (Jun 12, 1986, 10th Ed.; Rev thru Sep 23, 1986)
UL 50	Cabinets and Boxes (Apr 25, 1980, 8th Ed.; Rev. thru Feb 21, 1982)
UL 57	Electric Lighting Fixtures (Aug 30, 1972, 12th Ed.; Errata Sep 23, 1975; Rev. thru Jul 22, 1982)
UL 98	Enclosed and Dead Front Switches (Jan 13, 1987, 11th Ed.; Rev thru Feb 3, 1988)
UL 198C	High-Interrupting-Capacity Fuses, Current-Limiting Types (Jul 21, 1986, 5th Ed.; Rev. thru Mar 26, 1987, Errata Sep 3, 1987)
UL 198F	Plug Fuses (Mar 14, 1988, 4th Ed.)
UL 198H	Class T Fuses (Jul 13, 1988, 4th Ed.)
UL 360	Liquid-Tight Flexible Steel Conduit (Aug 18, 1986, 3rd Ed.)
UL 467	Grounding and Bonding Equipment (Nov 22, 1984, 6th Ed.; Rev. April 30, 1985)
UL 498	Attachment Rings and Receptacles (Nov 3, 1986,; 11th ed.; Rev thru Jan 14, 1989)
UL 506	Specialty Transformers (Dec 26, 1979 9th Ed; Rev. thru Feb 4, 1989)
UL 508	Industrial Control Equipment (Aug 17, 1984, 14th Ed.; Rev. thru Dec 5, 1986)
UL 514A	Metallic Outlet Boxes (Dec 1, 1983, 7th Ed.; Rev. thru June 13, 1989)
UL 514B	Fittings for Conduits and Outlet Boxes (Mar 15, 1989, 2nd Ed.)
UL 514C	Nonmetallic Outlet Boxes, Flush Device Boxes and Covers (Oct 31, 1988, 2nd Ed; Rev thru Jun 13, 1989)
UL 674	Electric Motors and Generators for Use in Hazardous Locations, Class I, Groups C and D, Class II, Groups E, F, G (1st Ed., Rev thru Nov 21, 1984)
UL 797	Electrical Metallic Tubing (Oct 10, 1983, 5th Ed.)
UL 817	Cord Sets and Power-Supply Cords (Dec 22, 1986, 9th Ed.; Rev thru Sep 7, 1987)
UL 844	Electric Lighting Fixtures for Use in Hazardous Locations (Nov 29, 1984, 9th Ed.;

	Rev Oct 10, 1985)
UL 845	Motor Control Centers (Feb 18, 1988, 3rd Ed.; Rev thru Sep 7, 1988)
UL 857	Busways and Associated Fittings (Jan 11, 1982, 9th Ed.; Rev. thru Dec 28, 1987)
UL 869	Service Equipment (May 28, 1984, 6th Ed.; Rev. thru Jun 8, 1987)
UL 877	Circuit Breakers and Circuit Breaker Enclosures for Use in Hazardous (Classified) Locations (Aug 15, 1985, 3rd Ed., Rev thru Mar 23, 1987)
UL 886	Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations (Jun 12, 1985, 9th Ed., Rev thru Feb 2, 1988)
UL 891	Dead-Front Switchboards (Nov 13, 1984, 8th Ed.; Rev thru Feb 1, 1988, Errata Apr 1, 1988)
UL 894	Switches for Use in Hazardous (Classified) Locations (Sep 17, 1986, 6th Ed.; Rev thru Jul 13, 1987)
UL 924	Emergency Lighting and Power Equipment (Mar 16, 1984, 6th Ed.; Rev thru Jul 24, 1987)
UL 943	Ground-Fault Circuit Interrupters (Dec 11, 1972, 1st Ed.; Rev. thru Dec 5, 1977)
UL 1022	Line Isolation Monitors (Jul 30, 1979, 2nd Ed.; Rev. thru Jun 15, 1984)
UL 1029	High-Intensity-Discharge Lamp Ballasts (Dec 1, 1986, 4th Ed,; Rev thru Jul 19, 1988)
UL 1047	Isolated Power Systems Equipment (Aug 18, 1976, 1st Ed.; Rev. thru Sep 13, 1985)
UL 1236	Battery Chargers (Dec 23, 1986, 3rd Ed.
UL 1242	Intermediate Metal Conduit (Oct 10, 1983, 1st Ed.; Rev April 10, 1986)
UL 1570	Standard for Fluorescent Lighting Fixtures (Apr 11, 1988, 3rd Ed.; Rev thru Sep 9, 1988)
UL 1571	Incandescent Lighting Fixtures (Feb 7, 1984, 2nd Ed.; Rev thru Mar 31, 1987)
UL 1572	High Intensity Discharge Lighting Fixtures (Dec 10, 1984,; Rev thru May 2, 1988)

2. GENERAL.

2.1. RULES. Unless otherwise specified, the installation shall conform to the requirements of the National Electrical Code, NFPA No. 70. Damp locations, in addition to those defined in the NEC, shall include all cold-storage areas and the interior exposed surfaces of all perimeter single wythe masonry or concrete walls above or below grade. Wet locations, in addition to those defined in the NEC, shall include shower rooms and commercial-type laundry facilities.

2.2. COORDINATION. The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment will be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be located to avoid interference with mechanical or structural features;

otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit work tasks when work stations are fixed by design and shown on contract drawings. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. Attachment of suspended electrical equipment loads in excess of 50 pounds shall be made at panel points (intersections of members) of roof joists. If any conflicts occur necessitating departures from the drawings, details of departures and reasons therefor shall be submitted as soon as practicable for written approval of the Contracting Officer. See SECTION: SPECIAL CLAUSES (01100), paragraph 4.5: EQUIPMENT ROOM DRAWINGS.

2.3. NOT USED. LOCATIONS. [Wiring and equipment in designated locations shall conform to the NFPA No. 70 (NEC) for Class [I] [II] [III], Division [1] [2] hazardous locations. Equipment shall be suitable for [Group _____] [and] [operating temperature of ____ degrees F.] [Wiring and equipment in designated locations shall be of the classes, groups, divisions, indicated [and shall be suitable for the operating temperature indicated].]

2.4. **STANDARD PRODUCTS.** Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.5. **IDENTIFICATION NAMEPLATES.** Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Unless otherwise specified, all identification nameplates shall be made of laminated plastic in accordance with Fed. Spec. L-P-387 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws or approved nonadhesive metal fasteners. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4-Inch High Letters	Minimum 1/8-Inch High Letters
Panelboards	Control Power Transformers
Starters	Instrument Transformers
Safety Switches	Control Devices (Relays, Contactors, Etc.)
Motor Control Centers	
Transformers	
Equipment (Air Handling Units, Exhaust Fans, Pumps, Etc.)	
Switchgear	
Switchboards	

2.6. **INSULATING FLUIDS.** Fluids containing tetrachloroethylene (perchloroethylene) or polychlorinated biphenyls (PCBs) are not acceptable as an insulating medium in transformers, ballasts, capacitors, or other equipment.

2.7. **UNUSUAL SERVICE CONDITIONS.** All items furnished under this section shall be specifically suitable for the following unusual service conditions.

2.7.1. **Altitude.** 5265 feet above mean sea level.

2.7.2. **Ambient Temperature.** minus 20 degrees F.

2.8. **APPLICATION OF THIS SECTION.** All electrical equipment and materials must conform to the product requirements of this section (ELECTRICAL WORK, INTERIOR), and must be installed in the manner prescribed in this section to the extent not covered under other electrical sections of these specifications. The provisions of ELECTRICAL WORK, INTERIOR shall also apply to electrical supporting items required by equipment furnished under nonelectrical sections and to electrical subsystems and components of equipment specified as package assemblies in nonelectrical sections, unless specifically excluded or modified in those sections. For additional requirements pertaining to connection of various types of equipment, see paragraph EQUIPMENT CONNECTIONS later in this section.

2.9. **SEISMIC CONSIDERATIONS.** The provisions of this section will provide a minimum level of seismic protection (zone 1). [For some items, additional measures will be required; see SECTION: SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT for specific requirements.]

3. **SUBMITTALS.**

3.1. **SUBMITTAL PROCEDURES.** Data shall be submitted in accordance with the overall requirements detailed in the SECTION: SPECIAL CLAUSES and the specific requirements of this section. Documents shall consist of a complete list of equipment and materials, manufacturer's descriptive and technical literature, brochures, catalog cuts, performance data, diagrams, and other material as appropriate. As a minimum the following must be submitted:

3.1.1. **Category I.**

Drawings and data on the following components:

Service Equipment (Para. 5.27, 13)

[Ground Fault Protection (Service) (Para. 6.1, 13.3, 30)]

Motor Control (Para. 5.22, 20, 21, 27.1)

Motor Control Centers (Para. 5.22, 21.4)

Power Factor Correction Capacitors (Para. 20.3,5.6)

Lighting Controls (Components and Systems) (Para. 5.11, 24)

Emergency Power System (Battery Inverter) (Para. 24.10)

Equipment and Devices for Use in Other Than General Purpose Areas (Para. 2.3, 2.7, 5.14.4, 10.2)

Power Distribution Centers (for computers) (Para. 14A)

Secondary Switchgear (Para. 5.8, 5.15, 5.25, 5.30, 5.31, 12, 15, 17)

Transformers (Para. 5.34, 23)

Nonstandard Lighting Fixtures (not listed in Series 40-06-04) (Para. 5.14, 24.2)

Metering Equipment [including pulse initiators] (Para. 5.20,13.2)[(Para. 13.2.1)]

#(N)#

[Conductor Terminators and Connectors Rated [75 degrees C. (#12 through #1)] [90 deg. C.] (Para. 5.10, 5.29, 7.7)]

Special Cable Tray Systems (Para. 5.4,7.6)

Special Receptacles (Para. 5.26, 10.9)

Busway Systems (Para. 5.2, 7.4)

Protective Coordination Study (Para. 3.6.3)
Supplementary Contractor's Drawings, as applicable (Para. 3.7)
Factory Tests and Certifications (Para. 3.5.2)
Operation and Maintenance Manuals (Para. 3.4)

3.1.2. **Category II (For Information).**
Drawings and data on the following components:
Standard Lighting Fixtures listed in Series 40-06-04 (Para. 5.14, 5.19, 5.28, 24.2, 24.9)
Field Tests and Certifications (Para. 3.6.1, 3.6.2)
List of Equipment and Materials (Para. 3.3)

3.2. **PROOF OF COMPLIANCE.** Where materials or equipment are specified to conform to the standards or publications, and requirements of ANSI, ASTM, AWWA, IEEE, NEMA, NFPA, or UL, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements.

3.2.1. **Underwriters Laboratories, Inc. (UL) Publications.** The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, the Contractor shall submit a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer.

3.2.2. **Non-Underwriters Laboratories, Inc. (UL) Publications.** For equipment and materials specified to conform to Federal Specifications, or any of the above commercial standards, a manufacturer's certification or published catalog specification data statement that the items comply with applicable specifications or standards publications will be acceptable evidence of such compliance.

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, and the name of the manufacturer of each such item.

#(N)#

3.4. NOT USED. INSTRUCTION MANUALS. Instruction manuals shall be furnished 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 and 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. The following equipment shall be covered: _____, _____, _____.]

3.5. **MANUFACTURER'S CERTIFICATIONS.**

3.5.1. **Certificates of Compliance.** Certificates shall be prepared by the manufacturer 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 data or reports shall be submitted on such items for which the manufacturer normally performs routine tests, including tests required by standards listed in paragraph: MATERIALS AND EQUIPMENT.

3.6. **CONTRACTOR'S DATA.** The Contractor shall submit the following types of data to supplement the Contractor's drawings.

3.6.1. **Certifications.** Certifications shall be submitted when specified or required, including 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 test reports shall be written and certified by the Contractor to the Contracting Officer. Field tests shall include [ground fault,] cable, operational, and resistance-to-ground tests. #(N)#

[3.6.3. NOT USED. Coordination Study. The Contractor shall prepare and submit a complete protective coordination study within 30 calendar days following the complete approval of circuit protective devices, including circuit breakers, fuses, thermal overloads, and protective relays.]

3.7. **SUPPLEMENTARY CONTRACTOR'S DRAWINGS.** If the submittal data required above is not sufficient to demonstrate compliance with applicable contract requirements, the Contractor shall prepare and submit additional drawings as required to supplement the contract drawings, manufacturer's data and drawings, and Contractor's data. Drawings shall be dimensioned or scaled to show the relative arrangement and mounting details of the equipment or equipment assemblies.

4. **WORKMANSHIP.** Materials and equipment shall be installed in accordance with recommendations of the manufacturer to conform with the contract documents. The installation shall be accomplished by workmen skilled in this type of work.

5. **MATERIALS AND EQUIPMENT.** Materials and equipment shall conform to the respective publications and other requirements specified below. Other materials and equipment shall be as specified elsewhere herein and as shown on the drawings.

5.1. NOT USED. BALLASTS.

5.1.1. **Fluorescent Lamp Ballasts.** High-power-factor type conforming to Fed. Spec. W-B-30. In addition, ballasts for [34] [35] [and] [40]-watt and larger lamps shall be Class P and shall be automatic-resetting type.

5.1.2. **HID Ballasts.** Ballasts supplying high-intensity discharge lamps shall be high-power factor type conforming to ANSI C82.4 and UL 1029 and designed for multiple (parallel) connection.

5.2. NOT USED. UL 857. Buses shall be [copper] [or] [aluminum]. [If not otherwise indicated, include a full size neutral and a [25] [50] percent minimum ground bus.] Enclosures shall be [steel] [aluminum]. Short-circuit ratings, except as indicated, shall be in accordance with NEMA BU 1.

5.2.1. **Feeder Busways.** Feeder busways shall be [ventilated, except that firewall penetrations and vertical busways within 6 feet 0 inch of floors shall be unventilated] [unventilated] low-impedance busway.

5.2.2. **Plug-In Busways.** Plug-in busways shall be unventilated.

#(N)#

5.3. **CABLES.** Cables shall conform to Fed. Spec. J-C-30 and shall be of annealed copper, except that AA-8000 series alloy aluminum conductors may be used as an equivalent for copper conductors of No. [6] [4] AWG or larger. Intermixing of copper and aluminum conductors in these sizes is not permitted. Design is based on copper conductors and aluminum conductors shall have an ampacity not less than that of the indicated copper conductors. Cables may be single-conductor type, unless otherwise indicated.

5.3.1. NOT USED. Metallic Armored Cable. Type ACHH or ACT.

5.3.2. **Nonmetallic Sheathed Cables.** Type NM or NMC, with ground conductor.

5.3.3. **Service Entrance Cable.** Type SE.

5.3.4. **Grounding Cables.** Grounding cables shall be bare or shall have green low-voltage insulation.

5.3.5. **Cord Sets and Power-Supply Cords.** UL 817.

5.4. NOT USED. CABLE TRAYS. NEMA VE 1.

5.5. NOT USED. FOR COMMUNICATIONS. UL 50.

#(N)#

5.6. NOT USED. IEEE No. 18.

5.7. NOT USED. BATTERY. UL 1236.

#(N)#

5.8. **CIRCUIT BREAKERS.**

5.8.1. **Molded-Case and Insulated-Case Circuit Breakers.** Fed. Spec. W-C-375. [(Hazardous Locations: UL 877)]

5.8.2. **Low-Voltage-Power.** NEMA SG 3.

5.9. **CONDUIT.**

5.9.1. **Flexible Steel Conduit.** Fed. Spec. WW-C-566 and UL 360.

5.9.2. **Rigid Metal Conduit.** UL 6.

5.9.3. NOT USED. Aluminum. Fed. Spec. WW-C-540.

#(N)#

5.9.4. **Rigid Plastic.** Fed. Spec. W-C-1094 and NEMA TC 2.

5.9.5. **PVC Coated Rigid Steel Conduit.** NEMA RN 1.

5.9.6. **Intermediate Metal Conduit (IMC).** UL 1242, Type I.

5.9.7. **Surface Metal Raceways.** UL 5.

5.9.8. NOT USED. Assembly. UL 5 and Fed. Spec. W-C-596E.

5.9.9. **Conduit Coatings.**

5.9.9.1. **Plastic Resin System.** Fed. Spec. L-C-530, Type I; or Fed. Spec. L-P-1035, composition, type, class, and grade suitable for the purpose, thickness as required for the Type I system of Fed. Spec. L-C-530; or NEMA RN 1, Type A-40.

5.9.9.2. **Epoxy System.** Fed. Spec. L-C-530, Type II.

5.9.9.3. **Coal-Tar System.** AWWA C 203. The thickness of the dry coating system shall be not less than 1/16 inch at any point.

5.9.9.4. **Pipe Wrapping Plastic Tape.** Fed. Spec. L-T-1512, type I.

5.10. **CONNECTORS, WIRE PRESSURE.** Fed. Spec. W-S-610.

5.11. NOT USED. LIGHTING CONTACTORS. NEMA ICS 1 and ICS 2.

5.12. NOT USED. DEVICE PLATES. UL 514A.

5.13. FITTINGS, CABLE AND CONDUIT. Fed. Spec. W-F-406 and W-F-408.

5.14. NOT USED. FIXTURES. Standard Drawings 40-06-40 and UL 57, unless otherwise specified.

5.14.1. Emergency Lighting Fixtures. UL 924.

5.14.2. Fluorescent, Industrial-Type Fixtures. Fed. Spec. W-F-1234 modified as required for circuits specified.

5.14.3. Fluorescent, General-Purpose Fixtures. Fed. Spec. W-F-414, Type II, Style A, B, C and D, and W-F-1662, and UL 1570.

5.14.4. Hazardous Location Fixtures. UL 844.

5.14.5. High-Intensity Discharge Fixtures. UL 1572.

5.14.6. Incandescent Lighting Fixtures. UL 1571.

5.15. FUSES.

5.15.1. Cartridge Fuses. Nonrenewable, dual element, time lag type, ANSI C97.1, Class H.

5.15.2. Current Limiting Fuses. Fed. Spec. W-F-1814 (Class G, J, K1, K5, K9, RK1, RK5, L), UL 198C (Class G, CC, J, L), UL 198E (Class RK1, RK5) and UL 198H (Class T).

#(N)#

[5.15.3. NOT USED. Fuses. Tamperproof, instantaneous, time delay, UL 198F, maximum 30A.]

[5.16. NOT USED. X-RAY FILM. Fed. Spec. GG-I-446, type and class as specified hereinafter.]

5.17. INSTRUMENTS-RELAYS, ELECTRICAL INDICATING. NEMA II 2.

5.18. NOT USED. LAMPS.

5.18.1. Fluorescent Lamps. Fed. Spec. W-L-116.

5.18.2. High-Intensity Discharge Lamps. ANSI C78.380.

5.18.3. Incandescent Lamps, Large. Fed Spec W-L-101.

5.19. NOT USED. LIGHT SETS. Fed. Spec. W-L-305.

#(N)#

5.20. METERING EQUIPMENT.

5.20.1. Kilowatt Hour Meters. ANSI C12.1 and C12.10.

5.20.2. Current and Voltage Transformers. ANSI C12.11 and C57.13.

5.20.3. Demand Registers. ANSI C12.4.

5.21. MOTORS, AC, FRACTIONAL AND INTEGRAL HORSEPOWER (500 HP AND SMALLER). Fed. Spec. CC-M-1807. [(Hazardous Locations: UL 674).]

5.22. MOTOR CONTROLS AND MOTOR CONTROL CENTERS. NEMA ICS 1, ICS 2, ICS 3, ICS 4, and ICS 6, and UL 508 and 845. [(Hazardous Locations: UL 886.]

5.23. OUTLETS.

5.23.1. Conduit, Cast-Metal or Malleable Metal. Fed. Spec. W-C-586.

5.23.2. Floor. UL 514A.

[5.23.3. Hazardous Locations. UL 886.]

5.24. OUTLET BOXES.

5.24.1. Nonmetallic Outlet Boxes for Use with Nonmetallic Wiring Systems. UL 514C.

5.24.2. Sheet-Steel Outlet Boxes. Fed. Spec. W-J-800.

5.24.3. Switch, Box; (Enclosed), Surface-Mounted. UL 98.

5.25. PANELBOARDS. Dead-front construction, Fed. Spec. W-P-115.

5.25.1. Lighting and appliance power feeder, and distribution panelboards, Class 1, type as specified hereinafter.

5.25.2. Load-center panelboards, Type I, Class 2.

[5.25.3. Hazardous Locations. UL 877].

5.26. **RECEPTACLES.**

5.26.1. NOT USED. Hospital Grade Receptacles. UL 498.

5.26.2. **General Grade Receptacles.** Fed. Spec. W-C-596.

5.26.3. **Standard Grade Receptacles.** UL 498.

5.26.4. **Ground Fault Interrupters.** UL 943, Class A or B.

#(N,d)#

5.27. **SERVICE EQUIPMENT.** [Fed. Spec. W-S-865, Type HD [or NDS] [NDS or NDD]. [Fed. Spec. W-C-375] and UL 869, general purpose enclosure unless otherwise specified. Size and voltage as required by the drawings.

5.28. NOT USED. SOCKETS, MEDIUM-SCREW BASE. Fed. Spec. W-L-142.

5.29. **SPLICE, CONDUCTOR.** Fed. Spec. W-S-610.

#(N)#

5.30. NOT USED. DEAD-FRONT DISTRIBUTION TYPE. NEMA PB-2 and UL 891.

#(N)#

5.31. NOT USED. ASSEMBLIES, POWER. NEMA SG 5.

5.32. **SWITCHES.**

#(N,d)#

5.32.1. **Enclosed Safety Switches.** Fed. Spec. W-S-865, Type HD [or NDS] [NDS or NDD] with general purpose enclosures unless otherwise specified. Size and voltage as required by the drawings. [(Hazardous Locations: UL 895).]

5.32.2. **Snap Switches.** UL 20. [(Hazardous Locations: UL 894).]

5.33. **TAPES.**

5.33.1. **Friction Tape.** ASTM D 69.

5.33.2. **Plastic Tape.** Fed. Spec. HH-I-595.

5.33.3. **Rubber Tape.** Fed. Spec. HH-I-553.

5.34. **TRANSFORMERS.**

5.34.1. NOT USED. Transformers. ANSI C12.11 for 0.6 kV insulation class with a primary rating suitable for the rated voltage and current of the secondary main bus of the transformer station.

5.34.2. **Dry-Type Utilization Transformers.** UL 506 as modified herein.

5.35. **TUBING, ELECTRICAL, ZINC-COATED STEEL (EMT).** UL 797.

5.36. NOT USED. POWER SYSTEMS. UL 1047, with monitor UL 1022.

5.37. **GROUNDING AND BONDING.** UL 467.

#(N)#

5.37.1. **Ground Rods.** Ground rods shall be of [zinc-coated] [copper-clad] steel. If an exact size is not shown in the plans the contractor may select a size, but it must not be less than 3/4 inch in diameter, 8 feet long, driven full length into the earth.

[5.37.2. Ground Bus. The ground bus shall be bare copper conductor or flat copper bar in one piece, if practicable. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment.]

6. GROUNDING.

6.1. **SERVICE GROUNDING.** The service ground connection shall be made to the neutral conductor of the wiring system at the main service equipment and shall be extended to the grounding electrode system. The grounding electrode

#(N)#

system shall be as stated in the NEC with the additional requirement that at least one driven ground rod shall be provided in addition to other available

electrodes and a bonding connection shall not be provided to the exterior portion of metallic underground water pipe (even if an isolating fitting is not presently installed). Provide a minimum of two driven rods if no other NEC electrodes are available. Interior metallic water pipe shall be bonded to the grounding electrode system. Connection to the water pipe shall be made by a suitable ground clamp. A separate grounding connection shall be made from the neutral conductor of separately derived systems [to the nearest available structural steel or alternate electrode] [to the main service ground electrodes] [as indicated on the plans].

6.2. **EQUIPMENT GROUNDING.** Except where specifically indicated otherwise, all exposed noncurrent-carrying metallic parts of electrical equipment, metallic raceway systems, [ground bus,] [metallic cable armor,] [grounding conductor of nonmetallic sheathed cables,] [grounding conductor in nonmetallic raceways] shall
#(N)#
be grounded. [In addition to the metallic raceway system used as a grounding conductor, a separate green wire grounding conductor shall be provided for receptacle circuits. The receptacle shall either be bonded to the outlet box or shall be a self-grounding type receptacle. The additional green wire shall be connected to the receptacle ground terminal or the bonding jumper and carried through all feeder and service ducts to the service ground point or separately derived source ground.] [Whenever feeders are paralleled using nonmetallic conduit, a full size equipment grounding conductor shall be included in each conduit per NFPA No. 70.]

6.3. **CONTINUITY.** The electrical continuity of metallic raceway systems and cable armor shall be assured by removing any portions of nonconducting coatings which might interrupt or diminish such continuity. Grounding continuity between recessed outlet boxes and the grounding circuits of receptacles shall be established by means of a bonding jumper between the outlet box and the receptacle grounding terminal or by the use of a selfgrounding receptacle. Where surface-mounted boxes and conventional receptacles are used, the retainer washers on the receptacle mounting screws shall be removed to permit metal-to-metal contact between the yoke and the outlet box.

6.4. NOT USED. GROUNDING PROVISIONS. Grounding for main telephone service shall be provided by installing bare #6 copper wire in 1/2-inch conduit between main telephone cabinet or service point and building electric service ground.
#(N)#

6.5. **GROUND RODS.** The maximum resistance of a driven ground, measured in accordance with IEEE No. 142, shall not exceed 25 ohms under normally dry conditions. [If this resistance cannot be obtained with a single rod, two additional rods not less than 6 feet on centers, or if sectional type rods are used, two additional sections may be coupled and driven with the first rod. If the resultant resistance exceeds 25 ohms measured not less than [24] [48] hours after rainfall, the Contracting Officer shall be notified immediately.] All measurements shall be made in the presence of the Contracting Officer.

6.6. NOT USED. BUS. Ground bus shall be provided in the electrical equipment room[s] [as indicated]. [If not otherwise identified, install one copper bar, 1/8 x 1 x 12 inch minimum near service equipment [or] [transformers].] Noncurrent-carrying metal parts of electrical equipment [and transformer neutrals] shall be effectively grounded by bonding to the bus. The ground bus shall be bonded to both the entrance ground, and to a local ground rod or rods as specified above having the upper ends terminating approximately

4 inches above the floor. The external grounding connections described above are supplementary provisions required in addition to conventional equipment grounding via an electrically continuous raceway system [or a separate equipment grounding conductor installed within the raceway system adjacent to corresponding phase conductors.]

7. WIRING METHODS.

7.1. GENERAL REQUIREMENTS. Unless otherwise indicated, wiring shall consist of [nonmetallic-sheathed cables or metallic-armored cables installed in areas as permitted by NFPA No. 70, and in other areas shall consist of] insulated conductors installed in rigid aluminum or plastic conduit, rigid zinc-coated steel conduit, #(N)# electrical metallic tubing, or Type I intermediate metal conduit. Plastic conduit is not acceptable for interior wiring[.] [, however, it may be installed under floor slabs.]

7.2. CONDUIT AND TUBING SYSTEMS. Conduit and tubing systems shall be #(N,d)# installed as indicated. Conduit sizes shown are based on the use of TW insulation for conductors smaller than No. 8 AWG, THW insulation for conductors No. 8 AWG and larger, except where otherwise indicated. If the aluminum option is selected, increase the size of the raceway system as required to maintain the same relative proportion of fill as would be provided using the copper conductor #(d)# and the raceway sizes shown on the plans. In some cases, it may be necessary to upsize conduit two trade sizes. Minimum size of raceways shall be 1/2 inch. Electrical metallic tubing may be installed only within buildings. Electrical metallic tubing may be installed in concrete and grout in dry locations. [Electrical metallic tubing installed in concrete or grout shall be provided with concrete tight fittings.] EMT shall not be installed in damp or wet locations. Aluminum conduit may be used only where installed exposed in dry locations. Nonaluminum sleeves shall be used where aluminum conduit passes through concrete floors and firewalls. IMC Type I may be used as an option for rigid steel conduit in areas as permitted by NFPA No. 70, except as hereinafter specified. Raceways shall not be installed under the firepits of boilers and furnaces and shall be kept 6 inches away from parallel runs of flues, steam pipes and hot-water pipes. Raceways shall be concealed where possible within finished walls, ceilings, and floors other than slabs-on-grade. Raceways crossing structural expansion joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding. Wiring installed in [underfloor duct system] [underfloor raceway system] shall be suitable for installation in wet locations. Bushings shall be installed on the ends of all conduits and shall be of the insulating type where required by NFPA No. 70. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered.

7.2.1. NOT USED. Conductors and Conduit Below Slab-on-Grade or in the Ground. All electrical wiring below slab-on-grade shall be protected by a conduit system. No conduit system shall be installed horizontally within #(N)# concrete slabs-on-grade. For slab-on-grade construction, horizontal runs of rigid plastic or rigid steel or IMC shall be installed below the floor slab. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC.

Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field-wrapped with 0.010-inch thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied plastic resin, epoxy, or coal-tar coating system. Zinc coating may be omitted from rigid steel conduit, or from IMC which has a factory-applied epoxy system.

7.2.2. NOT USED. in Slabs Other Than on Grade. Conduits shall be installed as close to the middle of concrete slabs as practicable without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness and conduits shall be spaced not closer than 3 diameters on centers except at cabinet locations where the slab thickness shall be increased as approved by the Contracting Officer.

7.2.3. NOT USED. Cable and Raceways. Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings.

7.2.4. **Changes in Direction of Runs.** Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be entirely freed of obstructions or shall be replaced.

7.2.5. **Supports.** Raceways shall be securely and rigidly fastened in place at intervals of not more than 10 feet with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps with retainers, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structures, but no load shall be applied to joist bridging. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4 inch in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Conduit shall not be supported using wire or nylon ties. Raceways shall be installed as a complete system and be independently supported from the structure. Supporting means will not be shared between electrical raceways and mechanical piping or ducts and shall not be fastened to hung ceiling supports. Conduits shall be fastened to all sheet-metal boxes and cabinets with two locknuts where required by NFPA No. 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Bushings shall be installed on the ends of all conduits and shall be of the insulating type where required by NFPA No. 70. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered.

7.2.6. NOT USED. Risers. Exposed risers in wire shafts of multi-story buildings shall be supported by U-clamp hangers at each floor level, and at intervals not to exceed 10 feet.

7.2.7. Lengths of Conduit Containing Voltages Over 600 Volts. Exposed lengths of conduit containing high-voltage power conductors operating at more than 600 volts shall have two red bands 2 inches wide spaced 8 inches apart painted near each coupling; the intervening space between the red bands shall be painted white, and on the white space the voltage shall be stenciled in black: _____ volts.

7.2.8. Raceways. Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirements that no length of run shall exceed 50 feet for 1/2-inch and 3/4-inch sizes, and 100 feet for 1-inch or larger sizes, and shall not contain more than two 90-degree bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1-inch size or larger shall be not less than ten times the nominal diameter.

7.2.9. Pull Wires. A pull wire shall be inserted in each empty raceway in which wiring is to be installed by others if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200-pound tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

7.3. **CABLE SYSTEMS.** Cables shall be installed concealed behind ceiling or wall finish where practicable. Cables shall be threaded through holes bored on the approximate centerline of wood members; notching of end surfaces will not be permitted. Sleeves shall be provided through bond beams of masonry-block walls for threading cables through hollow spaces. Exposed cables shall be installed parallel or at right angles to walls or structural members. In rooms or areas not provided with ceiling or wall finish, cables and outlets shall be installed so that a room finish may be applied in the future without disturbing the cables or resetting the boxes. Exposed nonmetallic-sheathed cables less than 4 feet above floors shall be protected from mechanical injury by installation in conduit or tubing.

7.4. NOT USED. SYSTEMS. Busway systems shall be of the voltage, capacity, and phase characteristics indicated. Vertical runs of busways within 6 feet of the floor shall have solid enclosures. Busways shall be supported at intervals not exceeding 5 feet, and shall be braced properly to prevent lateral movement. Busways penetrating walls or floors shall be provided with flanges to completely close wall or floor openings. If vertical portion exceeds 20 feet, install adjustable floor supports at each floor penetration. Penetrations of exterior walls must be weathersealed. [A hook stick of suitable length shall be provided for operating plug-in units from the floor.] [Plug-in units shall be of the circuit-breaker type.] [Plug-in units shall be of the handle-operated switch type equipped with high-interrupting-capacity current-limiting fuses.]

7.5. NOT USED. CABLE SYSTEMS. Mineral-insulated cable system, Type MI may be used in lieu of exposed conduit and wiring. Conductor sizes shall be not less than those indicated for the conduit installation. Cables shall be fastened within 12 inches of each turn or offset and at intervals of not more than 6 feet. Cable terminations shall be made in accordance with manufacturer's recommendations immediately upon stripping of sheath. Single-conductor cables of a circuit having capacities of more than 50 amperes shall terminate in a

single box or cabinet opening. Individual conductors in all outlets and cabinets shall be color-coded.

7.6. NOT USED. TRAYS. Cable trays shall form a wireway system, and shall be of nominal [3] [4] [6] -inch depth, of [steel] [or] [aluminum]. Wireways shall include splice and end plates, dropouts, and miscellaneous hardware. Wireways shall be supported at not more than [6] [____] -foot intervals unless otherwise indicated. [Contact surfaces of aluminum connections shall be coated with an antioxidant compound prior to assembly.] All edges, fittings, and hardware shall be finished free from burrs and sharp edges. [Steel cable trays shall be zinc-coated after fabrication.] [Steel cable trays shall be aluminum or zinc-coated before fabrication.] Fittings shall have not less than the load-carrying ability of straight tray sections and shall have manufacturer's minimum standard radius unless otherwise indicated. [Radius of bends shall be [12] [24] [36] inches.] [A No. 2 AWG bare copper [or No. 1/0 aluminum] conductor shall be laid throughout the cable tray system and bonded to each section thereof. This conductor shall be connected to the building ground [bus.] [as indicated.] Bonding of the No. 2 conductor to the cable tray system shall be made by bolted or thermochemical type connections.]

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7.6.1. **Trough-type Cable Trays** shall be of a nominal [6] [12] [18] [24] -inch width as indicated[.] [and have a removable cover.]

7.6.2. **Ladder-type Cable Trays** shall be of nominal [6] [12] [18] [24] -inch width. Rung spacing shall be on [6] [9] [12] [18] -inch maximum centers as indicated.

7.6.3. **Channel-type Cable Trays** shall be of [3] [4] -inch width as indicated. Trays shall be one-piece construction having slots spaced not more than 4-1/2 inches on centers.

7.6.4. **Cantilever-type, Center-hung Cable Trays** conforming to NEMA VE-1, except for provisions therein pertaining to side rails, may be provided at the Contractor's option in lieu of other cable types specified herein.

7.7. **CONDUCTORS.** Conductors in raceways and cable shall be of copper, except that aluminum conductors may be used as an equivalent for copper conduct-

#(N)#

tors of No. [6] [4] AWG and larger. Aluminum conductors shall have ampacity of not less than the copper conductors. Wire connectors of insulating material or solderless pressure connectors properly taped shall be utilized for all splices where possible. Soldered mechanical joints insulated with tape shall be kept to a minimum. Pressure connectors for aluminum conductors shall have tinned aluminum bodies. Aluminum contact surfaces of conductors and connectors shall be cleaned and covered with antioxidant compound prior to making of connections.

#(N)#

[Circuits that have been specifically required to be suitable for use at [75 degrees C.] [90 degrees C.] must be supplied with terminating components approved for use at that temperature. The temperature rating must be marked on [all terminals sized #12 through #1 AWG and intended for use at 75 degrees C.] [all terminals intended for use at 90 degrees C.]] Connection of oversize conductors to equipment or devices having smaller terminals shall be made with suitable connectors or adapters which will accommodate the entire conductor cross section (trimming "excess" stranding is not acceptable).

7.7.1. **Sizes** shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long,

from panel to center of load, shall be No. 10 AWG. Conductors for control, signaling, or power limited applications shall be not less than No. 14 AWG in class 1 circuits and not less than No. 16 AWG in class 2 circuits.
#(N)#

7.7.2. **Insulation.** Conductor insulation shall be suitable for the application and shall have a temperature rating of not less than 75 degrees C. [except sizes smaller than No. 1/0 AWG may be 60 degrees C.]
#(N)#

7.7.3. **Conductor and Phase Identification.** Conductor identification of each phase shall be by color-coded insulation. The color of the insulation of the ungrounded conductors of different voltage systems shall be as follows:

208Y/120 volt, 3-phase: black, red, and blue
480Y/277 volt, 3-phase: brown, orange, and [purple] [yellow]
120/240 volt, single-phase: red and black

In multiphase circuits, the above colors, left to right, shall be connected to A, B, and C phases, respectively. Phases must be identified by tags or labels wherever the above format has not been followed. Control circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved by the Contracting Officer. Control conductors shall not repeat the power circuit color coding unless control wiring is clearly distinguishable by application or by added identification. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable. Where insulation of the required color is not available, electrical tape of the required color shall be half-lapped for the entire length within the indicated enclosures.

7.8. **WIREWAYS** shall be of the size indicated on the drawings and shall be provided with a screw-on cover. Wireways shall be supported at intervals not exceeding 5 feet.

7.9. **SPECIAL APPLICATIONS.**

7.9.1. **Penetrations of Fire Barriers.** Conduit penetrations of above grade floor slabs, time-rated partitions and fire walls shall be fire
#(18B)#
stopped [around conduit and sleeves with fire resistant fittings or materials of equivalent rating as the barrier.] [in accordance with SECTION: FIRESTOPPING.] Busways shall be unventilated type within 6 feet of the penetration and be sealed with fire resistant fittings or materials at the penetration. Cable trays must terminate within 10 inches from both sides of smoke and fire partitions or walls. Conductors continuing through fire barriers shall be installed in at least two 4-inch rigid steel conduits with grounding bushings extending [12 inch] [3 feet] beyond each side of the barriers. Install additional 4-inch conduit as required if the cross sectional area of the tray exceeds that of the conduit. Each end of each conduit shall be bonded to the cable tray grounding conductor with No. 2 copper conductors. Provide jumpers as required elsewhere to maintain grounding of conduit and trays. The installation shall be sealed as required to preserve the smoke and fire rating of the barriers.

7.9.2. Installation in Plenums. Conventional power, signal, or control wiring routed into ceilings, or other spaces utilized as plenums for environmental air must be installed in metal raceway or an alternate wiring method approved by NFPA No. 70 must be used. (See mechanical floor plans for locations.) Cable may be run exposed if it is specifically rated and identified for plenum use or the type of construction has been approved for plenum applications (such as MI or MC assemblies). Cable tray must be metal trough type with solid bottom and solid metal cover[.] [or at the Contractors option, open type may be used if all wiring is plenum rated.] Preassembled flexible metallic cable assemblies furnished with light fixtures or other equipment must be approved for the application.

8. **BOXES AND SUPPORTS.** Boxes shall be provided in the wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Each box must have the volume required by NFPA No. 70 for the number of conductors enclosed in the box.

8.1. **APPLICATION REQUIREMENTS.** Boxes for metallic raceways shall be of the cast-metal hub type when located in normally wet locations, when surface mounted on outside of exterior surfaces, when located in hazardous areas, and when installed exposed up to 7 feet above interior floors and walkways. Boxes in other locations shall be sheet steel except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic-sheathed or metallic-armored cable system. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Apply a flush mounting adapter (Crousse Hinds FS031, FS031PM or equal), if the box is not installed in a poured concrete wall. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The edge of boxes shall flush with the finished surfaces in gypsum, plasterboard installation. The bottom of boxes installed in masonry-block walls for concealed wiring shall be flush with the top of a block to minimize cutting of blocks and boxes shall be located horizontally to avoid cutting webs of block. Indicated elevations are approximate, [except where minimum mounting heights for hazardous areas are required by NFPA No. 70]. Unless otherwise indicated, boxes for wall switches and receptacles shall be mounted per attached Drawing 40-15-01, Sheet 2.

8.2. **SUPPORTING PROVISIONS.** Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. In partitions of light steel construction, bar hangers (with 1-inch long threaded studs) or metal stud "C" brackets shall be used to secure boxes to the building structure. Bar hangers are to be mounted between the vertical metal wall studs, metal stud "C" brackets are to be snapped on and tab locked to metal wall studs. When "C" brackets are used, additional box support shall be placed on the side of the box opposite the brackets. Boxes with permanently attached side-mounting brackets that snap and lock onto wall studs or that fasten to wall studs with screws, may be substituted for the "C" bracket configuration. Press-in-place clips are not acceptable. The opposite side ("far-side") box support must be included in the optional configurations. In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used

for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel.

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8.3. BOXES FOR USE WITH RACEWAY SYSTEMS. Boxes shall not be less than 1-1/2 inches deep except where shallower boxes required by structural conditions are approved. Boxes for other than lighting-fixture and telephone outlets shall be not less than 4 inches square except that 4- by 2-inch boxes may be used where only one raceway enters the outlet. In applications where cast boxes are required, boxes may be 4 x 2-1/4 inch by 2-1/2 inch depth minimum. (All dimensions are internal.) Cast metal boxes with 3/32-inch wall thickness are acceptable.

8.4. BOXES FOR USE WITH CABLE SYSTEMS. Boxes shall be not less than 3- by 3-inch sectional boxes, 2 inches deep.

8.5. BOXES FOR LIGHTING APPLICATIONS. Boxes for mounting lighting fixtures shall be not less than 4 inches square except that smaller boxes may be installed as required by fixture configuration, as approved. Cast boxes may be 3-5/8 inches round by 2 inches deep minimum. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

8.6. NOT USED. BOXES FOR COMMUNICATIONS APPLICATIONS. Boxes for telephone outlets shall be not smaller than 4-11/16 inches square and 2-1/8 inches deep. In locations where cast boxes are required, two-gang boxes (side by side) of 2-1/2 inch minimum depth may be used.

8.7. PULL BOXES. Pull boxes of not less than the minimum size required by NFPA No. 70 shall be constructed of aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified above. Boxes shall be furnished with screw-fastened covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

8.8. CLOCK OUTLET. Clock outlet, for use in other than a wired clock system, shall consist of an outlet box, a plaster cover where required, and a single receptacle with clock-outlet plate. The receptacle shall be recessed sufficiently within the box to allow the complete insertion of a standard cap, flush with the plate. A suitable clip or support for hanging the clock shall be secured to the top of the plate. Material and finish of the plate shall be as specified in paragraph: DEVICE PLATES.

8.9. FLOOR OUTLETS. Individually installed outlets shall be as specified below. Outlets installed in multiple along a raceway assembly shall be as specified in SECTION: UNDERFLOOR DUCT SYSTEM.

8.9.1. Surface Mounted Floor Outlets. Outlets shall be [adjustable] [nonadjustable] and each outlet shall consist of a cast metal box with threaded openings for conduits, [an adjustable ring,] [a flange ring,] a cover plate with 1/2- or 3/4-inch threaded flush plug, and a surface mounted service fitting. Service fittings for telephone applications shall consist of a horizontal cast housing with [a 1-inch bushed side opening] [an 8-pin jack

assembly]. Each receptacle-type service fitting shall consist of a horizontal cast housing with a receptacle as specified mounted in the side. Gasket shall be used where necessary to ensure a watertight installation. The plugs, with installation instructions, shall be delivered to the Contracting Officer at the job site for capping outlets upon removal of service fittings.

8.9.2. **Recessed Floor Outlets.** Outlets shall consist of cast boxes with [adjustable] [nonadjustable] top and [bronze] [aluminum] access (cover) plates. Assemblies shall be configured for installation of simplex or #(d)#
duplex receptacles as indicated on the plans. Access plates must have [threaded openings and plugs] [hinged lid(s)].

8.10. **CONDUIT STUB-UPS.** Conduits stubbed up through concrete floors for connections to freestanding equipment shall be provided with a short elbow and an adjustable top or coupling threaded inside for plugs, set flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Screwdriver-operated threaded flush plugs shall be installed in conduits from which no equipment connections are made to suit the devices installed.

9. NOT USED. DEVICE PLATES. One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be zinc-coated sheet steel, cast-metal, or impact resistant plastic having rounded or beveled edges. [Plates on finished walls shall be of steel with baked enamel finish or impact-resistant plastic and shall be [brown.] [ivory.]] [Plates on finished walls shall be of satin finish corrosion-resistant steel or of satin finish chromium plated brass.] Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alinement tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed. Device plates for telephone and intercommunication outlets shall have a 3/8-inch bushed opening in center.

10. **RECEPTACLES.** (See paragraph titled GROUNDING). Device shall be straight blade type unless twist lock versions have been designated on the plans.
#(N)#

10.1. **STANDARD RECEPTACLES.** Single and duplex receptacle for the ordinary application shall be 125-volt, two-pole, three-wire grounding type with polarized parallel slots. Devices rated 15 amperes (NEMA 5-15) may be furnished for all devices not specifically required to be 20 ampere (NEMA 5-20). Bodies shall be of [brown] [ivory] [gray] phenolic compound supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Switched receptacles shall be the same as other receptacles specified except that the ungrounded pole of each switched receptacle shall be provided with a separate terminal. Only the top receptacle of a duplex receptacle shall be wired for switching application.

10.2. **WEATHERPROOF RECEPTACLES.** Weatherproof receptacles shown shall be mounted in a box with a gasketed, weatherproof, cast-metal cover plate and cap over each receptacle opening. The cap [shall be permanently attached to the

cover plate by a short length of bead chain.] [shall be provided with a spring-hinged flap.]

10.3. NOT USED. 15-AMPERE, 250-VOLT (NEMA 6-15). Receptacles, 15-ampere, 250-volt, shall be [single] [duplex] two-pole, three-wire, grounding type with bodies of brown phenolic compound supported by mounting yoke having plaster ears. The third grounding pole shall be connected to the metal yoke. Each receptacle shall be provided with a mating cord-grip cap.

10.4. NOT USED. 20-AMPERE, 250-VOLT (NEMA 6-20). Receptacles, single, 20-ampere, 250-volt, shall be molded plastic, two-pole, three-wire, grounding type complete with appropriate mating cord-grip plug.

10.5. NOT USED. 30-AMPERE, 125/250-VOLT. Receptacles, single, #(N)# 30-ampere, 125/250-volt, shall be molded-plastic, [three-pole, four-wire grounding type, (NEMA 14-30)] [three-pole, three-wire nongrounding type (NEMA 10-30),] complete with appropriate mating cord-grip type attachment plug. [Each dryer receptacle shall be furnished with a non-detachable power supply cord for connection to the electric clothes dryer. The cord shall be an angle-type 36-inch length of Type [SRD] [SRDE] range and dryer cable with three No. 10 AWG conductors.]

10.6. NOT USED. 30-AMPERE, 250-VOLT (NEMA 6-30). Receptacles, single, 30-ampere, 250-volt, shall be molded-plastic, two-pole, three-wire grounding type, complete with appropriate mating cord-grip plug.

10.7. NOT USED. 50-AMPERE, 125/250-VOLT. Receptacles, single 50-ampere, #(N)# 125/250-volt, shall be flush, molded-plastic, [three-pole, four-wire grounding type (NEMA 14-50).] [three-pole, three-wire nongrounding type (NEMA 10-50).]. [Each range receptacle shall be furnished with a non-detachable power supply cord for connection to the electric range. The cord shall be an angle-type 36-inch length of [SRD] [SRDE] [SRDT] range and dryer cable with one No. 8 and two No. 6 AWG conductors.]

10.8. NOT USED. 50-AMPERE, 250-VOLT (NEMA 6-50). Receptacles, single, 50-ampere, 250-volt, shall be flush molded-plastic, two-pole, three-wire grounding type, complete with appropriate mating cord-grip plug.

10.9. NOT USED. OR HEAVY-DUTY RECEPTACLES. Special-purpose or heavy-duty receptacles shall be of the type and of ratings and number of poles #(d)# indicated or required for the anticipated purpose. Contact surfaces may be either round (pin) or rectangular (blade). One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking of receptacles, indicated to be the locking type, shall be accomplished by the rotation of the plug (30A or less) or by use of a locking ring (sizes over 30A).

10.10. GROUND FAULT PROVISIONS. Designated receptacles must incorporate ground fault circuit interrupting (GFI or GFCI) capability. Features shall include test, reset, and trip indication provisions. Conventional receptacles located downstream of a feed through type GFI receptacle must be labeled (on or adjacent to device plate) to identify the GFI protection and location of the device with the reset provisions (example: "Ground Fault Protected, Reset in Room xxx"). Unless indicated otherwise, GFI receptacles in bathrooms, that are connected to a feeder which serves conventional receptacles in other rooms downstream, must be non-feed through type or be connected to the circuit on its incoming (upstream) side only.

#(N)#

11. NOT USED.WALL SWITCHES. Switches shall be of the totally enclosed tumbler type with bodies of phenolic compound. Handles shall be [brown] [ivory]. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than [one switch] [two switches] shall be installed in a single-gang position. Switches shall be rated [15-ampere] [20-ampere] [120] [277] -volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be red.

#(N)#

12. **CIRCUIT BREAKERS.** Circuit breakers shall have voltage, current, and interrupting ratings as indicated.

12.1. **MOLDED-CASE CIRCUIT BREAKERS.** Single-pole breakers shall be full module size; two poles shall not be installed in a single module. Multipole breakers shall be of the common-trip type having a single operating handle but for sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multipole unit having an internal, mechanical nontamperable common trip mechanism and external handle ties. [Breakers of 225 ampere and larger frame sizes shall have interchangeable thermal magnetic tripping elements. The thermal portion may have a factory preset rating; the magnetic portion must be an adjustable setting type. At the Contractors option, breakers with solid state programmable tripping assemblies (4 function minimum) may be furnished.] Breakers coordinated with current-limiting fuses shall have a combined interrupting capacity of 100,000 symmetrical amperes. All poles of associated breakers shall open if any fuse blows. Breakers equipped with ground fault interrupters shall have ground fault class, interrupting capacity, and voltage and current ratings indicated.

12.2. **LOW-VOLTAGE-POWER CIRCUIT BREAKERS.** Breakers shall have continuous, short time withstand, and interrupting current ratings and frame sizes as indicated. Breakers shall have adjustable [long time] [short time] [ground fault] [instantaneous] solid state trip elements as indicated. Breakers shall be stored energy, [manually] [electrically] operated [, except solenoid operated breakers are permitted in 600 amperes frame or smaller].

12.3. **INSULATED-CASE, SYSTEMS-TYPE CIRCUIT BREAKERS.** Breakers shall have continuous, short time withstand, and interrupting current ratings and frame
#(d)#
sizes as indicated. Breakers shall have adjustable [long time] [short time] [ground fault] [instantaneous] solid state trip elements as indicated. Breakers shall be stored energy, [manually] [electrically] operated type.

13. **SERVICE [AND METERING] EQUIPMENT.**

#(N)#

13.1. **DISCONNECTING PROVISIONS.** Service-disconnecting means shall be of the [drawout power circuit breaker] [insulated case circuit breaker] [enclosed
#(d)#
molded-case circuit breaker] [fusible safety switch] type as indicated with external handle for manual operation. The disconnect device [shall be housed in an individual sheet metal enclosure with hinged cover or door, and shall be suitable for surface mounting unless indicated otherwise.] [shall be part of

an equipment assembly. (See paragraph: [PANELBOARDS] [POWER SWITCHGEAR ASSEMBLIES].) The assembly shall be listed as suitable for service entrance equipment.]

13.2. **METERING EQUIPMENT.** Kilowatt-hour meters shall be three single stator type conforming to applicable portions of ANSI C12.1 and C12.10. Current transformers (CTs) and voltage transformers (VTs) conforming to ANSI C12.11 and C57.13 shall be included with ratios appropriate for use on a _____ volt, _____-phase, _____-wire system. [Meters must have [demand registers] [and] [provisions for connection to facility energy monitoring and control systems (EMCS)]. Demand registers should be cumulative type using a 15-minute demand sampling interval.]

13.2.1. NOT USED. EMCS Transducers. Capability to interface the [existing] Energy Monitoring and Control System shall be provided by use of electronic pulse initiators. Pulse initiators shall be solid-state devices incorporating light-emitting diodes, photo-transistors and power transistors. Output contacts must have 2A, 500V, 100VA rating with a life rating of one billion operations. Mercury wetted contacts are acceptable. Initiators shall be capable of accurate processing over the full range of meter speeds (up to a maximum generation rate of 500 pulses per minute without false pulses (detent protection)). Initiators shall be selected and internal components configured to provide the highest number of pulses per KWH available from a given manufacturer. The pulse rate shall be identified by label or other marking on each initiator.

13.3. NOT USED. GROUND FAULT PROTECTION. Ground fault provisions shall be installed #(d)#
on the service equipment as indicated on the plans. Sensors shall be of the vectorial summation type. Ampere and time settings shall be [as shown] [coordinated with main service protective devices. Settings must have sufficient margins to prevent false tripping.] [For double ended service applications, a selective relaying system, as indicated, shall be provided to ensure tripping of correct breakers.]

13.4. **SURGE PROTECTION.** Install secondary surge [arrestors] [suppression #(d)#
devices] on power feeders at locations indicated on the plans. Arrestors shall be 150 volts to ground (for 240Y/120 volt services), 600V on all other configurations. Surge suppression devices shall be installed on incoming communication lines [at the point of entrance to the building] [or] [as indicated #(d)#
on the plans].

14. **PANELBOARDS.** Panelboards shall not exceed 78 inches in height and shall be so mounted that the height of the top operating handle will not exceed 6 feet 6 inches from the floor. Locks for distribution and branch circuit panelboards shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate load served by each circuit and mounted in holder behind a clear protective covering. [Buses shall be copper.] [If aluminum buses are furnished, circuit breakers must be the bolt-on type.] Submittals shall identify bus material. A circuit breaker or switch, which is to be used as a motor disconnecting means and is within a panelboard out of sight of the motor, must have provisions to be locked in the open position (or optionally a separate disconnect means shall be provided per paragraph: MOTOR DISCONNECT MEANS).

14.1. **LOAD-CENTER PANELBOARDS.** Load-center panelboards shall be Type I, Class 2 of Fed. Spec. W-P-115, and shall be circuit-breaker equipped.

14.2. **BRANCH-CIRCUIT PANELBOARDS.** Lighting and appliance branch-circuit panelboards shall be circuit-breaker equipped, Type I, Class 1 of Fed. Spec. W-P-115.

14.3. **DISTRIBUTION PANELBOARDS.** Distribution, power, or feeder panelboards shall be circuit-breaker equipped, Type I [or fusible-switch equipped, Type II]. [Multipole fusible switches shall be of the hinged-door type; single-pole fusible switches shall be of tumbler switch and fuse type. Switches serving as motor-disconnect means shall be horsepower rated in conformance with Table III of Fed. Spec. W-S-863.] [Fusible panelboards of the multipole type may have doors over individual circuits and trim over wiring gutter only, provided each circuit is arranged for locking in the open and closed positions and each branch circuit has an individual identification card in a cardholder with clear plastic covering.]
#(d)#

14A. NOT USED. **POWER DISTRIBUTION CENTERS.** Each assembly shall have power distribution, monitoring, and control capability appropriate for a data processing application consolidated into a modular self-contained package. [An isolation transformer shall be included.] [The center shall have a nominal rating of [15] [30] [50] [75] [100] [125] [150] [200] kVA minimum with a [30] [42] [84] pole distribution capability.] [Sizes shall be as shown on the plans.] All breakers shall be bolt-on type. The input side breaker must be a shunt trip type operated [by a pushbutton device located near the data processing area entrance.] [as indicated on the plans.] Branch breakers in the output section(s) shall be provided per the panel schedule(s) on the plans. [The neutral conductor/bus bar shall be sized to provide 133% minimum of the line conductor ampacity.] Surge suppression devices shall be included.
#(N)#

15A. NOT USED. **POWER-SWITCHGEAR ASSEMBLIES (LOW VOLTAGE POWER CIRCUIT BREAKER SWITCHGEAR).** Low voltage power switchgear shall be metal-enclosed, freestanding general-purpose [ventilated] type and shall be installed to provide front [and rear] access. Devices shall be housed in individual isolated, grounded, compartments. Buses shall be [factory insulated] [copper] [or] [aluminum]. [If not otherwise indicated, neutral shall be full size and ground bus shall be [25] [50] percent, minimum of phase bus ampacity.] Assembly shall be approximately 90 inches high; arrangement of circuit breakers [and other items specified] shall be as #(d)#
indicated. The design of the switchgear assembly shall be based on [the indicated interrupting rating.] [an interrupting rating of ___ amperes symmetrical minimum.] The rating must apply to the entire assembly. A series rated configuration is not acceptable in lieu of a fully rated assembly unless so indicated on the plans.

15A.1. **CIRCUIT BREAKERS.** Protective functions, and switching capability if so indicated, shall be provided by 4 - position, drawout type low-voltage-power circuit breakers. A cell position indicator must be included to positively identify the position of the breaker assembly.

15A.2. **AUXILIARY EQUIPMENT.**

15A.2.1. Instruments. Instruments shall be long scale, 6.8 inches minimum, semiflush rectangular, indicating switchboard type.

15A.2.1.1. Ammeter, range 0 to ___ amperes; complete with selector switch having off position and positions to read each phase current.

15A.2.1.2. Voltmeter, range 0 to ___ volts, complete with selector switch having off position and positions to read [each] phase [to phase] [to neutral] voltage.

15A.2.2. Instrument Transformers.

15A.2.2.1. Voltage transformers shall be rated _____ to 120 volts.

15A.2.2.2. Current transformers shall be rated _____ to 5 amperes.

#(N)#

[15A.2.3. Control Switch. A control switch with indicating lights shall be provided for each electrically-operated breaker.]

#(N)#

15B. POWER-SWITCHGEAR ASSEMBLIES (DEADFRONT DISTRIBUTION SWITCHBOARDS, HEAVY DUTY). Assemblies shall be metal-enclosed, freestanding general-purpose [ventilated] type and shall be installed to provide front [and rear] access. Construction shall be heavy duty power switchgear type with devices housed in individual insulated, grounded, compartments. Buses shall be [factory insulated] [copper] [or] [aluminum]. [If not otherwise indicated, neutral shall be full size and ground bus shall be [25] [50] percent minimum of phase bus ampacity.] Assembly shall be approximately 90 inches high; arrangement of circuit breakers #(d)# [and other items specified] shall be as indicated. The design of the entire assembly shall be based on [the indicated interrupting rating.] [an interrupting rating of _____ amperes symmetrical minimum.]

15B.1. CIRCUIT BREAKERS. Fault protection, and switching capability if applicable, shall be provided by 4 - position, drawout insulated-case, systems type circuit breakers. A cell position indicator must be included to identify the position of the breaker assembly. [Molded-case circuit breakers may be used where breakers of [400] [200] amperes or less are indicated.]

15B.2. AUXILIARY EQUIPMENT.

15B.2.1. Instruments. Instruments shall be long scale, 6.8 inches minimum, semiflush rectangular, indicating switchboard type.

15B.2.1.1. Ammeter, range 0 to ___ amperes, complete with selector switch having off position and positions to read each phase current.

15B.2.1.2. Voltmeter, range 0 to _____ volts, complete with selector switch having off position and positions to read [each] phase [to phase] [to neutral] voltage.

15B.2.2. Instrument Transformers.

15B.2.2.1. Voltage transformers shall be rated _____ to 120 volts.

15B.2.2.2. Current transformers shall be rated _____ to 5 amperes.

#(N)#

[15B.2.3. Control Switch. A control switch with indicating lights shall be provided for each electrically operated breaker.]

#(N)#

15C. POWER-SWITCHGEAR ASSEMBLIES (DEADFRONT DISTRIBUTION SWITCHBOARDS, NORMAL DUTY). Switchboards shall be metal-enclosed, freestanding general-purpose

[ventilated] type and shall be installed to provide front [and rear] access. [If not otherwise indicated, the neutral shall be full size and the ground bus shall be [25] [50] percent minimum of phase bus ampacity.] Buses shall be [copper] [or] [aluminum]. Assembly shall be approximately 90 inches high; arrangement of circuit breakers or switches [and other items specified] shall be as indicated. The design of the entire switchboard assembly shall be based on [the indicated interrupting rating.] [an interrupting rating of _____ amperes symmetrical minimum.] Fault protection, and switching capability if applicable, shall be provided by [molded-case circuit breakers] [molded-case circuit breakers coordinated with current-limiting fuses] [fusible switches]. [Provide auxiliary equipment as indicated [on the plans.] [in paragraph: SERVICE [AND METERING] EQUIPMENT.]]

16. NOT USED. CABINETS. Cabinets for communications systems shall have boxes constructed of zinc-coated sheet steel. Cabinets shall be constructed with interior dimensions not less than those indicated. Trim shall be fitted with hinged door and flush catch. Doors shall provide maximum-size openings to the box interiors. Boxes shall be provided with a 5/8-inch plywood backboard having a two-coat insulating varnish finish.

#(N)#
17. FUSES. A complete set of fuses for switches, panels, bus plugs, switchgear, and control centers shall be furnished as required. Time-current-tripping characteristics of fuses serving motors or connected in series with circuit breakers shall be coordinated for the proper operation. Fuses shall have a voltage rating not less than the circuit voltage. [If the type is not otherwise identified, the fuse sizes shown on the plans assume the use of Class RK5 dual element fuses for motor, transformer, and ballast type lighting loads and Class RK1 single element fuses for general loads, Class RK1 dual element fuses for mixed loads.] Class H fuses may be used only where specifically designated. Cartridge fuses shall be used for circuits rated in excess of 30 amperes, 125 volts, except where indicated otherwise on the plans.
#(N,d)#
[17.1. NOT USED. FUSES. Plug fuses shall be of the nonrenewable time-delay type and shall be used for circuits rated 125 volts or less and 30 amperes or less #(d)#
where indicated on the plans.]

17.2. CARTRIDGE FUSES; NONCURRENT-LIMITING TYPE. Cartridge fuses of the noncurrent-limiting type shall be Class H, nonrenewable, dual element, time lag type and shall have interrupting capacity of 10,000 amperes. At 500 percent current, cartridge fuses shall not blow in less than 10 seconds.
#(N)#
17.3. CARTRIDGE FUSES; CURRENT-LIMITING TYPE. Cartridge fuses, current-limiting type, Class [G] [J] [L] [RK1] [RK5] [RK9] [T] [CC] shall have tested interrupting capacity not less than [100,000] [200,000] amperes. Fuse-holders shall be the type that will reject all Class H fuses.

#(N)#
18. NOT USED. CONDUITS. Empty conduits for underground [electric- service cable] [and] [telephone cable] shall be installed as indicated. Except where otherwise indicated, conduits shall terminate a minimum of 5 feet beyond the

building wall and 2 feet below finished grade, with the outside ends bushed and plugged or capped.

19. **AERIAL SERVICE.** Aerial-service entrance conductors shall be installed in [rigid] [IMC] conduit of sizes as indicated, from service equipment to a point on the exterior of the building as directed by the Contracting Officer. Four feet of slack conductor shall be extended from service-entrance fitting to permit connection to service drop. Conduit shall be concealed within the walls of the building where possible, and shall terminate on the exterior with an appropriate weatherproof fitting. [Service-entrance cable in the specified sizes may be used in lieu of insulated conductors in conduit. Cable shall be attached with malleable-iron clamps to the exterior surface at not more than 24-inch intervals and shall terminate in a suitable weatherproof fitting. Point of cable entrance through wall shall be caulked with sealing compound and protected by cast-metal sill plate.]

#(N)#
20. **MOTORS.** (Also see paragraph: EQUIPMENT CONNECTIONS.) Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degrees C. ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified elsewhere. Each motor controller and/or disconnect switch hereinafter specified shall be clearly labeled on the cover to indicate the equipment controlled. The labeling shall be consistent with subparagraph 2.5: IDENTIFICATION NAMEPLATES of this section.

20.1. **SIZE SELECTION.** Motors shall be of sufficient size for the duty to be performed and shall not exceed the full-load rating when the driven equipment is operating at specified capacity under the most severe conditions likely to be encountered. In addition, all motors installed above a mean sea level altitude of 3,300 feet shall be derated 1 percent for each 330 feet or fraction thereof above 3,300 feet. Derating due to altitude will not be required on hermetically sealed motors and integrally mounted motors (integrally mounted motors are those in equipment where the motor housing and driven equipment housing are integral and on the same common shaft). Motor service factor cannot be considered in selection of horsepower size or altitude derating; the standard service factor must be available undiminished in the field installation. The horsepower ratings indicated on electrical plans are for guidance only and do
#(N)#
not limit the equipment size. When electrically driven equipment furnished under other sections of these specifications materially differs from the contemplated design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices, starters, controls, and branch-circuit protection to accommodate the equipment actually installed.
#(N)#
20.2. **ENERGY CONSERVATION.** Unless indicated otherwise, motors for conventional applications over 15 horsepower shall be the energy efficient type. This requirement is not applicable to hermetically sealed motors, integrally mounted motors (as defined in the preceding paragraph), motors specified [under SECTION: AIR SUPPLY AND DISTRIBUTION SYSTEM or] as part of energy efficient equipment in other sections of these specifications (such as chillers specified on a kW/ton basis), wound rotor motors, or any application involving special

construction or performance. Guaranteed minimum full load efficiencies shall be (based on 1,800 rpm, open dripproof):

20 hp	91.2%	75 hp	93.0%
25 hp	91.5%	100 hp	93.5%
30 hp	91.7%	125 hp	94.75%
40 hp	92.2%	150 hp	94.0%
50 hp	92.5%	200 hp	94.5%
60 hp	92.7%	600 hp	96.0%

Other motors of different speed or housing classification shall also be of the energy efficient type, as advertised by the motor manufacturer, with efficiencies greater than the standard line. Motor efficiencies shall have been verified in accordance with NEMA Std. MG 1-12.53.a., and determined using the dynamometer method as described in IEEE Std. 112, Method B. All shop drawing submittals on motor driven equipment shall include the motor efficiency.

#(N)#

20.3. POWER FACTOR CORRECTION. Capacitors of the KVAR size indicated shall be provided on [designated motors] [single speed motors of 25 horsepower or larger] sizes shown are based on standard efficiency 1,800 rpm, T frame motors. Contractor shall adjust KVAR sizes as in accordance with manufacturer's recommendations for other types and speeds. Capacitors must be connected downstream of motor overload protective devices unless separate disconnecting means are provided per NEC 460. Capacitors shall be 3-phase, [240] [480] [600] volt and include provisions for draining charge. Assemblies must be dustproof unless indicated otherwise. Submit data on selected devices for review.

#(N)#

21. MOTOR CONTROL. (Also see paragraph: EQUIPMENT CONNECTIONS) Each motor or group of motors requiring a single control shall be provided with a suitable controller and devices that will perform the functions as specified for the respective motors. If a motor control center has been required on the plans, the controller function for the designated motors must be provided per the MOTOR CONTROL CENTERS subparagraph in this section. In the absence of specific instructions in other sections of the specifications or on the plans, a controller may be furnished with the motor or the equipment it controls, or it may be separately furnished and mounted on the nearest clear wall space at the Contractor's option. [Specific control features shall be provided as indicated on the plans and elsewhere in the specifications.] All control shall be 120 volts or less unless otherwise indicated. Auxiliary contacts shall be included as required to accommodate the specific control requirements called for elsewhere in the specifications or on the plans. Unless indicated otherwise, in each magnetic starter provide [one spare normally open and one normally closed auxiliary contact] [and] [one normally open auxiliary contact for all motors 5 horsepower and larger designated on the plans to have future EMCS monitoring.]

#(N)#

21.1. CONTROLLER APPLICATION. Single- or double-pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float, or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have

an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic control device actuating the pilot-control circuit. When the automatic control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. When combination manual- and automatic-control is specified and the automatic-control device operates the motor directly, a switch of the double-throw, three-position tumbler, or rotary type shall be provided for the manual control. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagrams approved by the Contracting Officer unless such diagram is included on the drawings.

21.2. **OVERLOAD PROTECTION.** Each motor of 1/8 horsepower or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. In magnetic starters, the overload contacts shall be connected on the grounded side (i.e., downstream) of the starter operating coil per NEMA ICS 2.

#(N)#

21.3. **SPECIAL PURPOSE CONTROLLERS.**

21.3.1. **Reduced-Voltage Controller.** Reduced-voltage controllers shall be provided for polyphase motors ___ horsepower or larger. Reduced-voltage starters shall be of the single-step autotransformer, reactor, or resistor type having an adjustable time interval between application of reduced and full voltages to the motors. Wye-delta reduced voltage starter or part winding increment starter having an adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced voltage starters specified above for starting of motor-generator sets, centrifugally operated equipment or reciprocating compressors provided with automatic unloaders.

#(N)#

21.3.2. **Multispeed Controllers.** Controllers for specific equipment [as designated on the plans] [as described elsewhere in the specifications] must be capable of supporting the indicated [2] [ ]-speed operation.

21.3.3. **Reversing Controllers.** Controllers for specific equipment [shown on the plans] [described elsewhere in the specifications] must be capable of supporting motors that will operate in both forward and reverse modes.

21.4. **MOTOR CONTROL CENTERS.** Control centers shall be indoor type and shall contain combination starters and other equipment as indicated. Control centers shall be NEMA ICS 2, Class ___, Type ___. [Control voltage shall be 120 volts unless indicated otherwise.] [Buses shall be copper. Submittals shall identify bus material.] Each control center shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Combination starters shall be provided with [circuit breakers] [fusible switches] [switches equipped with high-interrupting-

capacity current-limiting fuses]. [Single-phase compensators must be included in the fusible switch type of starter.]

21.5. **MISCELLANEOUS CONTACTS.** Contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

21.6. **BOILER SAFETY CONTROLS.** Safety controls for boilers shall be connected to a 2-wire, 120-volt grounded circuit supplied from the associated boiler-equipment circuit. Where the boiler circuit is more than 120 volts to ground, safety controls shall be energized through a two-winding transformer having its 120-volt secondary winding grounded. Overcurrent protection shall be provided in the ungrounded secondary conductor and shall be sized for the load encountered.

22. **MOTOR-DISCONNECT MEANS.** (Also see paragraph: EQUIPMENT CONNECTIONS.) Each motor shall be provided with a disconnecting means when required by NFPA No. 70 even though not indicated. Each disconnect shall be located in sight from the motor controller location. The disconnecting means shall be capable of being locked in the open position when the motor is not in sight of the switch and controller unless another disconnecting means is located at the motor. For single-phase motors, a single- or double-pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Enclosed switches shall be horsepower-rated in conformance with Table III of Fed. Spec. W-S-865. Switches shall disconnect all ungrounded conductors.

#(N)#
23. **TRANSFORMERS.** Utilization transformers shall be general-purpose dry-type in an [indoor] [weatherproof] enclosure. Single- or three-phase transformers shall have not less than two windings per phase. Use of dry type transformers is limited to 500 kVA maximum. Use of auto-transformers is not allowed. [Full-capacity NEMA standard taps shall be provided in the high-voltage winding.] "T" connected transformers may be provided in the range of 15 kVA and less. Transformers with sound levels greater than 50 dBs shall be installed on resilient, vibration-isolating mountings to prevent amplification of sound. Transformers shall be the quiet type with sound level not exceeding the following:

Transformer Rating, kVA	Average Sound Level, Decibels
0-9	40
10-50	45
51-150	50
151-300	55
301-500	60

24. NOT USED.LAMPS AND LIGHTING FIXTURES. Lighting fixtures (luminaries) may be provided with No. 18 AWG stranded copper conductors in 3/8-inch flexible metal conduits not over 6 feet long where flexible metal conduits are permitted by NFPA No. 70.

Lamps shown on the standard drawing series 40-06-04 represent generic categories. Actual size and performance characteristics shall be determined from the lamp codes designated on the plans or in the body of the specifications.

24.1. **LAMPS.** Lamps of the proper type, wattage, and voltage rating shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project.

24.1.1. **Incandescent Lamps** shall be for 125-volt operation unless otherwise indicated.

#(N)#

24.1.2. **Fluorescent Lamps** of the 34- and 40-watt sizes shall have standard cool-white color characteristics unless otherwise indicated and shall be of a type that will not require starter switches. Lamps shall be of the rapid-start type unless otherwise indicated.

#(N)#

24.2. **FIXTURES.** Fixtures shall conform to the following specifications and shall generally be as detailed on Drawing No. 40-06-04, which accompanies

#(d)#

and forms a part of this specification for the types indicated. In some instances, provisions on the plans may supplement or modify the 40-06-04 details. Other types of fixtures, not included in the 40-06-04 series, shall be as detailed on the plans. Illustrations shown on these sheets are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light-distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. Fixtures containing radioactive materials are not acceptable.

24.2.1. Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

#(N)#

24.2.2. **Suspended Fixtures** shall be provided with swivel hangers in order to ensure a plumb installation. Pendants 4 feet or longer shall be braced to minimize or limit swinging (under 1/2 inches per foot of pendant preferred. Single-unit suspended fluorescent fixtures shall have twin-stem hangers unless shown otherwise on the plans. Multiple-unit or continuous-row fluorescent units shall have a tubing or stem for wiring at one point, and a tubing or rod suspension provided for each unit length of chassis including one at each end. Maximum distance between adjacent tubing or stems shall be 10 feet. Rods shall be of not less than 3/16 inch diameter.

24.2.3. **Ceiling Mounted Fixtures** shall be coordinated with and suitable for installation in, on, or from the suspended ceiling provided under other sections of these specifications. Installation and support of fixtures shall be in accordance with NFPA No. 70 and manufacturer's recommendations. Where seismic requirements are specified herein, fixtures shall be supported as shown or specified. Recessed fixtures shall have adjustable fittings to permit alinement with ceiling panels. Recessed fixtures installed in fire-resistive type of suspended ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling panels, in conformance with the Building Materials Directory of Underwriters Laboratories, Inc. Surface-mounted fixtures shall be suitable for fastening to the structural support for ceiling panels.

24.2.4. **Sockets** of industrial, strip, and other open type fluorescent fixtures shall be of the type requiring a forced movement along the longitudinal axis of the lamp for insertion and removal of the lamp.

#(N)#

24.3. **BALLASTS.** Ballasts shall be provided to suit the lamp and circuit specified. [Fluorescent ballasts operating in unheated areas shall be rated for use down to 0 degrees F.] [High-intensity discharge ballasts shall be constant wattage or regulating type and be suitable for operation down to [5 degrees] [minus 20 degrees] F.]

#(N)#

24.4. **DIMMING EQUIPMENT.** Dimmers of the capacities indicated on the plans shall be furnished to control the illumination output of incandescent lighting. Illumination level must be continuously controllable over the range from 0 percent to 100 percent of the normal uncontrolled output. An "off" position (zero current flow) must be included. Selection of dimming equipment and branch circuit overcurrent devices must be coordinated to avoid possible nuisance tripping due to high inrush current demand by the dimmers.

24.5. **LABELS.** Fixtures in which lamps of higher wattage than the design lamp could be inserted shall be provided with labels identifying the design lamp.

[24.6. **X-RAY-FILM ILLUMINATORS.** Illuminators shall be Type II or Type IV, and shall be [flush] [surface] -mounted, fluorescent-lighted, single- or multiple-unit as indicated, mounted 5 feet 3 inches from floor to center of box. Film illuminators installed in hazardous areas as indicated shall be explosionproof.]

[24.7. **STAGE FOOTLIGHTS.** Stage footlights shall be of the disappearing type constructed in 5-foot sections. Each section shall consist of a galvanized 20-gage sheet-steel housing mounted on a seasoned hardwood frame, and a cover panel. The panel shall be framed flush and shall match the material and character of the stage flooring in all respects. The panel shall have two flush ring pulls, two friction catches, and not less than three hinges, all finished to match the hardware of the surroundings. The footlight sections shall be so constructed and installed that when closed, the top of all panels will be flush with the stage floor and the hinges will be concealed. The sheet-steel trough shall have an enamel finish on both inside and outside. Each section of trough shall be equipped with nine individual Alzak-finished aluminum reflectors with hinged holders for lenses, sized for 75- to 150-watt lamps. The sockets shall be spaced 6 inches on centers and alternately wired for three color circuits. Reflectors shall be equipped with heat-resisting, diffusing, natural-colored glass roundels of straw, pink, and blue. Each section of the footlights shall include a splice box with terminal block installed in the footlight recess with knockouts for cable and conduit connections and shall be provided with No. 12 AWG flexible-cable leads connected to a mercury-tube cutoff switch, which shall be automatically operated by raising or lowering the cover panel.]

[24.8. **STAGE BORDER-LIGHT STRIPS.** Stage border-light strips shall be of the individual-reflector type, of lengths as indicated. Trough and wire box shall be constructed of not lighter than 20-gage galvanized sheet steel with aluminum finish. Scenery guards and chain hangers shall be spaced not more than 4 feet on centers. Alzak-aluminum reflectors for 200-watt lamps shall be spaced 8 inches on centers and shall be furnished with heat-resisting, diffusing,

natural-colored glass roundels of straw, pink, and blue, in the hinged holders. Border strips shall be alternately wired for three color circuits and shall be complete with splice box, flexible traveling cables, strain insulators, pulleys, hoisting ropes, and pipe battens.]

#(N)#

24.9. **EMERGENCY LIGHT SETS.** Emergency light sets shall be Type 1, Class 1, Style D or E [or F] with the number of heads as indicated. Sets shall be permanently connected to the wiring system by conductors installed in short lengths of flexible conduit. Connection shall be made [to lighting circuits #(d)# upstream of the switches.] [as shown on the plans.] Each set must include a charge status indicator.

#(N)#

24.10. **EMERGENCY POWER SYSTEM** shall be the type of system that changes battery power to AC, shall conform to requirements of the Underwriters Laboratories, Inc., and shall have the following characteristics and components:

#(d)#

Input section suitable for connection to a [480] [277] [208] [120] volt source [as indicated on the plans].

Rated output capacity [as indicated on the drawings] of [100] [200] [400] [600] [800] [1,000] [1,200] [1,800] [2,500] [4,000] [5,000] watts nominal or not less than ___ volt amperes at ___ power factor and capability to provide the above output through a temperature range of [0 degree C to 40 degree C] [ ].

Normal power supplied to load at [277] [120] volts, 60 hertz.

Communications grade battery rated and warranted for 10-year life.

Battery maintained at full charge while in normal mode.

Surge current limited by the charger to 30 percent above system rated current. Short circuit and overload protection shall protect the system from damage by sustained overcurrents but shall allow the transient inrush current occurring when ballasts or incandescent lamps are energized.

Automatic transfer of load on fault, or failure of normal power, to emergency (battery) mode and return to normal mode.

Solid state inverter [having a 60 hertz sine wave or quasi-sine wave output; square wave output is not acceptable]. Load can be supplied for 90 minutes without normal power.

[Free standing] [Wall-mounted] enclosure.

Indicator and audible alarm for low battery voltage.

"Normal power on" indicator.

Automatic low battery cutoff to disconnect the batteries at 85-90 percent of nominal battery voltage.

"Battery on charge" indicator.

Low-battery electrolyte indicator (not required if sealed, maintenance free batteries are supplied).

Voltmeter and ammeter (D.C.).

[Energy storing circuitry or accessories as required to maintain the arc discharge during the switching interval from Normal to Emergency mode. (This provision prevents the extended period of darkness characteristic of HID lamps whenever their arc is extinguished; if a given unit supplies only non-HID lighting the feature may be omitted.)]

#(N)#
[25. NOT USED. INSTALLATION OF DIAGNOSTIC X-RAY EQUIPMENT. Installation of diagnostic X-ray equipment shall be in accordance with manufacturer's recommendations.]

26. NOT USED. BATTERY CHARGERS. Battery chargers shall be general purpose, continuous current output, with solid state rectifiers. Means shall be provided to regulate and adjust the DC output voltage. Chargers shall have continuous current ratings of 10 to 15 percent higher than battery current outputs based upon an 8-hour discharge.

27. EQUIPMENT CONNECTIONS. (Also see subparagraph: APPLICATION OF THIS SECTION). All wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Power connections to motors, appliances, and other fixed equipment shall be provided under this section and shall comply with the applicable requirements of paragraph: WIRING METHODS. Flexible raceways 6 feet or less in length shall be provided to all electrical equipment subject to vibration or movement and for all motors and generators. Liquid-tight raceways shall be used in damp or wet locations.

27.1. MOTORS AND MOTOR CONTROL. Motors will be furnished under other sections of the specifications unless otherwise indicated. Power feeders and control equipment (such as starters) which acts directly on the power feeder shall be furnished and connected under this section of the specifications unless shown or specified otherwise. Except as otherwise specifically noted, automatic-control, signaling, regulatory, and safety control devices are not included in this section of the specifications, but shall be furnished and installed under other sections of the specifications. Control wiring [not shown on the drawings] shall be furnished under the other sections of the specifications. Protective devices (overloads, fuses, limit switches, etc.) which act on the motor feeder directly shall be furnished under this section.

27.2. INSTALLATION OF GOVERNMENT-FURNISHED EQUIPMENT. Wiring shall be extended to the equipment, and proper connections made thereto.

27.3. FOOD-SERVICE EQUIPMENT PROVIDED UNDER OTHER SECTIONS OF THE SPECIFICATIONS. Wiring shall be extended to the equipment and proper connections made thereto.

27.4. DISCONNECTING PROVISIONS. When a process control, temperature control, or other auxiliary panel is furnished without an interrupting device, an external switch that will disconnect all ungrounded conductors shall be installed.

28. PAINTING AND FINISHING. Field-applied paint on exposed surfaces shall be provided under SECTION: PAINTING, GENERAL.

29. REPAIR OF EXISTING WORK. The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be

repaired by skilled mechanics of the trades involved, at no additional cost to the Government.

30. **TESTS.** After the interior-wiring-system installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this specification. The test shall be performed in the presence of the Contracting Officer. The Contractor shall furnish all instruments and personnel required for the tests, and the Government will furnish the necessary electric power. The Contractor shall submit in writing to the Contracting Officer upon completion of the project the measured ground resistance of each ground rod, indicating the location of the rod and the resistance and the soil conditions at the time the measurements were made. [The ground fault protection system shall be performance tested in accordance with #(N)#
manufacturer's recommended procedures. A written report of the results shall be furnished.]

31. **SPARE PARTS.** At least one set of spare fuses shall be furnished--one minimum of each type and size. Lamps shall be furnished equivalent to [2 percent] [5 percent] of the total installed, but not less than one of each size and type.