AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE	OF PAGES
N/A	1	

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
0002	16 AUG 2002		DACW09-02-B-0010

6. ISSUED BY CODE

U.S. ARMY ENGINEER DISTRICT, LOS ANGELES
P.O. BOX 532711
LOS ANGELES, CALIFORNIA 90053-2325

7. ADMINISTERED BY (If other than Item 6) CODE

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)

CODE FACILITY CODE

(√) X

9A. AMENDMENT OF SOLICITATION NO.
DACW09-02-B-0010

9B. DATED (SEE ITEM 11)
3 SEPT 2002 (Bid Opening Date)

10A. MODIFICATION OF CONTRACTS/ORDER NO.

10B. DATED (SEE ITEM 13)

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

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

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

(a) By completing Items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

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

(√)

A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).

C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

D. OTHER (Specify type of modification and authority)

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

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

PHASE 1A, RIO SALADO ENVIRONMENTAL RESTORATION, MARICOPA COUNTY, ARIZONA

2 Encl:

1. REVISED SECTION 00100, 00800, 01330b, 01355, 01356, 02300, 02371, 02821, 02915, 02930, 15060, 15081, 15955, 16010, 16015, 16050, 16110, 16120, 16405, 16405a, 16425, 16450, 16485, 16500, 16520, 16670, and 16950.
2. REVISED DRAWINGS (30 drawings): District File No. 471-0292 (D-5), 471-0296 (C-1), 471-0322 (C-13), 471-0324 (C-15), 471-0326 (C-16), 471-0332 (C-22), 471-0338 (C-28), 471-0339 (C-29), 471-0343 (C-33), 471-0344 (C-34), 471-0345 (C-35), 471-0361 (CW-10), 471-0427 (W-1), 471-0428 (W-2), 471-0429 (W-3), 471-0436 (W-10), 471-0437 (W-11), 471-0456 (M-1), 471-0461 (M-6), 471-0462 (M-7), 471-0463 (S-1), 471-0464 (S-2), 471-0465 (S-3), 471-0466 (S-4), 471-0469 (S-7), 471-0470 (S-8), 471-0474 (S-12), 471-0518 (A-1.1), 471-0519 (A-1.2), and 471-0521 (S-2).

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

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

Section 00100 Bidding Schedule/Instructors to Bidders

52.0000-4010 INQUIRIES
52.0000-4023 SAFETY REQUIREMENTS
52.211-2 AVAILABILITY OF SPECIFICATIONS LISTED IN THE DOD INDEX OF SPECIFICATIONS AND STANDARDS (DODISS) AND DESCRIPTIONS LISTED IN THE ACQUISITION MANAGEMENT SYSTEMS AND DATA REQUIREMENTS CONTROL LIST, DOD 5010.12-L (DEC 1999)
52.214-3 AMENDMENTS TO INVITATIONS FOR BIDS (DEC 1989)
52.214-4 FALSE STATEMENTS IN BIDS (APR 1984)
52.214-5 SUBMISSION OF BIDS (MAR 1997)
52.214-6 EXPLANATION TO PROSPECTIVE BIDDERS (APR 1984)
52.214-7 LATE SUBMISSIONS, MODIFICATIONS, AND WITHDRAWALS OF BIDS (NOV 1999)
52.214-18 PREPARATION OF BIDS--CONSTRUCTION (APR 1984)
52.214-19 CONTRACT AWARD--SEALED BIDDING--CONSTRUCTION (AUG 1996)
52.214-34 SUBMISSION OF OFFERS IN THE ENGLISH LANGUAGE (APR 1991)
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52.228-1 BID GUARANTEE (SEP 1996)
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52.233-2 SERVICE OF PROTEST (AUG 1996)
52.236-27 SITE VISIT (CONSTRUCTION) (FEB 1995)
52.236-28 PREPARATION OF PROPOSALS--CONSTRUCTION (OCT 1997)

CLAUSES INCORPORATED BY FULL TEXT

52.0000-4010 INQUIRIES

Perspective bidders/offerors should submit inquiries related to this solicitation by writing or calling the following (collect calls will not be accepted:

(1) For inquiries of a contractual nature (solicitation requirements, interpretation of contractual language) call:
Sandra Oquita
213 452-3249

For bid results only, call (213) 452-3235.

(2) All technical questions on the specification or drawings will be submitted in writing to:
Address:
Jatin Desai
911 Wilshire Boulevard
Los Angeles, CA 90017

(3) Please include the solicitation number, project title and location of project with your questions. Written inquiries must be received by this office not later than 14 calendar days prior to bid opening date/date set for receipt of offers.

(4) Oral explanations or instructions are not binding. Any information given to a bidder/offeror which impacts the bid/offer will be given in the form of a written amendment to the solicitation.

52.0000-4023 SAFETY REQUIREMENTS

The bidder's attention is directed to the latest version of U.S Army Corps of Engineers Safety and Health Manual, EM 385-1-1, which will be strictly enforced. This publication may be obtained from the U.S. Army Engineer District, Los Angeles, ATTN: Safety Office, P.O. Box 532711, Los Angeles, California 90053-2325.

52.0001-4004 BID RESULTS

The telephone number for bid results after the opening is Area Code (213) 452-3235.

52.211-2 AVAILABILITY OF SPECIFICATIONS LISTED IN THE DOD INDEX OF SPECIFICATIONS AND STANDARDS (DODISS) AND DESCRIPTIONS LISTED IN THE ACQUISITION MANAGEMENT SYSTEMS AND DATA REQUIREMENTS CONTROL LIST, DOD 5010.12-L (DEC 1999)

Copies of specifications, standards, and data item descriptions cited in this solicitation may be obtained--

(a) From the ASSIST database via the Internet at http://assist.daps.mil; or

(b) By submitting a request to the--Department of Defense Single Stock Point (DoDSSP), Building 4, Section D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Telephone (215) 697-2667/2179, Facsimile (215) 697-1462.

(End of provision)

52.214-3 AMENDMENTS TO INVITATIONS FOR BIDS (DEC 1989)

(a) If this solicitation is amended, then all terms and conditions which are not modified remain unchanged.

(b) Bidders shall acknowledge receipt of any amendment to this solicitation (1) by signing and returning the amendment, (2) by identifying the amendment number and date in the space provided for this purpose on the form for submitting a bid, (3) by letter or telegram, or (4) by facsimile, if facsimile bids are authorized in the solicitation. The Government must receive the acknowledgment by the time and at the place specified for receipt of bids.

(End of provision)

52.214-4 FALSE STATEMENTS IN BIDS (APR 1984)

Bidders must provide full, accurate, and complete information as required by this solicitation and its attachments. The penalty for making false statements in bids is prescribed in 18 U.S.C. 1001.

(End of provision)

52.214-5 SUBMISSION OF BIDS (MAR 1997)

(a) Bids and bid modifications shall be submitted in sealed envelopes or packages (unless submitted by electronic means) (1) addressed to the office specified in the solicitation, and (2) showing the time and date specified for receipt, the solicitation number, and the name and address of the bidder.

(b) Bidders using commercial carrier services shall ensure that the bid is addressed and marked on the outermost envelope or wrapper as prescribed in subparagraphs (a)(1) and (2) of this provision when delivered to the office specified in the solicitation.

(c) Telegraphic bids will not be considered unless authorized by the solicitation; however, bids may be modified or withdrawn by written or telegraphic notice.

(d) Facsimile bids, modifications, or withdrawals, will not be considered unless authorized by the solicitation.

(e) Bids submitted by electronic commerce shall be considered only if the electronic commerce method was specifically stipulated or permitted by the solicitation.

(End of provision)

52.214-6 EXPLANATION TO PROSPECTIVE BIDDERS (APR 1984)

Any prospective bidder desiring an explanation or interpretation of the solicitation, drawings, specifications, etc., must request it in writing soon enough to allow a reply to reach all prospective bidders before the submission of their bids. Oral explanations or instructions given before the award of a contract will not be binding. Any information given a prospective bidder concerning a solicitation will be furnished promptly to all other prospective bidders as an amendment to the solicitation, if that information is necessary in submitting bids or if the lack of it would be prejudicial to other prospective bidders.

(End of provision)

52.214-7 LATE SUBMISSIONS, MODIFICATIONS, AND WITHDRAWALS OF BIDS (NOV 1999)

(a) Bidders are responsible for submitting bids, and any modifications or withdrawals, so as to reach the Government office designated in the invitation for bids (IFB) by the time specified in the IFB. If no time is specified in the IFB, the time for receipt is 4:30 p.m., local time, for the designated Government office on the date that bids are due.

(b)(1) Any bid, modification, or withdrawal received at the Government office designated in the IFB after the exact time specified for receipt of bids is “late” and will not be considered unless it is received before award is made, the Contracting Officer determines that accepting the late bid would not unduly delay the acquisition; and--

(i) If it was transmitted through an electronic commerce method authorized by the IFB, it was received at the initial point of entry to the Government infrastructure not later than 5:00 p.m. one working day prior to the date specified for receipt of bids; or

(ii) There is acceptable evidence to establish that it was received at the Government installation designated for receipt of bids and was under the Government's control prior to the time set for receipt of bids.

(2) However, a late modification of an otherwise successful bid that makes its terms more favorable to the Government, will be considered at any time it is received and may be accepted.

(c) Acceptable evidence to establish the time of receipt at the Government installation includes the time/date stamp of that installation on the bid wrapper, other documentary evidence of receipt maintained by the installation, or oral testimony or statements of Government personnel.

(d) If an emergency or unanticipated event interrupts normal Government processes so that bids cannot be received at the Government office designated for receipt of bids by the exact time specified in the IFB and urgent Government requirements preclude amendment of the IFB, the time specified for receipt of bids will be deemed to be

extended to the same time of day specified in the solicitation on the first work day on which normal Government processes resume.

(e) Bids may be withdrawn by written notice received at any time before the exact time set for receipt of bids. If the IFB authorizes facsimile bids, bids may be withdrawn via facsimile received at any time before the exact time set for receipt of bids, subject to the conditions specified in the provision at 52.214-31, Facsimile Bids. A bid may be withdrawn in person by a bidder or its authorized representative if, before the exact time set for receipt of bids, the identity of the person requesting withdrawal is established and the person signs a receipt for the bid.

(End of provision)

52.214-18 PREPARATION OF BIDS--CONSTRUCTION (APR 1984)

(a) Bids must be (1) submitted on the forms furnished by the Government or on copies of those forms, and (2) manually signed. The person signing a bid must initial each erasure or change appearing on any bid form.

(b) The bid form may require bidders to submit bid prices for one or more items on various bases, including--

(1) Lump sum bidding;

(2) Alternate prices;

(3) Units of construction; or

(4) Any combination of subparagraphs (1) through (3) above.

(c) If the solicitation requires bidding on all items, failure to do so will disqualify the bid. If bidding on all items is not required, bidders should insert the words "no bid" in the space provided for any item on which no price is submitted.

(d) Alternate bids will not be considered unless this solicitation authorizes their submission.

(End of provision)

52.214-19 CONTRACT AWARD--SEALED BIDDING--CONSTRUCTION (AUG 1996)

(a) The Government will evaluate bids in response to this solicitation without discussions and will award a contract to the responsible bidder whose bid, conforming to the solicitation, will be most advantageous to the Government, considering only price and the price-related factors specified elsewhere in the solicitation.

(b) The Government may reject any or all bids, and waive informalities or minor irregularities in bids received.

(c) The Government may accept any item or combination of items, unless doing so is precluded by a restrictive limitation in the solicitation or the bid.

(d) The Government may reject a bid as nonresponsive if the prices bid are materially unbalanced between line items or subline items. A bid is materially unbalanced when it is based on prices significantly less than cost for some work and prices which are significantly overstated in relation to cost for other work, and if there is a reasonable doubt that the bid will result in the lowest overall cost to the Government even though it may be the low evaluated bid, or if it is so unbalanced as to be tantamount to allowing an advance payment.

(End of provision)

52.214-34 SUBMISSION OF OFFERS IN THE ENGLISH LANGUAGE (APR 1991)

Offers submitted in response to this solicitation shall be in the English language. Offers received in other than English shall be rejected.

(End of provision)

52.214-35 SUBMISSION OF OFFERS IN U.S. CURRENCY (APR 1991)

Offers submitted in response to this solicitation shall be in terms of U.S. dollars. Offers received in other than U.S. dollars shall be rejected.

(End of provision)

EFARS 52.214-5000 ARITHMETIC DISCREPANCIES

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

(1) Obviously misplaced decimal points will be corrected;

(2) Discrepancy between unit price and extended price, the unit price will govern;

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

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

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

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

(End of statement)

52.0214-4583 TELEGRAPHIC BIDS/OFFERS ARE NOT ACCEPTABLE

Any telegram to modify or withdraw a bid/offer sent to this office must be physically delivered to the office designated for receipt of bid/offer by the date and time set for bid opening/receipt of proposals.
No one from this office will be dispatched to the local telegraph office to pick up any telegram for any reason.

FACSIMILE BIDS/OFFERS

Facsimile bids/offers, modifications thereto, or cancellations of bids/offers will not be accepted.

52.0214-4599 EVALUATION FOR AWARD

The Government contemplates award of one contract to the responsive, responsible bidder who submits the low bid for the total of all the items in the Bidding Schedule.

52.214-5001 DIRECTIONS FOR SUBMITING BIDS (APR 2002)

Envelopes containing bids must be sealed, marked and addressed as follows:

MARK ENVELOPES:

Bid under IFB No. DACW09-02-B-0010
Bid Opening Date: 3 September 2002

ADDRESS ENVELOPES TO:

Department of the Army
U. S. Army Engineer District, Los Angeles
ATTN: Contracting Division
C/O: Sandra Oquita
P. O. Box 532711
Los Angeles, CA 90053-2325

SPECIAL INSTRUCTIONS PERTAINING TO HAND-CARRIED BIDS:
Due to security precautions, all Corps of Engineers visitors/couriers are now required to check in at the Public Affairs Office (PAO), Suite 980, Wilshire Blvd, Los Angeles, CA. Bidders are no longer permitted to hand-carry their bids directly to Contacting Division without an authorized escort. **Bids may NOT be left unattended at the Public Affairs Office (PAO), Suite 980.**

Bidders who desire to hand-deliver their bids prior to the scheduled bid opening time/date must notify the Contracting Division to arrange for receipt of their bid by Contracting Division personnel. Normally the contact will be the Contract Specialist designated above. In the event the Contract Specialist cannot be reached, please call the main Contracting Division telephone number, 213-452-3231 or the following alternative telephone numbers -3249, -3235, or - 3234, in order to request assistance.

30 minutes prior to the scheduled bid opening time/date, the Bid Opening Officer will be in the Public Affairs Office (PAO) Suite 980, to accept bids. After visitor in-processing, all bidders will subsequently be escorted to Bid Opening Room, where the bids will be publicly opened and read.

In order to expedite visitor processing, bidders are encouraged to complete the information requested on the Notice of Visitor(s) Form (attached). The completed form can be faxed to the Contract Specialist at (213)452-4184 or 4187, prior to the date for receipt of bids. In addition, no more than 2 visitors per firm will be permitted within the building. No exceptions will be made. The offeror is responsible for compliance with the security requirements and shall ensure that any company representative, courier or delivery personnel are aware of these special procedures pertaining to hand carried bids.

NOTICE OF VISITOR(S)		
1. Date(s) of Visit *(Inclusive)*	**2. Arrival Time**	
3. Name of Visitor(s) *(Last, First)*	**4. Agency/Company of Visitor**	
5. Name of Person Being Visited *(Include Div, Br, Sec)*	**6. Suite Number**	**7. Telephone Number**
8. Contact Person *(if other than Person Being Visited)*		**9. Telephone Number**
10. Other Comments or Instructions		

- All visitors must report to the Public Affairs Office, Suite 980
- Visitors must use the Visitor Tag provided.
- Visitors must be escorted to Corps of Engineers floors
- Parking validation is only available for Engineering Division, Construction-Operations, and Information Management field personnel.
- Delivery personnel will be validated for 30 minutes only.

52.216-1 TYPE OF CONTRACT (APR 1984)

The Government contemplates award of a one (1) contract resulting from this solicitation.

(End of clause)

52.219-8 UTILIZATION OF SMALL BUSINESS CONCERNS (OCT 2000)

(a) It is the policy of the United States that small business concerns, veteran-owned small business concerns, service-disabled veteran-owned small business concerns, HUBZone small business concerns, small disadvantaged business concerns, and women-owned small business concerns shall have the maximum practicable opportunity to participate in performing contracts let by any Federal agency, including contracts and subcontracts for subsystems, assemblies, components, and related services for major systems. It is further the policy of the United States that its prime contractors establish procedures to ensure the timely payment of amounts due pursuant to the terms of their subcontracts with small business concerns, veteran-owned small business concerns, service-disabled veteran-owned small business concerns, HUBZone small business concerns, small disadvantaged business concerns, and women-owned small business concerns.

(b) The Contractor hereby agrees to carry out this policy in the awarding of subcontracts to the fullest extent consistent with efficient contract performance. The Contractor further agrees to cooperate in any studies or surveys as may be conducted by the United States Small Business Administration or the awarding agency of the United States as may be necessary to determine the extent of the Contractor's compliance with this clause.

Definitions. As used in this contract--

HUBZone small business concern means a small business concern that appears on the List of Qualified HUBZone Small Business Concerns maintained by the Small Business Administration.

Service-disabled veteran-owned small business concern--

(1) Means a small business concern--

(i) Not less than 51 percent of which is owned by one or more service-disabled veterans or, in the case of any publicly owned business, not less than 51 percent of the stock of which is owned by one or more service-disabled veterans; and

(ii) The management and daily business operations of which are controlled by one or more service-disabled veterans or, in the case of a veteran with permanent and severe disability, the spouse or permanent caregiver of such veteran.

(2) Service-disabled veteran means a veteran, as defined in 38 U.S.C. 101(2), with a disability that is service-connected, as defined in 38 U.S.C. 101(16).

Small business concern means a small business as defined pursuant to Section 3 of the Small Business Act and relevant regulations promulgated pursuant thereto.

Small disadvantaged business concern means a small business concern that represents, as part of its offer that--

(1) It has received certification as a small disadvantaged business concern consistent with 13 CFR part 124, subpart B;

(2) No material change in disadvantaged ownership and control has occurred since its certification;

(3) Where the concern is owned by one or more individuals, the net worth of each individual upon whom the certification is based does not exceed $750,000 after taking into account the applicable exclusions set forth at 13 CFR 124.104(c)(2); and

(4) It is identified, on the date of its representation, as a certified small disadvantaged business in the database maintained by the Small Business Administration (PRO-Net).

Veteran-owned small business concern means a small business concern--

(1) Not less than 51 percent of which is owned by one or more veterans (as defined at 38 U.S.C. 101(2)) or, in the case of any publicly owned business, not less than 51 percent of the stock of which is owned by one or more veterans; and

(2) The management and daily business operations of which are controlled by one or more veterans.

Women-owned small business concern means a small business concern--

(1) That is at least 51 percent owned by one or more women, or, in the case of any publicly owned business, at least 51 percent of the stock of which is owned by one or more women; and

(2) Whose management and daily business operations are controlled by one or more women.

(d) Contractors acting in good faith may rely on written representations by their subcontractors regarding their status as a small business concern, a veteran-owned small business concern, a service-disabled veteran-owned small business concern, a HUBZone small business concern, a small disadvantaged business concern, or a women-owned small business concern.

(End of clause)

52.225-12 NOTICE OF BUY AMERICAN ACT REQUIREMENT-- CONSTRUCTION MATERIALS UNDER TRADE AGREEMENTS (MAY 2002)

(a) Definitions. Construction material, designated country construction material, domestic construction material, foreign construction material, and NAFTA country construction material, as used in this provision, are defined in the clause of this solicitation entitled “Buy American Act--Construction Materials under Trade Agreements” (Federal Acquisition Regulation (FAR) clause 52.225-11).

(b) Requests for determination of inapplicability. An offeror requesting a determination regarding the inapplicability of the Buy American Act should submit the request to the Contracting Officer in time to allow a determination before submission of offers. The offeror shall include the information and applicable supporting data required by paragraphs (c) and (d) of FAR clause 52.225-11 in the request. If an offeror has not requested a determination regarding the inapplicability of the Buy American Act or Balance of Payments Program before submitting its offer, or has not received a response to a previous request, the offeror shall include the information and supporting data in the offer.

(c) Evaluation of offers. (1) The Government will evaluate an offer requesting exception to the requirements of the Buy American Act, based on claimed unreasonable cost of domestic construction materials, by adding to the offered price the appropriate percentage of the cost of such foreign construction material, as specified in paragraph (b)(4)(i) of FAR clause 52.225-11.

(2) If evaluation results in a tie between an offeror that requested the substitution of foreign construction material based on unreasonable cost and an offeror that did not request an exception, the Contracting Officer will award to the offeror that did not request an exception based on unreasonable cost.

(d) Alternate offers. (1) When an offer includes foreign construction material, other than designated country or NAFTA country construction material, that is not listed by the Government in this solicitation in paragraph (b)(3) of FAR clause 52.225-11, the offeror also may submit an alternate offer based on use of equivalent domestic, designated country, or NAFTA country construction material.

(2) If an alternate offer is submitted, the offeror shall submit a separate Standard Form 1442 for the alternate offer, and a separate price comparison table prepared in accordance with paragraphs (c) and (d) of FAR clause 52.225-11 for the offer that is based on the use of any foreign construction material for which the Government has not yet determined an exception applies.

(3) If the Government determines that a particular exception requested in accordance with paragraph (c) of FAR clause 52.225-11 does not apply, the Government will evaluate only those offers based on use of the equivalent domestic, designated country, or NAFTA country construction material, and the offeror shall be required to furnish such domestic, designated country, or NAFTA country construction

material. An offer based on use of the foreign construction material for which an exception was requested--

(i) Will be rejected as nonresponsive if this acquisition is conducted by sealed bidding; or

(ii) May be accepted if revised during negotiations.

(End of provision)

52.228-1 BID GUARANTEE (SEP 1996)

(a) Failure to furnish a bid guarantee in the proper form and amount, by the time set for opening of bids, may be cause for rejection of the bid.

(b) The bidder shall furnish a bid guarantee in the form of a firm commitment, e.g., bid bond supported by good and sufficient surety or sureties acceptable to the Government, postal money order, certified check, cashier's check, irrevocable letter of credit, or, under Treasury Department regulations, certain bonds or notes of the United States. The Contracting Officer will return bid guarantees, other than bid bonds, (1) to unsuccessful bidders as soon as practicable after the opening of bids, and (2) to the successful bidder upon execution of contractual documents and bonds (including any necessary coinsurance or reinsurance agreements), as required by the bid as accepted.-

(c) The amount of the bid guarantee shall be 20% percent of the bid price or $3,000,000.00, whichever is less.-

(d) If the successful bidder, upon acceptance of its bid by the Government within the period specified for acceptance, fails to execute all contractual documents or furnish executed bond(s) within 10 days after receipt of the forms by the bidder, the Contracting Officer may terminate the contract for default.-

(e) In the event the contract is terminated for default, the bidder is liable for any cost of acquiring the work that exceeds the amount of its bid, and the bid guarantee is available to offset the difference.

(End of clause)

52.228-4506 INDIVIDUAL SURETIES IN SUPPORT OF BID BONDS

Bidder/offerors utilizing individual sureties in support of a bid bond shall include a Standard Form (SF) 28 (Affidavit of Individual Surety), accompanied by a pledge of acceptable assets from each person acting as an individual surety, and include these with the SF 24 (Bid Bond), and the bid itself (see clause titled "Pledges of Assets," FAR 52.228-11).

Pledges of acceptable assets shall be in the form of (1) evidence of an escrow account and/or (2) a recorded lien on real estate. If this is an RFP, failure to provide required documentation described herein may cause the offeror to be deemed "unacceptable".

52.228-4507 BID GUARANTEE FORM AND AMOUNT

When bids/proposals exceed $100,000, the offeror shall furnish a separated bid guarantee in accordance with the solicitation provision titled "Bid Guarantee", FAR 52.228-1. In accordance with FAR 28.101-2 the bid guarantee amount shall be a least 20 percent of the "bid price" but shall not exceed $3 million. When the penal sum is expressed as a percentage, a maximum dollar limitation may be stated. If there are option line items on the Pricing Schedule (Schedule B), the term "bid price" is hereby defined as the total bid not to include any amount for line items designated as "options". In bids/proposals that contain "additives", the "bid price" is defined as the total of all bid items including additive line items. FAR 28.106-1 states that a Standard Form (SF) 24 shall be used for the bid bond. In accordance with FAR 28.202(a)(1), corporate sureties utilized must appear on the list contained in the Department of Treasury Circular 570 titled "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and Acceptable Reinsuring Companies."

52.232-38 SUBMISSION OF ELECTRONIC FUNDS TRANSFER INFORMATION WITH OFFER (MAY 1999)

The offeror shall provide, with its offer, the following information that is required to make payment by electronic funds transfer (EFT) under any contract that results from this solicitation. This submission satisfies the requirement to provide EFT information under paragraphs (b)(1) and (j) of the clause at 52.232-34, Payment by Electronic Funds Transfer--Other than Central Contractor Registration.

(1) The solicitation number (or other procurement identification number).

(2) The offeror's name and remittance address, as stated in the offer.

(3) The signature (manual or electronic, as appropriate), title, and telephone number of the offeror's official authorized to provide this information.

(4) The name, address, and 9-digit Routing Transit Number of the offeror's financial agent.

(5) The offeror's account number and the type of account (checking, savings, or lockbox).

(6) If applicable, the Fedwire Transfer System telegraphic abbreviation of the offeror's financial agent.

(7) If applicable, the offeror shall also provide the name, address, telegraphic abbreviation, and 9-digit Routing Transit Number of the correspondent financial institution receiving the wire transfer payment if the offeror's financial agent is not directly on-line to the Fedwire and, therefore, not the receiver of the wire transfer payment.

(End of provision)

52.233-2 SERVICE OF PROTEST (AUG 1996)

Protests, as defined in section 33.101 of the Federal Acquisition Regulation, that are filed directly with an agency, and copies of any protests that are filed with the General Accounting Office (GAO), shall be served on the Contracting Officer (addressed as follows) by obtaining written and dated acknowledgment of receipt from Patricia B. Bonilla.
(b) The copy of any protest shall be received in the office designated above within one day of filing a protest with the GAO.

(End of provision)

52.236-27 SITE VISIT (CONSTRUCTION) (FEB 1995)

(a) The clauses at 52.236-2, Differing Site Conditions, and 52.236-3, Site Investigations and Conditions Affecting the Work, will be included in any contract awarded as a result of this solicitation. Accordingly, offerors or quoters are urged and expected to inspect the site where the work will be performed.

(b) Site visits is scheduled for 13 August 2002 at 10:30 a.m., Contractors should meet at the SE corner of the Central Avenue Bridge over the Salt River, point of contact is:

Name: Neil Erwin
Address: 7046 Fighter Country Avenue
Telephone: 623 935-0820

(End of provision)

52.236-28 PREPARATION OF PROPOSALS--CONSTRUCTION (OCT 1997)

(a) Proposals must be (1) submitted on the forms furnished by the Government or on copies of those forms, and (2) manually signed. The person signing a proposal must initial each erasure or change appearing on any proposal form.

(b) The proposal form may require offerors to submit proposed prices for one or more items on various bases, including--

(1) Lump sum price;

(2) Alternate prices;

(3) Units of construction; or

(4) Any combination of paragraphs (b)(1) through (b)(3) of this provision.

(c) If the solicitation requires submission of a proposal on all items, failure to do so may result in the proposal being rejected without further consideration. If a proposal on all items is not required, offerors should insert the words “no proposal” in the space provided for any item on which no price is submitted.

(d) Alternate proposals will not be considered unless this solicitation authorizes their submission.

REFERENCES TO ENVIRONMENTAL ASSESSMENT REPORTS

The data and information in the Environmental Assessment Reports referenced within these specifications were prepared several years ago by the City of Phoenix and other local agencies to meet their requirements and for their own purposes. The referenced reports were the result of limited investigations that were performed for limited purposes. The referenced reports have not been updated since their publication, and may not reflect current conditions and information accurately or completely. The data and information in the referenced reports are made available to bidders and contractors for their information and to assist them in conducting their own investigation of facts and circumstances.

The Government has referenced the data and information contained in the reports to avoid claims of superior knowledge, and makes no warranties as to their accuracy, completeness, or truthfulness. Knowledgeable persons may reasonably draw different conclusions and interpretations from the data and information.

The data and information in the referenced reports are not and never have been U.S. Government data, and are not and will not be part of a contract resulting from this RFP. The reports shall not be construed as part of the Contract or as setting forth any contractual obligations or responsibilities on the part of the Contracting Officer. Contract obligations with the Government are controlled by the plans and specifications provided in the contract documents furnished by the Government to bidders.

(End of provision)

Section 00800

Special Contract Requirements

52.01-4001 CONTRACT ADMINISTRATION DATA

52.0028-4001 REQUIRED INSURANCE

52.211-10 COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (APR 1984)

52.211-12 LIQUIDATED DAMAGES--CONSTRUCTION (SEP 2000)

52.211-18 VARIATION IN ESTIMATED QUANTITY (APR 1984)

52.222-23 NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY FOR CONSTRUCTION (FEB 1999)

52.228-12 PROSPECTIVE SUBCONTRACTOR REQUESTS FOR BONDS (OCT 1995)

52.228-14 IRREVOCABLE LETTER OF CREDIT (DEC 1999)

52.228-15 PERFORMANCE AND PAYMENT BONDS--CONSTRUCTION (JUL 2000)

EFARS 52-231-5000 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE (MAR 1995)

52.232-33 PAYMENT BY ELECTRONIC FUNDS TRANSFER—CENTRAL CONTRACTOR REGISTRATION (MAY 1999)

52.232-4001 CONTINUING CONTRACTS (ALTERNATE) (MAR 1995) EFARS 52-232-5002

52.236-4 PHYSICAL DATA (APR 1984)

52.236-16 QUANTITY SURVEYS (APR 1984)

52.236-21 SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION (FEB 1997)

EFARS 52.236-5000 PLANT AND MATERIAL REMOVAL AFTER CONTRACT TERMINATION (MAR 1995)

EFARS 52.249-5000 BASIS FOR SETTLEMENT OF PROPOSALS

252.236-7001 CONTRACT DRAWINGS, MAPS, AND SPECIFICATIONS (AUG 2000)

Section 00800

Special Contract Requirements

CLAUSES INCORPORATED BY FULL TEXT

52.01-4001 CONTRACT ADMINISTRATION DATA

The Contract Administration Office for this contract subsequent to award is:

Department of the Army
Los Angeles District, Corps of Engineers
P.O. Box 532711
Los Angeles, California 90053-2325

ATTN: (Sandra Oquita)
Telephone No: (213 452-3249)

Payment will be made by:

USACE Finance Center
ATTN: CEFC-AO-P
5270 Integrity Drive
Millington, TN 38054-5005

Submit Invoices to:

Road Runner Resident office
7046 Fighter Country Avenue
Luke Air Force Base

52.0028-4001 REQUIRED INSURANCE

Insurance is required as follows:

a. Either Workman's Compensation or Employer's Liability Insurance with a minimum limit of $100,000.00.

b. General Liability. The Contracting Officer shall require bodily injury liability insurance coverage written on the comprehensive form or policy of at least $500,000.00 per occurrence.

c. Automobile Liability Insurance for Bodily Injury and Property Damage with minimum limits of $200,000.00 for injury or death of any one person; $500,000.00 for each accident or occurrence of bodily injury liability; and $20,000.00 for each accident or occurrence for property liability.

d. In every case the insurance coverage shall amount to at least the limits stated above. However, where the Financial Responsibility Compulsory Insurance Law of the State in which the installation is located requires higher limits, the Automobile Liability Insurance Policy should provide coverage of at least those limits.

Prior to the commencement of work hereunder, the Contractor shall furnish to the Contracting Office a certificate or written statement of the above required insurance. The policies evidencing required insurance shall contain an endorsement to the effect that cancellation or any material change in the policies adversely affecting the interests of the Government in such insurance shall not be effective until 10 days after written notice thereof to the Contracting Officer.

The Contractor agrees to insert the substance of this clause, including this paragraph, in all subcontracts.

52.211-10 COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (APR 1984)

The Contractor shall be required to (a) commence work under this contract within 10 calendar days after the date the Contractor receives the notice to proceed, (b) prosecute the work diligently, and (c) complete the entire work ready for use not later than 360 calendar days after the Contractor receives the notice to proceed. The time stated for completion shall include final cleanup of the premises.

*The Contracting Officer shall specify either a number of days after the date the contractor receives the notice to proceed, or a calendar date.

(End of clause)

52.211-12 LIQUIDATED DAMAGES--CONSTRUCTION (SEP 2000)

(a) If the Contractor fails to complete the work within the time specified in the contract, the Contractor shall pay liquidated damages to the Government in the amount of $ 1,350.00 for each calendar day of delay until the work is completed or accepted.

(b) If the Government terminates the Contractor's right to proceed, liquidated damages will continue to accrue until the work is completed. These liquidated damages are in addition to excess costs of repurchase under the Termination clause.

(End of clause)

52.211-18 VARIATION IN ESTIMATED QUANTITY (APR 1984)

If the quantity of a unit-priced item in this contract is an estimated quantity and the actual quantity of the unit-priced item varies more than 15 percent above or below the estimated quantity, an equitable adjustment in the contract price shall be made upon demand of either party. The equitable adjustment shall be based upon any increase or decrease in costs due solely to the variation above 115 percent or below 85 percent of the estimated quantity. If the quantity variation is such as to cause an increase in the time necessary for completion, the Contractor may request, in writing, an extension of time, to be received by the Contracting Officer within 10 days from the beginning of the delay, or within such further period as may be granted by the Contracting Officer before the date of final settlement of the contract. Upon the receipt of a written request for an extension, the Contracting Officer shall ascertain the facts and make an adjustment for extending the completion date as, in the judgment of the Contracting Officer, is justified.

52.222-23 NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY FOR CONSTRUCTION (FEB 1999)

(a) The offeror's attention is called to the Equal Opportunity clause and the Affirmative Action Compliance Requirements for Construction clause of this solicitation.

(b) The goals for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Goals for minority participation for each trade	Goals for female participation for each trade
[Insert Goals]	[Insert Goals]

These goals are applicable to all the Contractor's construction work performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, the Contractor shall apply the goals established for the geographical area where the work is actually performed. Goals are published periodically in the Federal Register in notice form, and these notices may be obtained from any Office of Federal Contract Compliance Programs office.

(c) The Contractor's compliance with Executive Order 11246, as amended, and the regulations in 41 CFR 60-4 shall be based on (1) its implementation of the Equal Opportunity clause, (2) specific affirmative action obligations required by the clause entitled "Affirmative Action Compliance Requirements for Construction," and (3) its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade. The Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor, or from project to project, for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, Executive Order 11246, as amended, and the regulations in 41 CFR 60-4. Compliance with the goals will be measured against the total work hours performed.

(d) The Contractor shall provide written notification to the Deputy Assistant Secretary for Federal Contract Compliance, U.S. Department of Labor, within 10 working days following award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the --

(1) Name, address, and telephone number of the subcontractor;

(2) Employer's identification number of the subcontractor;

(3) Estimated dollar amount of the subcontract;

(4) Estimated starting and completion dates of the subcontract; and

(5) Geographical area in which the subcontract is to be performed.

(e) As used in this Notice, and in any contract resulting from this solicitation, the "covered area" is the City of Phoenix, Maricopa County, Arizona.

(End of provision)

52.228-12 PROSPECTIVE SUBCONTRACTOR REQUESTS FOR BONDS (OCT 1995)

In accordance with Section 806(a)(3) of Pub. L. 102-190, as amended by Sections 2091 and 8105 of Pub. L. 103-355, upon the request of a prospective subcontractor or supplier offering to furnish labor or material for the performance of this contract for which a payment bond has been furnished to the Government pursuant to the Miller Act, the Contractor shall promptly provide a copy of such payment bond to the requester.

(End of clause)

52.228-14 IRREVOCABLE LETTER OF CREDIT (DEC 1999)

(a) “Irrevocable letter of credit” (ILC), as used in this clause, means a written commitment by a federally insured financial institution to pay all or part of a stated amount of money, until the expiration date of the letter, upon presentation by the Government (the beneficiary) of a written demand therefor. Neither the financial institution nor the offeror/Contractor can revoke or condition the letter of credit.

(b) If the offeror intends to use an ILC in lieu of a bid bond, or to secure other types of bonds such as performance and payment bonds, the letter of credit and letter of confirmation formats in paragraphs (e) and (f) of this clause shall be used.

(c) The letter of credit shall be irrevocable, shall require presentation of no document other than a written demand and the ILC (including confirming letter, if any), shall be issued/confirmed by an acceptable federally insured financial institution as provided in paragraph (d) of this clause, and--

(1) If used as a bid guarantee, the ILC shall expire no earlier than 60 days after the close of the bid acceptance period;

(2) If used as an alternative to corporate or individual sureties as security for a performance or payment bond, the offeror/Contractor may submit an ILC with an initial expiration date estimated to cover the entire period for which financial security is required or may submit an ILC with an initial expiration date that is a minimum period of one year from the date of issuance. The ILC shall provide that, unless the issuer provides the beneficiary written notice of non-renewal at least 60 days in advance of the current expiration date, the ILC is automatically extended without amendment for one year from the expiration date, or any future expiration date, until the period of required coverage is completed and the Contracting Officer provides the financial institution with a written statement waiving the right to payment. The period of required coverage shall be:

(i) For contracts subject to the Miller Act, the later of--

(A) One year following the expected date of final payment;

(B) For performance bonds only, until completion of any warranty period; or

(C) For payment bonds only, until resolution of all claims filed against the payment bond during the one-year period following final payment.

(ii) For contracts not subject to the Miller Act, the later of--

(A) 90 days following final payment; or

(B) For performance bonds only, until completion of any warranty period.

(d) Only federally insured financial institutions rated investment grade or higher shall issue or confirm the ILC. The offeror/Contractor shall provide the Contracting Officer a credit rating that indicates the financial institution has the required rating(s) as of the date of issuance of the ILC. Unless the financial institution issuing the ILC had letter of credit business of less than $25 million in the past year, ILCs over $5 million must be confirmed by another acceptable financial institution that had letter of credit business of less than $25 million in the past year.

(e) The following format shall be used by the issuing financial institution to create an ILC:

_____

[Issuing Financial Institution's Letterhead or Name and Address]

Issue Date _____

IRREVOCABLE LETTER OF CREDIT NO. _____

Account party's name _____

Account party's address _____

For Solicitation No. _____(for reference only)

TO: [U.S. Government agency]

[U.S. Government agency's address]

1. We hereby establish this irrevocable and transferable Letter of Credit in your favor for one or more drawings up to United States $_____. This Letter of Credit is payable at [issuing financial institution's and, if any, confirming financial institution's] office at [issuing financial institution's address and, if any, confirming financial institution's address] and expires with our close of business on _____, or any automatically extended expiration date.

2. We hereby undertake to honor your or the transferee's sight draft(s) drawn on the issuing or, if any, the confirming financial institution, for all or any part of this credit if presented with this Letter of Credit and confirmation, if any, at the office specified in paragraph 1 of this Letter of Credit on or before the expiration date or any automatically extended expiration date.

3. [This paragraph is omitted if used as a bid guarantee, and subsequent paragraphs are renumbered.] It is a condition of this Letter of Credit that it is deemed to be automatically extended without amendment for one year from the expiration date hereof, or any future expiration date, unless at least 60 days prior to any expiration date, we notify you or the transferee by registered mail, or other receipted means of delivery, that we elect not to consider this Letter of Credit renewed for any such additional period. At the time we notify you, we also agree to notify the account party (and confirming financial institution, if any) by the same means of delivery.

4. This Letter of Credit is transferable. Transfers and assignments of proceeds are to be effected without charge to either the beneficiary or the transferee/assignee of proceeds. Such transfer or assignment shall be only at the written direction of the Government (the beneficiary) in a form satisfactory to the issuing financial institution and the confirming financial institution, if any.

5. This Letter of Credit is subject to the Uniform Customs and Practice (UCP) for Documentary Credits, 1993 Revision, International Chamber of Commerce Publication No. 500, and to the extent not inconsistent therewith, to the laws of _____ [state of confirming financial institution, if any, otherwise state of issuing financial institution].

6. If this credit expires during an interruption of business of this financial institution as described in Article 17 of the UCP, the financial institution specifically agrees to effect payment if this credit is drawn against within 30 days after the resumption of our business.

Sincerely,

_____

[Issuing financial institution]

(f) The following format shall be used by the financial institution to confirm an ILC:

_____
[Confirming Financial Institution's Letterhead or Name and Address]

(Date) _____

Our Letter of Credit Advice Number _____

Beneficiary: _____ [U.S. Government agency]

Issuing Financial Institution: _____

Issuing Financial Institution's LC No.: _____

Gentlemen:

1. We hereby confirm the above indicated Letter of Credit, the original of which is attached, issued by _____ [name of issuing financial institution] for drawings of up to United States dollars _____/U.S. $_____ and expiring with our close of business on _____ [the expiration date], or any automatically extended expiration date.

2. Draft(s) drawn under the Letter of Credit and this Confirmation are payable at our office located at _____.

3. We hereby undertake to honor sight draft(s) drawn under and presented with the Letter of Credit and this Confirmation at our offices as specified herein.

4. [This paragraph is omitted if used as a bid guarantee, and subsequent paragraphs are renumbered.] It is a condition of this confirmation that it be deemed automatically extended without amendment for one year from the expiration date hereof, or any automatically extended expiration date, unless:

(a) At least 60 days prior to any such expiration date, we shall notify the Contracting Officer, or the transferee and the issuing financial institution, by registered mail or other receipted means of delivery, that we elect not to consider this confirmation extended for any such additional period; or

(b) The issuing financial institution shall have exercised its right to notify you or the transferee, the account party, and ourselves, of its election not to extend the expiration date of the Letter of Credit.

5. This confirmation is subject to the Uniform Customs and Practice (UCP) for Documentary Credits, 1993 Revision, International Chamber of Commerce Publication No. 500, and to the extent not inconsistent therewith, to the laws of _____ [state of confirming financial institution].

6. If this confirmation expires during an interruption of business of this financial institution as described in Article 17 of the UCP, we specifically agree to effect payment if this credit is drawn against within 30 days after the resumption of our business.

Sincerely,

_____

[Confirming financial institution]

(g) The following format shall be used by the Contracting Officer for a sight draft to draw on the Letter of Credit:

SIGHT DRAFT

_____

[City, State]

(Date) _____

[Name and address of financial institution]

Pay to the order of _____ [Beneficiary Agency] _____ the sum of United States $_____. This draft is drawn under Irrevocable Letter of Credit No. _____.

_____

[Beneficiary Agency]

By: _____

(End of clause)

52.228-15 Performance and Payment Bonds--Construction (JUL 2000)

(a) Definitions. As used in this clause--

Original contract price means the award price of the contract; or, for requirements contracts, the price payable for the estimated total quantity; or, for indefinite-quantity contracts, the price payable for the specified minimum quantity. Original contract price does not include the price of any options, except those options exercised at the time of contract award.

(b) Amount of required bonds. Unless the resulting contract price is $100,000 or less, the successful offeror shall furnish performance and payment bonds to the Contracting Officer as follows:

(1) Performance bonds (Standard Form 25). The penal amount of performance bonds at the time of contract award shall be 100 percent of the original contract price.

(2) Payment Bonds (Standard Form 25-A). The penal amount of payment bonds at the time of contract award shall be 100 percent of the original contract price.

(3) Additional bond protection. (i) The Government may require additional performance and payment bond protection if the contract price is increased. The increase in protection generally will equal 100 percent of the increase in contract price.

(ii) The Government may secure the additional protection by directing the Contractor to increase the penal amount of the existing bond or to obtain an additional bond.

(c) Furnishing executed bonds. The Contractor shall furnish all executed bonds, including any necessary reinsurance agreements, to the Contracting Officer, within the time period specified in the Bid Guarantee provision of the solicitation, or otherwise specified by the Contracting Officer, but in any event, before starting work.

(d) Surety or other security for bonds. The bonds shall be in the form of firm commitment, supported by corporate sureties whose names appear on the list contained in Treasury Department Circular 570, individual sureties, or by other acceptable security such as postal money order, certified check, cashier's check, irrevocable letter of credit, or, in accordance with Treasury Department regulations, certain bonds or notes of the United States. Treasury Circular 570 is published in the Federal Register or may be obtained from the U.S. Department of Treasury, Financial Management Service, Surety Bond Branch, 401 14th Street, NW, 2nd Floor, West Wing, Washington, DC 20227.

(e) Notice of subcontractor waiver of protection (40 U.S.C. 270b(c). Any waiver of the right to sue on the payment bond is void unless it is in writing, signed by the person whose right is waived, and executed after such

person has first furnished labor or material for use in the performance of the contract.

(End of clause)

EFARS 52-231-5000 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE (MAR 1995)

(a) Allowable costs 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 for each piece of equipment or groups of similar serial and series for which the Government can determine both ownership and operating costs from the contractor's accounting records. When both ownership and operating costs cannot be determined for any piece of equipment or groups of similar serial or series equipment from the contractor's accounting records, costs for that equipment shall be based upon the applicable provisions of EP 1110-1-8, "Construction Equipment Ownership and Operating Expense Schedule," Region VII. Working conditions shall be considered to be average for determining equipment rates 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.

(b) 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.

(c) 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 of pricing data submitted are accurate, complete and current.

(End of clause)

52.232-33 PAYMENT BY ELECTRONIC FUNDS TRANSFER—CENTRAL CONTRACTOR REGISTRATION (MAY 1999)

(a) Method of payment. (1) All payments by the Government under this contract shall be made by electronic funds transfer (EFT), except as provided in paragraph (a)(2) of this clause. As used in this clause, the term “EFT” refers to the funds transfer and may also include the payment information transfer.

(2) In the event the Government is unable to release one or more payments by EFT, the Contractor agrees to either--

(i) Accept payment by check or some other mutually agreeable method of payment; or

(ii) Request the Government to extend the payment due date until such time as the Government can make payment by EFT (but see paragraph (d) of this clause).

(b) Contractor's EFT information. The Government shall make payment to the Contractor using the EFT information contained in the Central Contractor Registration (CCR) database. In the event that the EFT information changes, the Contractor shall be responsible for providing the updated information to the CCR database.

(c) Mechanisms for EFT payment. The Government may make payment by EFT through either the Automated Clearing House (ACH) network, subject to the rules of the National Automated Clearing House Association, or the Fedwire Transfer System. The rules governing Federal payments through the ACH are contained in 31 CFR part 210.

(d) Suspension of payment. If the Contractor's EFT information in the CCR database is incorrect, then the Government need not make payment to the Contractor under this contract until correct EFT information is entered into the CCR database; and any invoice or contract financing request shall be deemed not to be a proper invoice for the purpose of prompt payment under this contract. The prompt payment terms of the contract regarding notice of an improper invoice and delays in accrual of interest penalties apply.

(e) Contractor EFT arrangements. If the Contractor has identified multiple payment receiving points (i.e., more than one remittance address and/or EFT information set) in the CCR database, and the Contractor has not notified the Government of the payment receiving point applicable to this contract, the Government shall make payment to the first payment receiving point (EFT information set or remittance address as applicable) listed in the CCR database.

(f) Liability for uncompleted or erroneous transfers. (1) If an uncompleted or erroneous transfer occurs because the Government used the Contractor's EFT information incorrectly, the Government remains responsible for--

(i) Making a correct payment;

(ii) Paying any prompt payment penalty due; and

(iii) Recovering any erroneously directed funds.

(2) If an uncompleted or erroneous transfer occurs because the Contractor's EFT information was incorrect, or was revised within 30 days of Government release of the EFT payment transaction instruction to the Federal Reserve System, and--

(i) If the funds are no longer under the control of the payment office, the Government is deemed to have made payment and the Contractor is responsible for recovery of any erroneously directed funds; or

(ii) If the funds remain under the control of the payment office, the Government shall not make payment, and the provisions of paragraph (d) of this clause shall apply.

(g) EFT and prompt payment. A payment shall be deemed to have been made in a timely manner in accordance with the prompt payment terms of this contract if, in the EFT payment transaction instruction released to the Federal Reserve System, the date specified for settlement of the payment is on or before the prompt payment due date, provided the specified payment date is a valid date under the rules of the Federal Reserve System.

(h) EFT and assignment of claims. If the Contractor assigns the proceeds of this contract as provided for in the assignment of claims terms of this contract, the Contractor shall require as a condition of any such assignment, that the assignee shall register in the CCR database and shall be paid by EFT in accordance with the terms of this clause. In all respects, the requirements of this clause shall apply to the assignee as if it were the Contractor. EFT information that shows the ultimate recipient of the transfer to be other than the Contractor, in the absence of a proper assignment of claims acceptable to the Government, is incorrect EFT information within the meaning of paragraph (d) of this clause.

(i) Liability for change of EFT information by financial agent. The Government is not liable for errors resulting from changes to EFT information made by the Contractor's financial agent.

(j) Payment information. The payment or disbursing office shall forward to the Contractor available payment information that is suitable for transmission as of the date of release of the EFT instruction to the Federal Reserve System. The Government may request the Contractor to designate a desired format and method(s) for delivery of payment information from a list of formats and methods the payment office is capable of executing. However, the Government does not guarantee that any particular format or method of delivery is available at any particular payment office and retains the latitude to use the format and delivery method most convenient to the Government. If the Government makes payment by check in accordance with paragraph (a) of this clause, the Government shall mail the payment information to the remittance address contained in the CCR database.

(End of Clause)

52.232-4001 CONTINUING CONTRACTS (ALTERNATE) (MAR 1995) EFARS 52-232-5002

(a) Funds are not available at the inception of this contract to cover the entire contract price. The sum of $300,000.00 has been reserved for this contract and is available for payment to the contractor during the current fiscal year. It is expected that Congress will make appropriations for future fiscal years from which additional funds, together with funds provided by one or more non-federal project sponsors will be reserved for this contract. The liability of the United States for payment beyond the funds reserved for this contract is contingent on the reservation of additional funds.

(b) Failure to make payment in excess of the amount currently reserved, or that may be reserved from time to time, shall not be considered a breach of this contract, and shall not entitle the contractor to a price adjustment under the terms of this contract except as specifically provided in paragraphs (e) and (h) below.

(c) The Government may at any time reserve additional funds for payments under the contract if there are funds available for such purpose. The contracting officer will promptly notify the contractor of any additional funds reserved for the contract by issuing and administrative modification to the contract.

(d) If earnings will be such that funds reserved for the contract will be exhausted before the end of any fiscal year, the contractor shall give written notice to the contracting officer of the estimated date of exhaustion and of additional funds which will be needed to meet payments due or to become due under this contract during that fiscal year. This notice shall be given not less than 45 nor more than 60 days prior to the estimated date of exhaustion.

(e) No payments will be made after exhaustion of funds except to the extent that additional funds are reserved for the contract. If and when sufficient additional funds are reserved, the contractor shall be entitled to simple interest on any payment that the contracting officer determines was actually earned under the terms of this contract and would have been made except for exhaustion of funds. Interest shall be computed from the time such payment would otherwise have been made until actually or constructively made, and shall be at the rate established by the Secretary of the Treasury pursuant to Public Law 92-41, 85 Stat 97, as in effect on the first day of the delay in such payment.

(f) Any suspension, delay, or interruption of work arising from exhaustion or anticipated exhaustion of funds shall not constitute a breach of this contract and shall not entitle the contractor to any price adjustment under a "Suspension of Work" or similar clause or in any other manner under this contract.

(g) An equitable adjustment in performance time shall be made for any increase in the time required for performance of any part of the work arising from exhaustion of funds or the reasonable anticipation of exhaustion of funds.

(h) If, upon the expiration of sixty (60) days after the beginning of the fiscal year following an exhaustion of funds, the Government has failed to reserve sufficient additional funds to cover payments otherwise due, the contractor, by written notice delivered to the contracting officer at any time before such additional funds are reserved, may elect to treat his right to proceed with the work as having been terminated. Such a termination shall be at no cost to the Government, except that, to the extent that additional funds to make payment therefore are allocated to this contract, it may be treated as a termination for the convenience of the Government.

(i) If at any time it becomes apparent that the funds reserved for any fiscal year are in excess of the funds required to meet all payments due or to become due the contractor because of work performed and to be performed under this contract during the fiscal year, the Government reserves the right, after notice to the contractor, to reduce said reservation by the amount of such excess.

(j) The term "Reservation" means monies that have been set aside and made available for payments under this contract.

(End of clause)

52.236-4 PHYSICAL DATA (APR 1984)

Data and information furnished or referred to below is for the Contractor's information. The Government shall not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.

(a) The indications of physical conditions on the drawings and in the specifications are the result of site investigations by . . . . . [insert a description of investigational methods used, such as surveys, auger borings, core borings, test pits, probings, test tunnels].

(b) Weather conditions . . . . . (insert a summary of weather records and warnings).

(c) Transportation facilities . . . . . (insert a summary of transportation facilities providing access from the site, including information about their availability and limitations.

(d) . . . . . (insert other pertinent information).

(End of clause)

52.236-16 QUANTITY SURVEYS (APR 1984) - ALTERNATE I (APR 1984)

(a) Quantity surveys shall be conducted, and the data derived from these surveys shall be used in computing the quantities of work performed and the actual construction completed and in place.

(b) The Contractor shall conduct the original and final surveys and surveys for any periods for which progress payments are requested. All these surveys shall be conducted under the direction of a representative of the Contracting Officer, unless the Contracting Officer waives this requirement in a specific instance. The Government shall make such computations as are necessary to determine the quantities of work performed or finally in place. The Contractor shall make the computations based on the surveys for any periods for which progress payments are requested.

(c) Promptly upon completing a survey, the Contractor shall furnish the originals of all field notes and all other records relating to the survey or to the layout of the work to the Contracting Officer, who shall use them as necessary to determine the amount of progress payments. The

Contractor shall retain copies of all such material furnished to the Contracting Officer.

(End of clause)

52.236-21 SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION (FEB 1997)

(a) The Contractor shall keep on the work site a copy of the drawings and specifications and shall at all times give the Contracting Officer access thereto. Anything mentioned in the specifications and not shown on the drawings, or shown on the drawings and not mentioned in the specifications, shall be of like effect as if shown or mentioned in both. In case of difference between drawings and specifications, the specifications shall

govern. In case of discrepancy in the figures, in the drawings, or in the specifications, the matter shall be promptly submitted to the Contracting Officer, who shall promptly make a determination in writing. Any adjustment by the Contractor without such a determination shall be at its own risk and expense. The Contracting Officer shall furnish from time to time such detailed drawings and other information as considered necessary, unless otherwise provided.

(b) Wherever in the specifications or upon the drawings the words "directed", "required", "ordered", "designated", "prescribed", or words of like import are used, it shall be understood that the "direction", "requirement", "order", "designation", or "prescription", of the Contracting Officer is intended and similarly the words "approved", "acceptable", "satisfactory", or words of like import shall mean "approved by," or "acceptable to", or "satisfactory to" the Contracting Officer, unless otherwise expressly stated.

(c) Where "as shown," as indicated", "as detailed", or words of similar import are used, it shall be understood that the reference is made to the drawings accompanying this contract unless stated otherwise. The word "provided" as used herein shall be understood to mean "provide complete in place," that is "furnished and installed".

(d) Shop drawings means drawings, submitted to the Government by the Contractor, subcontractor, or any lower tier subcontractor pursuant to a construction contract, showing in detail (1) the proposed fabrication and assembly of structural elements, and (2) the installation (i.e., fit, and attachment details) of materials or equipment. It includes drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials furnished by the contractor to explain in detail specific portions of the work required by the contract. The Government may duplicate, use, and disclose in any manner and for any purpose shop drawings delivered under this contract.

(e) If this contract requires shop drawings, the Contractor shall coordinate all such drawings, and review them for accuracy, completeness, and compliance with contract requirements and shall indicate its approval thereon as evidence of such coordination and review. Shop drawings submitted to the Contracting Officer without evidence of the Contractor's approval may be returned for resubmission. The Contracting Officer will indicate an approval or disapproval of the shop drawings and if not approved as submitted shall indicate the Government's reasons therefore. Any work done before such approval shall be at the Contractor's risk. Approval by the Contracting Officer shall not relieve the Contractor from responsibility for any errors or omissions in such drawings, nor from responsibility for complying with the requirements of this contract, except with respect to variations described and approved in accordance with (f) below.

(f) If shop drawings show variations from the contract requirements, the Contractor shall describe such variations in writing, separate from the drawings, at the time of submission. If the Contracting Officer approves any such variation, the Contracting Officer shall issue an appropriate contract modification, except that, if the variation is minor or does not involve a change in price or in time of performance, a modification need not be issued.

(g) The Contractor shall submit to the Contracting Officer for approval four copies (unless otherwise indicated) of all shop drawings as called for under the various headings of these specifications. Three sets (unless otherwise

indicated) of all shop drawings, will be retained by the Contracting Officer and one set will be returned to the Contractor.

(End of clause)

EFARS 52.236-5000 PLANT AND MATERIAL REMOVAL AFTER CONTRACT TERMINATION (MAR 1995)

Should this contract be terminated as provided in clause 52.232-5001 because of the failure of Congress to provide additional funds for its completion, the contractor may be permitted to remove plant and material on which payments for preparatory work have been made, subject to an equitable deduction from the amounts due the contractor to reimburse the United States for the unabsorbed value of such plant and material.

(End of clause)

EFARS 52.249-5000 BASIS FOR SETTLEMENT OF PROPOSALS

Actual costs will be used to determine equipment costs for a settlement proposal submitted on the total cost basis under FAR 49.206-2(b). In evaluating a terminations settlement proposal using the total costs basis, the following principals will be applied to determine allowable equipment costs:

(1) Actual costs for each piece of equipment, or groups of similar serial or series equipment, need not be available in the contractor's accounting records to determine total actual equipment costs.

(2) If equipment costs have been allocated to a contract using predetermined rates, those charges will be adjusted to actual costs.

(3) Recorded job costs adjusted for unallowable and unallowable expenses will be used to determine equipment operating expenses.

(4) Ownership costs (depreciation) will be determined using the contractor's depreciation schedule (subject to the provisions of FAR 31.205-11).

(5) License, taxes, storage and insurance costs age normally recovered as an indirect expense and unless the contractor charges these costs directly to contracts, they will be recover through the indirect expense rate.

(End of Statement)

252.236-7001 CONTRACT DRAWINGS, MAPS, AND SPECIFICATIONS (AUG 2000)

(a) The Government will provide to the Contractor, without charge, one set of contract drawings and specifications, except publications incorporated into the technical provisions by reference, in electronic or paper media as chosen by the Contracting Officer.

(b) The Contractor shall--

(1) Check all drawings furnished immediately upon receipt;

(2) Compare all drawings and verify the figures before laying out the work;

(3) Promptly notify the Contracting Officer of any discrepancies;

(4) Be responsible for any errors that might have been avoided by complying with this paragraph (b); and

(5) Reproduce and print contract drawings and specifications as needed.

(c) In general--

(1) Large-scale drawings shall govern small-scale drawings; and

(2) The Contractor shall follow figures marked on drawings in preference to scale measurements.

(d) Omissions from the drawings or specifications or the misdescription of details of work that are manifestly necessary to carry out the intent of the drawings and specifications, or that are customarily performed, shall not relieve the Contractor from performing such omitted or misdescribed details of the work. The Contractor shall perform such details as if fully and correctly set forth and described in the drawings and specifications.

(e) The work shall conform to the specifications and the contract drawings identified on the following index of drawings:

Title	File	Drawing No.

(End of clause)

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							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
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		01200	SD-01 Preconstruction Submittals															
			Temporary Electrical Layout Plan	1.5.1	FIO													
			Contractor's Work Area Plan	1.17.1	FIO													
			Storm Water Management Plan		FIO													
		01270	SD-03 Product Data															
			Weight Certificates	1.3.24.2	G RE													
		01355	SD-01 Preconstruction Submittals															
			Environmental Protection Plan	1.7	G RE													
			Health and Safety Plan	1.7.4	G RE													
		01356	SD-07 Certificates															
			Mill Certificate or Affidavit	2.1.3	FIO													
		02230	SD-03 Product Data															
			Herbicide for Treatment of Plant		FIO													
			Roots															
		02300	SD-01 Preconstruction Submittals															
			Excavation Plan		FIO													
			SD-06 Test Reports															
			Testing	3.14	FIO													
			SD-07 Certificates															
			Testing	3.14	FIO													
		02316	SD-06 Test Reports															
			Field Density Tests	3.3.3	FIO													
			Testing of Backfill Materials	3.3.2	FIO													
		02371	SD-04 Samples															
			Gabions or Mattresses		FIO													
			Alternative Wire Fasteners	2.1.2	FIO													

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		02371	SD-06 Test Reports															
			Gabions or Mattresses		FIO													
			Alternative Wire Fasteners	2.1.2	FIO													
			SD-07 Certificates															
			Stone Fill	2.1.4	FIO													
			Filter Material	2.1.5	FIO													
		02373	SD-03 Product Data															
			Material		FIO													
			Manufacturing Quality Control		FIO													
			Manual Sampling and Testing															
			SD-04 Samples															
			Quality Assurance Samples and	3.1	FIO													
			Tests															
			SD-07 Certificates															
			Geotextile		FIO													
		02377	SD-03 Product Data															
			Materials Handling Plan	3.1.1	G	RE												
			Commercial Testing Laboratory	3.1.7	G	RE												
			SD-04 Samples															
			Clay	2.1	G	RE												
			Quality Assurance Samples	3.4.4	G	RE												
			SD-06 Test Reports															
			Clay	2.1	G	RE												
			Borrow Source Assessment	3.1	G	RE												
			Assessment Tests	3.1	G	RE												

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		02377	Moisture Content and Density	3.4.2	G	RE												
			Tests of In-Place Clay															
			Hydraulic Conductivity Tests of	3.4.3	G	RE												
			In-Place Clay															
		02510	SD-07 Certificates															
			Manufacturer's Certification	2.1	FIO													
		02531	SD-07 Certificates															
			Joints	2.3	G	RE												
		02630	SD-03 Product Data															
			Placing Pipe	3.3	G	RE												
			SD-04 Samples															
			Pipe for Culverts and Storm	2.1	G	RE												
			Drains															
			SD-07 Certificates															
			Resin Certification	2.1.5	FIO													
			Resin Certification	2.1.6	FIO													
			Pipeline Testing	3.7	FIO													
			Hydrostatic Test on Watertight	2.5	FIO													
			Joints															
			Frame and Cover for Gratings	2.3.5	FIO													
		02661B	SD-03 Product Data															
			Geomembrane		FIO													
			Polymer Resin		FIO													
			SD-04 Samples															
			Quality Assurance Program		FIO													
			SD-07 Certificates															

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		02661B	Manufacturer's Certificate of		FIO													
			Compliance															
			Geomembrane Installer's		FIO													
			Certification of Subsurface															
			Acceptability															
			Geomembrane Installer's		FIO													
			Certificate of Proper Installation															
		02666B	SD-01 Preconstruction Submittals															
			Quality Control Plan		FIO													
			Installer Qualifications		FIO													
			Borrow Source(s)		FIO													
			Source of Water		FIO													
			Moisture Control Plan		FIO													
			SD-02 Shop Drawings															
			Soil-Bentonite		FIO													
			SD-03 Product Data															
			Soil-Bentonite		FIO													
			Test Fill Plan		FIO													
			Stormwater Control and Erosion		FIO													
			Control Plans															
			SD-04 Samples															
			Soils		FIO													
			SD-06 Test Reports															
			Laboratory Testing Equipment		FIO													
			Bentonite Use Monitoring		FIO													
		02722	SD-03 Product Data															

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		02722	Plant, Equipment, and Tools	1.6	FIO													
			Waybills and Delivery Tickets		FIO													
			SD-06 Test Reports															
			Sampling and testing	1.4	FIO													
			Field Density Tests	1.4.2.4	FIO													
		02741	SD-03 Product Data															
			Mix Design	2.3	G													
			Contractor Quality Control	3.10	G													
			Material Acceptance and Percent	3.11	G													
			Payment															
			SD-04 Samples															
			Asphalt Cement Binder	2.2	FIO													
			Aggregates	2.1	FIO													
			SD-06 Test Reports															
			Aggregates	2.1	G													
			QC Monitoring	3.10.3.10	FIO													
			SD-07 Certificates															
			Asphalt Cement Binder	2.2	G													
			Testing Laboratory	3.6	FIO													
		02763	SD-03 Product Data															
			Equipment	1.4	G													
			Composition Requirements	2.2.1	FIO													
			Qualifications		FIO													
			SD-06 Test Reports															
			Sampling and Testing	2.6	FIO													
			SD-07 Certificates															

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		02763	Volatile Organic Compound	2.2.3	FIO													
			(VOC)															
		02770	SD-03 Product Data															
			Concrete	2.1	FIO													
			SD-06 Test Reports															
			Field Quality Control	3.8	FIO													
		02811	SD-02 Shop Drawings															
			Temporary Drip Irrigation System		FIO													
			SD-03 Product Data															
			Framed Instructions	3.3	FIO													
			Field Training	3.4	FIO													
			Drip Irrigation System	3.1	FIO													
			Spare Parts		FIO													
			Design Analysis and Calculations		FIO													
			SD-06 Test Reports															
			Field Tests	3.2	FIO													
			SD-07 Certificates															
			Drip Irrigation System	3.1	FIO													
			SD-10 Operation and Maintenance															
			Data															
			Drip Irrigation System	3.1	FIO													
			SD-11 Closeout Submittals															
			Record Drawings		FIO													
		02821	SD-07 Certificates															
			Chain Link Fence	2.1.1	FIO													
		02870	SD-02 Shop Drawings															

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		02870	Site Furnishing Standards	2.5	G													
			SD-03 Product Data															
			Site Furnishings	1.4	G													
			Installation	3.1	G													
			Materials	2.1	G													
			SD-04 Samples															
			Finish	2.4	G													
			SD-06 Test Reports															
			Recycled Material		G													
			Testing	3.1.4	G													
		02915	SD-02 Shop Drawings															
			Finished Grade and Topsoil	3.2.1	G	RE												
			Underground Utilities	3.1.4	G	RE												
			Delivered Topsoil	1.7.1	G	RE												
			Obstructions Below Ground	3.3.1	FIO													
			G< RE		FIO													
			SD-03 Product Data															
			Super Absorbent Polymers	2.2.4.2	G	RE												
			Equipment	1.4	G	RE												
			Transplanting Plan	1.4	G	RE												
			Maintenance Record	3.9.2.6	FIO													
			SD-06 Test Reports															
			Soil Test	3.1.6.2	G													
			Percolation Test	3.1.6.1	G													
			Recycled Compost	2.2.3.2	G													
			SD-07 Certificates															

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		02915	Topsoil	2.1	G													
			Fertilizer	2.2.2	G													
			Soil Conditioner	2.2.4	G													
			pH Adjuster	2.2.1	G													
			Pesticide	2.11	G													
			SD-10 Operation and Maintenance															
			Data															
			Maintenance Instructions	3.9.5	G													
		02921	SD-03 Product Data															
			Equipment	2.9	G	RE												
			Surface Erosion Control Material	2.8	G	RE												
			Chemical Treatment Material	1.4.3	G	RE												
			Delivery	1.4.1	G	RE												
			Finished Grade and Topsoil	3.2.1	G	RE												
			Topsoil	2.2	G	RE												
			Quantity Check	3.5	G	RE												
			Seed Establishment Period	3.9	G	RE												
			Maintenance Record	3.9.4.5	G	RE												
			Application of Pesticide	3.6	G	RE												
			SD-04 Samples															
			Delivered Topsoil	1.4.1.1	G	RE												
			Soil Amendments	2.3	G	RE												
			Mulch	2.4	G													
			SD-06 Test Reports															
			Equipment Calibration	3.1.3	G	RE												
			Soil Test	3.1.4	G													

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ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH #	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					
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		02921	SD-07 Certificates															
			Seed	2.1	G													
			Topsoil	2.2	G													
			pH Adjuster	2.3.1	G													
			Fertilizer	2.3.2	G													
			Organic Material	2.3.4	G													
			Soil Conditioner	2.3.5	G													
			Mulch	2.4	G													
			Non-Asphaltic Adhesive	2.5	G													
			Pesticide	2.7	G													
		02930	SD-02 Shop Drawings															
			Shop Drawings	3.3.1	G	RE												
			Finished Grade, Topsoil and Underground Utilities	3.2.1	G	RE												
			SD-03 Product Data															
			Chemical Treatment Material	1.5.3.2	G	RE												
			Maintenance Record	3.9.2.6	G													
			Equipment	3.7.2	G	RE												
			Delivery	1.5.1	G	RE												
			Plant Establishment Period	3.9	G	RE												
			Application of Pesticide	3.7	G													
			SD-04 Samples															
			Delivered Topsoil	1.5.1.2	G													
			Soil Amendments	3.1.4.2	G													
			Mulch	2.4	G													
			SD-06 Test Reports															

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		02930	Soil Test	3.1.4.2	G													
			Percolation Test	3.1.4.1	G													
			SD-07 Certificates															
			Plant Material	2.1	G													
			Topsoil	2.2	G													
			pH Adjuster	2.3.1	G													
			Fertilizer	2.3.2	G													
			Organic Material	2.3.3	G													
			Soil Conditioner	2.3.4	G													
			Organic Mulch	2.4.2	G													
			Mycorrhizal Fungi Inoculum	2.11	G													
			Pesticide	2.13	G													
			SD-10 Operation and Maintenance															
			Data															
			Maintenance Instructions	3.9.5	G													
		02935	SD-03 Product Data															
			Chemical Treatment Material	1.4.3	G	RE												
			Work Plan and Schedule	1.4.5	G	RE												
			Delivery Schedule	1.4.1	G	RE												
			Maintenance Record	3.6.4	G	RE												
			Application of Pesticide	3.5	G	RE												
			SD-06 Test Reports															
			Soil Tests	3.1	G	RE												
			SD-07 Certificates															
			pH Adjuster	2.1.1	G													
			Fertilizer	2.1.2	G													

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		02935	Mulch	2.2	G													
			Soil Amendments	2.1	G													
			Pesticide	2.4	G													
		03215B	SD-03 Product Data															
			Manufacturer's catalog information		G	RE												
			SD-04 Samples															
			Random Samples		G	RE												
			SD-07 Certificates															
			Installer's Qualification		FIO													
			SD-08 Manufacturer’s Instructions															
			Anchors		FIO													
			SD-09 Manufacturer’s Field															
			Reports															
			Doweling System		FIO													
			Special Inspection Report		FIO													
		03307	SD-03 Product Data															
			Air-Entraining Admixture	2.1.3.1	G													
			Water-Reducing or Retarding	2.1.3.2	G													
			Admixture															
			Curing Materials	2.1.8	G													
			Reinforcing Steel	2.1.5	G													
			Joint Sealants - Field Molded	2.1.7	G													
			Sealants															
			Water Stops	2.1.9	G													
			Precast Wetwells		G													
			Conveying and Placing Concrete	3.2	G													

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		03307	SD-06 Test Reports															
			Aggregates	2.1.2	FIO													
			Concrete Mixture Proportions	1.3.4	FIO													
			RE		FIO													
			SD-07 Certificates															
			Cementitious Materials	2.1.1	FIO													
			Aggregates	2.1.2	FIO													
		03371	SD-06 Test Reports															
			Mixture Proportions	1.5	G													
			Aggregates	2.1.2	G													
			Accelerator Compatibility	2.1.4.1	G													
			Preconstruction Test Panels	1.8	G													
			SD-07 Certificates															
			Portland Cement	2.1.1.1	G													
			Pozzolans	2.1.1.3	G													
			Silica Fume	2.1.1.4	G													
			Accelerating Admixtures	2.1.4.1	G													
			Curing Materials	2.1.5	G													
			Qualifications	1.7	G													
		03600B	SD-02 Shop Drawings															
			Product data of grouts		G	RE												
			Proposed method for keeping		G	RE												
			existing concrete surfaces wet prior															
			to placing grout															
			Forming method for fluid grout		G	RE												
			placements															

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		03600B	Curing method for grout		G RE													
			SD-08 Manufacturer's Instructions															
			Manufacturer's Written		FIO													
			Instructions															
			Manufacturer's proposed training		FIO													
			schedule for grout work															
			Manufacturer's Certificate of		FIO													
			Compliance															
			Manufacturer's Certificate of		FIO													
			Proper Installation															
			Statements of Qualification:		FIO													
			Nonshrink grout manufacturer's															
			representative															
			SD-06 Test Reports															
			Test report for 24-hour evaluation		FIO													
			of nonshrink grout															
			Test results and service report		FIO													
			from demonstration and training															
			session															
			Field test reports and laboratory		FIO													
			test results for field-drawn Samples															
		04200	SD-02 Shop Drawings															
			Masonry Work		G RE													
			SD-03 Product Data															
			Prefaced Concrete Masonry Units	2.3	G RE													
			SD-04 Samples															

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		04200	Concrete Masonry Units (CMU)	2.2	G	RE												
			Prefaced Concrete Masonry Units	2.3	G	RE												
			Expansion-Joint Material		G	RE												
			Joint Reinforcement	2.6	G	RE												
			SD-06 Test Reports															
			Efflorescence Test		G	RE												
			Field Testing of Grout	3.14.1	G	RE												
			Special Inspection	1.4	G	RE												
			SD-07 Certificates															
			Concrete Masonry Units (CMU)	2.2	G	RE												
			Prefaced Concrete Masonry Units	2.3	G	RE												
			Reinforcing Steel Bars and Rods	2.7	G	RE												
			Masonry Cement		G	RE												
			Grout Admixtures		G	RE												
		05120	SD-02 Shop Drawings															
			Structural Steel System		G													
			Structural Connections	3.2.1	G													
			SD-03 Product Data															
			Erection	3.2	G													
			Welding	3.3	G													
			SD-04 Samples															
			Carbon Steel Bolts and Nuts	2.5	G													
			Nuts Dimensional Style	2.6	G													
			Washers	2.7	FIO													
			SD-07 Certificates															
			Mill Test Reports		G													

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		05120	Welder Qualifications		G													
			Welding Inspector	1.5	G													
			Fabrication	3.1	G													
		05300	SD-02 Shop Drawings															
			Deck Units	2.1	G													
			Accessories	2.4	G													
			Attachments	3.2	G													
			Holes and Openings	3.3	G													
			SD-03 Product Data															
			Deck Units	2.1	G													
			Attachments	3.2	G													
			SD-04 Samples															
			Deck Units	2.1	G													
			Accessories	2.4	FIO													
			SD-07 Certificates															
			Deck Units	2.1	G													
			Attachments	3.2	FIO													
		05500	SD-02 Shop Drawings															
			Miscellaneous Metal Items	1.7	G	RE												
			SD-04 Samples															
			Miscellaneous Metal Items	1.7	G	RE												
		07412	SD-02 Shop Drawings															
			Metal Roofing	1.7.1	G	RE												
			SD-04 Samples															
			Accessories	2.2	G	RE												
			Roof Panels	2.1	G	RE												

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		07412	Fasteners	2.3	G RE													
			Gaskets and Insulating	2.8	FIO													
			Compounds															
			Sealant	2.7	G RE													
			SD-07 Certificates															
			Roof Panels	2.1	FIO													
			Installation	3.1	FIO													
			Accessories	2.2	FIO													
			Insulation	2.5	G RE													
			Installer	1.3.3	FIO													
			Warranties	1.7	G RE													
		07600	SD-02 Shop Drawings															
			Covering on flat, sloped, or curved		G RE													
			surfaces															
			Gravel stops and fascias		G RE													
			Flashing at roof penetrations	3.1.9	G RE													
			Drip edge	3.1.8	G RE													
			SD-11 Closeout Submittals															
			Quality Control Plan		FIO													
		07920	SD-03 Product Data															
			Sealants	2.1	FIO													
			Primers	2.2	FIO													
			Bond breakers	2.3	FIO													
			Backstops	2.4	FIO													
		08110	SD-02 Shop Drawings															
			Doors	2.1	G G													

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		08110	Doors	2.1	G	G												
			Frames	2.3	G	G												
			Frames	2.3	G	G												
			Accessories		FIO													
			SD-03 Product Data															
			Doors	2.1	G	RE												
			Frames	2.3	G	RE												
			Accessories		FIO													
		08710	SD-02 Shop Drawings															
			Hardware schedule	1.3	G	RE												
			Keying system	2.2.5	FIO													
			SD-03 Product Data															
			Hardware items	2.2	G	RE												
			SD-08 Manufacturer's Instructions															
			Installation	3.1	FIO													
			SD-10 Operation and Maintenance															
			Data															
			Hardware Schedule items, Data		G	RE												
			Package 1															
			SD-11 Closeout Submittals															
			Key bitting	1.4	FIO													
		09900	SD-02 Shop Drawings															
			Piping identification		FIO													
			stencil		FIO													
			SD-03 Product Data															
			Coating	2.1	G	RE												

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		09900	Manufacturer's Technical Data	2.1	FIO													
			Sheets															
			SD-04 Samples															
			Color		G	RE												
			SD-07 Certificates															
			Applicator's qualifications		FIO													
			Qualification Testing		G	RE												
			SD-08 Manufacturer’s Instructions															
			Application instructions		FIO													
			Mixing	3.5.2	FIO													
			Manufacturer's Material Safety	1.5.2	FIO													
			Data Sheets															
			SD-10 Operation and Maintenance															
			Data															
			Coatings:	2.1	G	RE												
		09915	SD-04 Samples															
			Color Schedule	2.2	G	RE												
		09971	SD-06 Test Reports															
			Joint Sealant Qualification Test		G	RE												
			Reports															
			Coatings Qualification Test	1.4.2.1	G	RE												
			Reports															
			Coating Sample Test Reports	3.1.3	G	RE												
			Abrasive Sample Test Reports	3.1.4	G	RE												
			Daily Inspection Reports	3.6.2.2	G	RE												

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		09971	Recycled Metallic Abrasive Field	1.4.2.2	G	RE												
			Test Reports (Daily and Weekly)															
			SD-07 Certificates															
			Work Plan	1.4.3.1	G	RE												
			Qualifications of Certified	1.4.3.2	G	RE												
			Industrial Hygienist (CIH)															
			Qualifications of Testing	1.4.3.3	G	RE												
			Laboratory for Coatings															
			Qualifications of Testing	1.4.3.4	G	RE												
			Laboratory for Abrasive															
			Qualifications of Coating	1.4.3.5	G	RE												
			Contractors															
			Qualifications of Coating	1.4.3.6	G	RE												
			Manufacturer's Representative															
			Joint Sealant Materials		G	RE												
			Coating Materials	1.4.3.7	G	RE												
			Coating System Component	1.4.3.8	G	RE												
			Compatibility															
			Non-metallic Abrasive	1.4.3.9	G	RE												
			Metallic Abrasive	1.4.3.10	G	RE												
			SD-08 Manufacturer’s Instructions															
			Joint Sealant Instructions		G	RE												
			Coating System Instructions	1.4.4.1	G	RE												
			SD-11 Closeout Submittals															
			Disposal of Used Abrasive	3.4.5	G	RE												
			Inspection Logbook	3.6.2.3	G	RE												

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		10800	SD-03 Product Data															
			Finishes	2.1.2	G	RE												
			Accessory Items	2.2	G	RE												
			SD-04 Samples															
			Finishes	2.1.2	G	RE												
			Accessory Items	2.2	G	RE												
			SD-10 Operation and Maintenance															
			Data															
			Electric Hand Dryer	2.2.2	G													
		11212	SD-02 Shop Drawings															
			Adjustable Frequency Drives		G	RE												
			Installation	3.1	FIO													
			SD-03 Product Data															
			Vertical Turbine Pumping Units	2.1.1	G	RE												
			Spare Parts		FIO													
			Vertical Turbine Pump System		FIO													
			SD-06 Test Reports															
			Factory Test Report		G	RE												
			Field Test Report		G	RE												
			Installation and Start-Up Engineer		FIO													
			SD-10 Operation and Maintenance															
			Data															
			Vertical Turbine Pumping Units	2.1.1	FIO													
		11214	SD-02 Shop Drawings															
			Installation	3.1	FIO													
			SD-03 Product Data															

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		11214	Vertical Turbine Pumping Units	2.1.1	G RE													
			Spare Parts		FIO													
			Vertical Turbine Pump System		G RE													
			Computations		FIO													
			SD-06 Test Reports															
			Testing	3.3	G													
			SD-10 Operation and Maintenance															
			Data															
			Vertical Turbine Pumping Units	2.1.1	G													
		11312	SD-02 Shop Drawings															
			Submersible Pump		G RE													
			SD-03 Product Data															
			Materials		FIO													
			Equipment Supplies and		FIO													
			Performance															
			Spare Parts		FIO													
			Computations		G RE													
			Installation Instruction Manual		G RE													
			Factory Test		FIO													
			Pump Field Tests		G													
			SD-06 Test Reports															
			Factory Test Report		G													
			Field Test Report		G													
			Installation and Start-Up Engineer		FIO													
			SD-10 Operation and Maintenance															
			Data															

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		11312	Operating and Maintenance		G													
			Instruction															
		13405	SD-02 Shop Drawings															
			Installation	3.1.1	G	RE												
			Wiring	3.1.1	G	RE												
			SD-03 Product Data															
			Instrumentation and Control	3.7	G	RE												
			System															
			Meters and Sensors	2.2	G	RE												
			Training Manual	3.8	G	RE												
			Performance Verification Test	3.5.2	G	RE												
			(PVT)															
			Factory Test Procedure	2.7.2	G	RE												
			SD-06 Test Reports															
			Factory Test Report	2.7.3	G	RE												
			Testing, Adjusting and	3.5.1	G	RE												
			Commissioning															
			Performance Verification	3.5.2	G	RE												
			Test(PVT)															
			Endurance Test	3.5.3	G	RE												
			SD-07 Certificates															
			Sensor and Control Wiring	3.3.1.2	G	RE												
			Testing of Ground Rods	3.5.1	G	RE												
			SD-10 Operation and Maintenance															
			Data															

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		13405	Instrumentation and Control	3.7	G	RE												
			System															
		15060	SD-02 Shop Drawings															
			Piping Support System		G	RE												
			SD-10 Operation and Maintenance															
			Data															
			Piping Support System		G	RE												
		15081	SD-03 Product Data															
			Insulation	1.2	FIO													
			Jacket	2.2	FIO													
			Jacket	2.4	FIO													
			SD-08 Manufacturer's Instructions															
			field-applied insulation		FIO													
		15400	SD-02 Shop Drawings															
			Plumbing System	3.4.1	G	AE												
			SD-03 Product Data															
			Welding	1.5.1	G	RE												
			Plumbing Fixture Schedule	3.5	G	AE												
			Plumbing System	3.4.1	G	AE												
			SD-06 Test Reports															
			Tests, Flushing and Disinfection	3.4	G	RE												
			Backflow Prevention Assembly		G	RE												
			Tests															
			SD-07 Certificates															
			Materials and Equipment		G	RE												

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		15400	SD-10 Operation and Maintenance															
			Data															
			Plumbing System	3.4.1	G	RE												
		15955	SD-06 Test Reports															
			Testing Plan		G	RE												
			SD-07 Certificates															
			Testing equipment		G	RE												
			Certified Test Report		G	RE												
		16015	SD-02 Shop Drawings															
			Short Circuit Study	1.3	G	RE												
			Short Circuit Study	1.4	G	RE												
			Short Circuit Study	1.6	G	RE												
			Protective Device Coordination	1.3	G	RE												
			Study															
		16050	SD-02 Shop Drawings															
			Device boxes		G	RE												
			Junction and Pull Boxes used at,		G	RE												
			or below, grade															
			Large Junction and Pull Boxes		G	RE												
			Terminal Junction Boxes		G	RE												
			Panelboards and Circuit Breaker		G	RE												
			Data															
			Wiring Devices		G	RE												
			Control Devices		G	RE												
			Control Relays		G	RE												
			Timers		G	RE												

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		16050	Fuses		G	RE												
			Magnetic Contactors		G	RE												
			Transformers		G	RE												
			Service and Metering Equipment		G	RE												
		16110	SD-02 Shop Drawings															
			PVC-Coated Rigid galvanized		G	RE												
			steel conduit															
			PVC Schedule 40 conduit		G	RE												
			Flexible metal, liquid-tight conduit		G	RE												
			Conduit fittings		G	RE												
			Precast Manholes and Handholes		G	RE												
			Equipment and machinery		G	RE												
			proposed for bending metal conduit															
			Method for bending PVC conduit		G	RE												
			less than 30 degrees															
		16120	SD-02 Shop Drawings															
			Wire and cable descriptive		G	RE												
			product information															
			Wire and cable accessories		G	RE												
			descriptive product information															
		16405	SD-02 Shop Drawings															
			Descriptive information		G	RE												
			Nameplate		G	RE												
			Enclosure		G	RE												
			Dimensions and total weight		G	RE												
			Conduit box		G	RE												

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		16405	Bearing type		G	RE												
			Bearing lubrication		G	RE												
			Bearing life		G	RE												
			Space heater		G	RE												
			Motor Thermal Protection		G	RE												
			Motor sound power level		G	RE												
			Maximum brake horsepower		G	RE												
			Submersible motor moisture and		G	RE												
			temperature sensing system															
			SD-06 Test Reports															
			Factory test report		G	RE												
			SD-10 Operation and Maintenance															
			Data															
			Operation and maintenance		G	RE												
			manual															
		16425	SD-02 Shop Drawings															
			Descriptive product information		G	RE												
			Itemized Bill of Material		G	RE												
			Dimensional drawings		G	RE												
			Operational description		G	RE												
			Anchoring instructions and details		G	RE												
			One-line, three-line, and control		G	RE												
			schematic drawings															
			Connection and interconnection		G	RE												
			drawings															

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		16425	Circuit Breakers: Copies of		G	RE												
			time-current characteristics															
			Ground Fault Protection: Relay		G	RE												
			time-current characteristics															
			Bus data		G	RE												
			Incoming line section equipment		G	RE												
			data															
			Transformer section equipment		G	RE												
			data															
			Conduit entrance locations		G	RE												
			SD-08 Manufacturer’s Instructions															
			Manufacturer's installation		G	RE												
			instructions															
			SD-06 Test Reports															
			Certified Factory Test Report		G	RE												
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance		G	RE												
			Manual															
			SD-07 Certificates															
			Manufacturer's Certification of		G	RE												
			Proper Installation															
		16450	SD-03 Product Data															
			Exothermic weld connectors	2.3.1	G	RE												
			Mechanical connectors	2.3.3	G	RE												
			Ground rods	2.1	G	RE												

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		16450	Compression connectors	2.3.2	G	RE												
		16485	SD-02 Shop Drawings															
			Dimension Drawings		G	RE												
			Outline Drawings		G	RE												
			Layout		G	RE												
			System Operating Description		G	RE												
			SD-03 Product Data															
			'dc link' capacitor		FIO													
			Adjustable Frequency Drive		G	RE												
			Ventilation		G	RE												
			Diagnostics		G	RE												
			Control and Interface Devices		G	RE												
			Bill-of-Materials		G	RE												
			Shipping and Handling		FIO													
			Instructions															
			SD-05 Design Data															
			Drive System Operating Data		G	RE												
			Individual and Total Harmonic		G	RE												
			Content															
			Pulse		G													
			SD-07 Certificates															
			Statement of Supplier		G	RE												
			qualifications															
			Factory functional test reports		G	RE												
			Field test reports		G	RE												

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		16485	Manufacturer's Certificate of		FIO													
			Proper Installation															
			SD-10 Operation and Maintenance															
			Data															
			System Schematic		G	RE												
			Spare Parts List		G	RE												
			Special Tools		G	RE												
			Operation and maintenance		G	RE												
			manual															
		16500	SD-03 Product Data															
			Interior Luminaires		G	RE												
			Lamps		G	RE												
			Ballasts		G	RE												
			Photocells		G	RE												
		16520	SD-02 Shop Drawings															
			Luminaire drawings	1.4.1.1	G	RE												
			Poles	1.4.1.2	G	RE												
			SD-03 Product Data															
			Luminaires	2.1	G	RE												
			Lamps	2.1.1	G	RE												
			Ballasts	2.1.2	G	RE												
			Lighting contactor	2.2	G	RE												
			Photocell switch	2.3	G	RE												
			Steel poles	2.4.1	G	RE												
			Brackets	2.5	FIO													
			SD-04 Samples															

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		16520	Luminaires	2.1	G	RE												
			SD-06 Test Reports															
			Test Data for luminaires	1.4.2	G	RE												
			Operating test	3.3	FIO													
		16670	SD-02 Shop Drawings															
			Lightning protection system layout		G	RE												
			Component locations		G	RE												
			Detailed plans		G	RE												
			Down conductor		G	RE												
			Connecting conductor		G	RE												
			Bond strap		G	RE												
			Air terminals		G	RE												
			Fittings		G	RE												
			Connectors		G	RE												
			Ground rods		G	RE												
			SD-06 Test Reports															
			Field test report		G	RE												
			SD-07 Certificates															
			Ground Witness Certification		G	RE												
			Post-Installation Certification		G	RE												
			UL 96 Master Label 'C'		G													
			Certification															
		16950	SD-01 Preconstruction Submittals															
			Schedule for performing		FIO													
			inspection and tests															

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		16950	List of references to be used for		FIO													
			each test															
			Sample copy of equipment and		FIO													
			materials inspection form(s)															
			Sample copy of individual device		FIO													
			test form															
			Sample copy of individual system		FIO													
			test form															
			SD-06 Test Reports															
			Test or inspection reports for each		FIO													
			electrical item tested															
			SD-07 Certificates															
			Certificates for each electrical item		FIO													
			tested															
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance		FIO													
			Manual															

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SECTION 01355

ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 REFERENCES

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

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

33 CFR 328	Definitions
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 279	Standards for the Management of Used Oil
49 CFR 171 - 178	Hazardous Materials Regulations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(1996) U.S. Army Corps on Engineers Safety and Health Requirements Manual
WETLAND MANUAL	Corps of Engineers Wetlands Delineation Manual Technical Report Y-87-1
WETLAND MANUAL	Corps of Engineers Wetlands Delineation Manual Technical Report Y-87-1

1.2 DEFINITIONS

1.2.1 Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally and/or historically.

1.2.2 Environmental Protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other

pollutants.

1.2.3 Contractor Generated Hazardous Waste

Contractor generated hazardous waste means materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste streams would typically consist of material brought on site by the Contractor to execute work, but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e. methyl ethyl ketone, toluene etc.), waste thinners,excess paints, excess solvents, waste solvents, and excess pesticides, and contaminated pesticide equipment rinse water.

1.2.4 Land Application for Discharge Water

The term "Land Application" for discharge water implies that the Contractor shall discharge water at a rate which allows the water to percolate into the soil. No sheeting action, soil erosion, discharge into storm sewers, discharge into defined drainage areas, or discharge into the "waters of the United States" shall occur. Land Application shall be in compliance with all applicable Federal, State, and local laws and regulations.

1.2.5 Surface Discharge

The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers,creeks, and/or "waters of the United States" and would require a permit to discharge water from the governing agency.

1.2.6 Waters of the United States

All waters which are under the jurisdiction of the Clean Water Act, as defined in 33 CFR 328.

1.2.7 Wetlands

Wetlands means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, and bogs. Official determination of whether or not an area is classified as a wetland shall be done in accordance with WETLAND MANUAL.

1.2.8 Waste Material Definitions

For purposes of the Rio Salado Project, the following definitions shall apply.

Unsatisfactory material: Materials that do not comply with the requirements for satisfactory material as specified in Section 02300 EARTHWORK.

Inert Material: Inert material is material as defined by ARS 49-701 (15), i.e. material that is not flammable, will not decompose, and will not leach significant concentrations of environmental contaminants. Typically for this project it will include concrete, asphaltic materials, metal reinforcement in concrete, and similar materials. It does not include

wood, tires, metal, or contaminated soils in significant amounts.

Construction Debris: Construction debris is material as defined by ARS 49-701 (5). It typically includes lumber, insulating material, drywall, concrete block, and similar products. Some landfills are permitted to receive construction debris, but not household waste.

Household Waste: Household waste is material as defined by ARS 49-701 (14), including general garbage and rubbish from household sources. For the Rio Salado project, it includes material excavated from landfills known to have accepted these types of wastes, but does not include inert material and construction debris where those materials are separable from the household waste.

Mixed Waste: Mixed waste is material that include two or more of the following waste types; construction debris, inert material, household waste, tires, and other special waste.

Special Waste: Includes material as defined by ARS 49-851.A(5). For the Rio Salado project, the type of special waste most likely to be encountered is petroleum contaminated soil where the concentration of petroleum products as determined by laboratory analysis exceeds non-residential soil cleanup standards established by the Arizona Department of Environmental Quality.

Hazardous Waste: Hazardous waste is material as defined by ARS 49-921 (5). Hazardous waste is typically defined as a result of exceeding certain established concentrations of contaminants, or by possessing characteristics such as toxicity, flammability, or explosive potential. In accordance with this, these types of materials, if encountered will be handled by the Contractor under a contingency plan.

1.3 GENERAL REQUIREMENTS

The Contractor shall minimize environmental pollution and damage that may occur as the result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of this contract. The Contractor shall comply with all applicable environmental Federal, State, and local laws and regulations. The Contractor shall be responsible for any delays resulting from failure to comply with environmental laws and regulations.

1.4 SUBCONTRACTORS

The Contractor shall ensure compliance with this section by subcontractors.

1.5 PAYMENT

No separate payment will be made for work covered under this section. The Contractor shall be responsible for payment of fees associated with environmental permits, application, and/or notices obtained by the Contractor. All costs associated with this section shall be included in the contract price. The Contractor shall be responsible for payment of all fines/fees for violation or non-compliance with Federal, State, Regional and local laws and regulations.

1.6 SUBMITTALS

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

SD-01 Preconstruction Submittals

Environmental Protection Plan; G, RE

Health and Safety Plan; G, RE

1.7 ENVIRONMENTAL PROTECTION PLAN

Prior to commencing construction activities or delivery of materials to the site, the Contractor shall submit an Environmental Protection Plan for review and approval by the Contracting Officer. The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental issues which the Contractor shall address during construction. Issues of concern shall be defined within the Environmental Protection Plan as outlined in this section. The Contractor shall address each topic at a level of detail commensurate with the environmental issue and required construction task(s). Topics or issues which are not identified in this section, but which the Contractor considers necessary, shall be identified and discussed after those items formally identified in this section. Prior to submittal of the Environmental Protection Plan, the Contractor shall meet with the Contracting Officer for the purpose of discussing the implementation of the initial Environmental Protection Plan; possible subsequent additions and revisions to the plan including any reporting requirements; and methods for administration of the Contractor's Environmental Plans. The Environmental Protection Plan shall be current and maintained onsite by the Contractor.

1.7.1 Compliance

No requirement in this Section shall be construed as relieving the Contractor of any applicable Federal, State, and local environmental protection laws and regulations. During Construction, the Contractor shall be responsible for identifying, implementing, and submitting for approval any additional requirements to be included in the Environmental Protection Plan.

1.7.2 Contents

The environmental protection plan shall include, but shall not be limited to, the following:

a. Name(s) of person(s) within the Contractor's organization who is(are) responsible for ensuring adherence to the Environmental Protection Plan.

b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site, if applicable.

c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

d. Description of the Contractor's environmental protection personnel training program.

e. Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plan shall include measures to minimize the amount of mud transported onto paved public roads by vehicles or runoff.

f. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas including methods for protection of features to be preserved within authorized work areas.

g. The Spill Control plan shall include in the SWPPP described in Section 01356 STORM WATER POLLUTION PREVENTION MEASURES.

h. A Waste Identification, Handling and Disposal Work Plan for inert debris, construction debris, household waste, tires, and mixed wastes comprised of these materials, which are encountered on site. This plan shall address in considerable detail how the Contractor plans to respond to the requirements discussed in Articles 1.9.2 and 1.9.3 of this specification.

i. A recycling and solid waste minimization plan with a list of measures to reduce consumption of energy and natural resources. The plan shall detail the Contractor's actions to comply with and to participate in Federal, State, Regional, and local government sponsored recycling programs to reduce the volume of solid waste at the source.

j. An air pollution control plan detailing provisions to assure that dust, debris, materials, trash, etc., do not become air borne and travel off the project site.

k. A contaminant prevention plan that: identifies potentially hazardous substances to be used on the job site; identifies the intended actions to prevent introduction of such materials into the air, water, or ground; and details provisions for compliance with Federal, State, and local laws and regulations for storage and handling of these materials. In accordance with EM 385-1-1, a copy of the Material Safety Data Sheets (MSDS) and the maximum quantity of each hazardous material to be on site at any given time shall be included in the contaminant prevention plan. As new hazardous materials are brought on site or removed from the site, the plan shall be updated.

l. A waste water management plan that identifies the methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines. If a settling/retention pond is required, the plan shall include the design of the pond including drawings, removal plan, and testing requirements for possible pollutants. If land application will be the method of disposal for the waste water, the plan shall include a sketch showing the location for land application along with a description of the pretreatment methods to be implemented. If surface discharge will be the method of disposal, a copy of the permit and associated documents shall be included as an attachment prior to discharging the waste water. If disposal is to a sanitary sewer, the plan shall include documentation that the City of Phoenix Waste Water Treatment Plant Operator has approved the flow rate, volume, and type of discharge.

m. A historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on the project site: and/or identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in the area are discovered during construction. The plan shall include methods to assure the protection of known or discovered resources and shall identify lines of communication between Contractor personnel and the Contracting Officer.

n. Hazardous and Special Waste Contingency Plan. The contractor shall prepare a Hazardous and Special Wastes Contingency that can be implemented should these suspected waste types be encountered during excavation, dewatering of degraded groundwater as described in paragraph 1.9.1, or any other construction activities. The plan will address the specific actions the contractor will take should this material be encountered. At a minimum the actions will include; methods for identification of suspected waste, protection of the public and workforce; monitoring, isolation of material; characterization of waste type, and removal of the hazardous or special waste in accordance with all regulations. Any encountered hazardous or special waste shall be removed to the full extent of the wastes from the project site, unless otherwise directed by the Contracting Officer. The plan shall address encountering suspected petroleum contaminated material, asbestos containing material, or unknown suspected hazardous material.

The contractor shall be prepared to implement the contingency plan within 24-hours of being directed by the Contraction Officer. If the Contractor does not have the in-house capabilities or licensed to perform this work, they will make prior arrangement to have an on-call environmental response subcontractor ready to perform the work.

1.7.3 Appendix

Copies of all environmental permits, permit application packages, approvals to construct, notifications, certifications, reports, and termination documents shall be attached, as an appendix, to the Environmental Protection Plan.

1.7.4 Contractor's Responsibility for Health and Safety

The Contractor shall be solely responsible for health, safety, and protection of all its personnel and subcontractor's personnel during the performance of the Work in these Contract Documents. Contractor health and safety requirements shall be in accordance with the guidelines established by OSHA in the March 6, 1989 Federal Register (29 CFR 1910.120) "Hazardous Waste Operations and Emergency Response; Final Rule."

The Contractor shall develop and implement a site-specific health and safety plan (Health and Safety Plan) that meets the requirements of 29 CFR 1910.120(i). The Health and Safety Plan will be reviewed by the Contracting Officer. The Health and Safety Plan shall include discussion of, but not be limited to, the following:

1. Work Areas, including:
    a. Zone 1 - Exclusion Zone.
    b. Zone 2 - Contaminant Reduction Zone.
    c. Zone 3 - Support Zone.

2. Personnel Protection Program.
3. Initial Onsite Training for Personnel.
4. Emergency and First-Aid Requirements.
5. Personal Hygiene and Decontamination.
6. Air Monitoring.
7. List of Contractor's competent person for each construction activity per OSHA requirements.
8. A contingency plan should suspected hazardous waste or special waste be encountered.

Information relating to the site, including site H&S Plan is attached as Appendix A. This information may be useful to the Contractor in developing a Health and Safety Plan and preparing the bid; however, the Contracting Officer makes no warranty as to the completeness or adequacy of the information. The Contractor shall collect added information as needed to prepare the Health and Safety Plan.

Submit the required "Contractor Medical and Training Certification Letter" to certify that the Contractor's personnel and subcontractors are participating in a medical surveillance program according to 29 CFR 1910.120 (f) and 29 CFR 1910.134, and that the Contractor's personnel have been trained according to 29 CFR 1910.120(e). Submit the "Contractor Medical and Training Certification Letter: prior to initiation of any field construction activities. Each employee who will be performing activities with potential for exposure to hazardous waste shall meet these requirements and shall be listed on the certification letter by name. Addition of any employees after initiation of field construction activities shall require a resubmittal of this letter.

The Contractor shall provide a designated Health and Safety Officer to implement, monitor, and enforce the Health and Safety Plan. The Health and Safety Officer shall have no other duties. The Health and Safety Officer shall be approved by the Contracting Officer and have the following qualifications:

1. Satisfactory completion of 40 hours initial training in Hazardous Waste Site Field Investigation, 3 days onsite apprenticeship, and 8 hours of specialized training.
2. Current certification in cardiopulmonary resuscitation (CPR) and multimedia first aid.
3. Attendance at refresher training within the past 12 months.
4. Knowledge of emergency preparedness techniques and considerations, including:

   a. Onsite accidents/exposure.
   b. Procedures for medical emergencies.
   c. Heat stress and cold stress prevention, symptomology, and treatment.

5. Specific familiarity with OSHA regulations for general industry (29 CFR 1910) and the construction industry (29 CFR 1926).
6. Experience in implementing the above-cited OSHA regulations as a designated Health and Safety Officer.
7. Experience working on one or more hazardous waste sites.
8. Experience with the types of activities that will be conducted at the site.
9. Experience with air monitoring equipment operation.
10. Experience with asbestos removal.

Contractor shall do all work necessary to protect the facility employees

and the general public from hazards. Temporary chain link fencing, solid fencing, barricades, flashing lights, and proper signs shall be furnished and installed in sufficient quantity to safeguard the public and the work.

1.8 PROTECTION FEATURES

This paragraph supplements the Contract Clause PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS. Prior to start of any onsite construction activities, the Contractor and the Contracting Officer shall make a joint condition survey. Immediately following the survey, the Contractor shall prepare a brief report including a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the Contractor's assigned storage area and access route(s), as applicable. This survey report shall be signed by both the the Contractor and the Contracting Officer upon mutual agreement as to its accuracy and completeness. The Contractor shall protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference which their preservation may cause to the Contractor's work under the contract.

Should the Contractor damage any trees identified for protection a credit will be issued to the Contracting Officer in accordance with the following schedule:

Less than 1.5" up to 2.5" caliper: $1000
2.5" caliper to less than 3.5" caliper: $1250
3.5" caliper and greater: $1500

1.9 SPECIAL ENVIRONMENTAL REQUIREMENTS

The Contractor shall comply with the special environmental requirements for this project.

1.9.1 Degraded Groundwater

The reach of the Salt River in which the project is located is in the vicinity of a number of study areas of the State of Arizona Water Quality Assurance Revolving Fund (WQARF). The WQARF program is designed to study and clean-up areas of degraded groundwater. **Environmental Assessment Reports for the project location are available for review at the City of Phoenix (COP), ATTN. Mr. Walt Kinsler, 200 West Washington St., Phoenix, AZ 85003, Telephone (602) 534-2160. Reference is made to Section 00100 INSTRUCTIONS TO BIDDERS which explains the Government's opinion of these reports.** The Contractor is responsible for obtaining and reviewing these reports as part of the bidding process. These assessments suggest that degraded groundwater will be present beneath some portions of the project during construction, but current indications are that the levels of contaminants are not high enough to be a hazard to worker health and safety according to a risk assessment prepared for this project. At least one employee who is certified in the OSHA 40-hour hazardous material training shall be present on site at all times during excavation activities. Proof of certification shall be provided to the Contracting Officer at the Pre-Construction meeting.

1.9.2 Landfills

There are a number of old landfill sites located along the river corridor within or adjacent to the Rio Salado project boundaries. These landfills may contain a variety of wastes including inert materials, construction debris, household wastes, special wastes, tires, and some hazardous waste. Landfill materials may be encountered during excavation and clearing, Environmental assessments of the project location are available for review from the Government. The Contractor shall be responsible for obtaining and reviewing these reports as part of the bidding process.

Investigations for landfill material, trash and debris have recently been completed and results of these investigations are available for review from the Government. These results are provided for information only, and represent conditions only at the boring locations and depths shown. No other assumptions as to the existence or non-existence of landfill material, trash or debris is to be inferred from this information. A figure showing the approximate location of known landfills is indicated at the end of this section.

The Contractor shall construct berms to divert nuisance flows away from any exposed suspect material. The Contractor shall keep adequately trained staff on site during construction activities where such landfill materials may be encountered. At least one employee who is certified in the OSHA 40-hour hazardous material training shall be present on site at all times during excavation activities. Proof of certification shall be provided to the Contracting Officer at the Pre-Construction meeting. Such staff shall be able to distinguish between inert wastes and soil stains, rubbish and other household or potentially hazardous wastes. If during construction, the Contractor encounters soil stains, chemical or petroleum odors, rubbish, household waste or what he believes may be other potentially regulated substances, he will immediately notify the Contracting Officer, and if necessary stop work only in this area. The Contracting Officer may notify the City of Phoenix (COP) environmental staff who will visit the work area, determine whether any immediate precautions should be taken, and make an evaluation of the appropriate characterization and disposal alternatives. At the same time the Contractor shall implement the Waste Identification, Handling and Disposal Work Plan.

Methane gas is often associated with household waste disposal sites, and has been detected at some locations within or adjacent to the project area. Such locations may include but are not limited to the former Central Avenue Landfill, 7th Avenue Landfill, 19th Avenue Landfill, and Del Rio Landfill as well as other locations along the river corridor.

The Contractor shall take appropriate precautions and actions as described in the Contractors Health and Safety Plan (HSP), and in the Contingency Response Plan and shall adhere to the excavation safety requirements of 29 CFR 1926.650-652. The Contractor shall also perform appropriate monitoring of activities as required by the Health and Safety Plan including monitoring for methane gas and submit all results to the Contracting Officer.

1.9.3 Waste Encountered

Upon encountering any waste materials the Contractor shall immediately notify the Contracting Officer of the location of this material and allow the Contracting Officer and the City of Phoenix (COP) full access to the site to inspect the wastes and recommend further procedures. The Contractor shall provide information necessary to comply with ARS 49-701 to the Contracting Officer. At a minimum, upon encountering any waste, including

inert materials, construction debris, household waste, special waste, tires and hazardous waste the Contractor shall notify the Contracting Officer of the location of this material by station points and offsets.

All waste materials will be characterized by the Contractor, including the lateral and horizontal extent of the waste materials. If characterization indicates the materials are determined to be hazardous waste, the material will be segregated by the Contractor's on-call environmental contractor. Once this has been accomplished the Contractor, at the direction of the Contracting Officer, can remove and dispose of all non-hazardous materials. This includes construction debris, inert material, special wastes and household wastes.

The Contractor shall separate inert material, construction debris and tires from native materials or other wastes. Construction debris and inert material loads containing more than 30% native soil materials, as determined by the Contracting Officer, will be paid as general soil excavation. Native materials separated from inert materials and construction debris may be used as backfill, if deemed appropriate by the Contracting Officer, or may be disposed of offsite as excess soil material.

In the event that household or special waste materials, or other unclassified mixed materials are encountered, the Contracting Officer may direct the Contractor to remove the material to a designated stockpile area indicated on the Plans, or may be directed to dispose of the material in accordance with the Waste Indentification, Handling and Disposal plan. In either case, the Contractor shall separate inert materials from these waste materials, unless otherwise directed by the Contracting Officer.

Materials taken to a stockpile area may, at the direction of the Contracting Officer, be segregated. Once segregated, the materials shall be disposed of in accordance with the waste handling and disposal plan. Waste segregation and disposal shall be completed within 75 days of the date the initial load of waste was placed in the stockpile area.

All tires or pieces of tires greater than 6-inches removed during excavation activities or recovered from the ground surface shall be handled, stored, transported, and disposed of in accordance with applicable federal, state, and local regulations. Applicable state regulations include: Arizona Revised Statues (ARS) §§44-1301 et seq: §44-1301; §44-1302; §44-1303; §44-1304.01; §44-1305; §44-1306; §44-1307.

A Landfill Use Permit will be required for all landfill disposals. Charges will be levied for each load delivered to the landfill in accordance with the current fee schedule.

Alternatively, the Contracting Officer may direct that the materials be disposed of without segregation. If so directed, the Contractor shall complete the disposal of the stockpile materials within 28 days. If the stockpile materials represent a mixture of wastes, the Contractor shall select the most cost-effective waste disposal option available under applicable regulatory constraints.

If flows in the river are imminent, such household waste or special waste shall be removed immediately before flows occur.

In all cases where waste materials of any type have been removed below the finished grade elevation, the resulting void shall be backfilled and compacted to neat line in accordance with Section 02300 EARTHWORK.

Within fourteen days of removal and disposal of any solid waste, the Contractor shall, unless otherwise directed by the Contracting Officer, provide the following information.

a. A written description of the removal project, including the types of material, approximate quantity, location and approximate dimensions of the excavation, a description of waste handling, storage, and transportation practices, and a description of the disposal method and location and approximate dimensions of the excavation.

b. Supporting documentation such as load receipts, manifests, etc.

1.9.3.1 Landfill Liners

The Contractor shall be responsible for odor and vector control of any household waste or special waste, or any unclassified waste as required, that is exposed during excavation activities. To mitigate these concerns, the Contractor shall be responsible to apply a temporary liner over any exposed face of any such waste at the end of each working day. However, if the temporary liner applied by the Contractor has been removed or disturbed, the Contractor shall be responsible for the re-application of the temporary liner.

A temporary liner shall be applied whenever household waste or special waste remains exposed overnight. A temporary liner for exposed waste shall consist of one of the following or other pre-approved equivalent methods:

a. A spray-on material such as Sanifoamâ, Posi-Shellâ, or pre-approved equivalent, applied in accordance with manufacturer's specifications.

b. A one-foot layer of soil consisting of Unified Soil Classification System (ASTM D 2488) type GM or finer.

c. A weighted tarp cover consisting of geosynthetic, cloth, or other pre-approved equal.

In addition to the use of any synthetic temporary liner, a stockpile of fine-grained soils will be maintained to provide temporary cover or fire suppression whenever excavation activities may encounter significant accumulations (more than 10 cubic yards) of decomposing or flammable waste. The soil shall consist of Unified Soil Classification System (ASTM D 2488) type SM or finer. The stockpile shall be located within one-quarter mile of excavation activities, and shall be an amount capable of covering the exposed burning or smoldering waste to a depth of at least three feet.

Prior to placement of structures, placement of backfill at such structures, any household waste or special waste remaining in place shall be completely covered with a permanent liner. The permanent liner will be constructed as specified in Section 02377 CLAY BARRIER LAYER or Section 02666 WETLAND LINERS - SOIL BENTONITE.

1.10 ENVIRONMENTAL ASSESSMENT OF CONTRACT DEVIATIONS

Any deviations, requested by the Contractor, from the drawings, plans and specifications which may have an environmental impact will be subject to approval by the Contracting Officer and may require an extended review,

processing, and approval time. The Contracting Officer reserves the right to disapprove alternate methods, even if they are more cost effective, if the Contracting Officer determines that the proposed alternate method will have an adverse environmental impact.

1.11 NOTIFICATION

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with Federal, State or local environmental laws or regulations, permits, and other elements of the Contractor's Environmental Protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or equitable adjustments allowed to the Contractor for any such suspensions. This is in addition to any other actions the Contracting Officer may take under the contract, or in accordance with the Federal Acquisition Regulation or Federal Law.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 ENVIRONMENTAL PERMITS AND COMMITMENTS

This paragraph supplements the Contractor's responsibility under the contract clause "PERMITS AND RESPONSIBILITIES" to the extent that the Government has obtained the environmental permits. The Contractor shall comply with the terms and conditions of the attached list of environmental commitments specified in Section 01200 GENERAL REQUIREMENTS.

The Contractor shall be responsible for obtaining and complying with all environmental permits and commitments required by Federal, State, Regional, and local environmental laws and regulations including those listed in Section 01200 GENERAL REQUIREMENTS.

3.2 LAND RESOURCES

The Contractor shall confine all activities to areas defined by the drawings and specifications. Prior to the beginning of any construction, the Contractor shall identify any land resources to be preserved within the work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without approval from the Contracting Officer. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. The Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs. Stone, soil, or other materials displaced into uncleared areas shall be removed by the Contractor.

3.2.1 Work Area Limits

Prior to commencing construction activities, the Contractor shall mark the areas that need to be disturbed under this contract. Isolated areas within the general work area which are not to be disturbed shall be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted

during darkness, any markers shall be visible in the dark. The Contractor's personnel shall be knowledgeable of the purpose for marking and/or protecting particular objects.

3.2.2 Landscape

Trees, shrubs, indicated and defined on the drawings to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques. The Contractor shall restore in-kind the landscape features damaged or destroyed during construction operations outside the limits of the approved work area.

3.2.3 Erosion and Sediment Controls

The Contractor shall be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations. The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of the Contractor's construction activities. The Contractor shall construct or install temporary and permanent erosion and sediment control Best Management Practices (BMPs) as specified in Section 01356 STORM WATER POLLUTION PREVENTION MEASURES.

3.2.4 Contractor Facilities and Work Areas

The Contractor's field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the drawings or as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only when approved. Erosion and sediment controls shall be provided for on-site stockpile areas to prevent sediment from entering nearby waters. Temporary excavation and embankments for plant and/or work areas shall be controlled to protect adjacent areas.

3.3 WATER RESOURCES

The Contractor shall monitor construction activities to prevent pollution of surface and ground waters. Toxic or hazardous chemicals shall not be applied to soil or vegetation unless otherwise indicated. All water areas affected by construction activities shall be monitored by the Contractor. For construction activities immediately adjacent to impaired surface waters, the Contractor shall be capable of quantifying sediment or pollutant loading to that surface water when required by State or Federally issued Clean Water Act permits.

The Contractor shall ensure that chemical applicators of pesticides, herbicides, wood preservatives, or any other such materials be certified by the Arizona Structural Pest Control Commission under the relevant certification category. Applicators shall be certified under the category relevant to the chemical application activity and all certifications shall be current. The Contractor shall ensure that chemical storage and application activities are carried out under the best practice guidelines of the Structural Pest Control Commission and the Best Management Practices developed for the City of Phoenix NPDES Permit No. AZ0024554, a copy of which is available for review at the Phoenix Area Office of the USACE.

3.4 AIR RESOURCES

Equipment operation, activities, or processes performed by the Contractor shall be in accordance with all Federal, State and county air emission and

performance laws and standards. The Contractor shall obtain a Dust Control Permit from Maricopa County.

3.4.1 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from asphaltic batch plants; shall be controlled at all times, including weekends, holidays and hours when work is not in progress. The Contractor shall maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates which would cause the Federal, State, and local air pollution standards to be exceeded or which would cause a hazard or a nuisance. Sprinkling will be permitted to control particulates in the work area. Sprinkling, to be efficient, shall be repeated to keep the disturbed area damp at all times. The Contractor shall have sufficient, competent equipment available to accomplish these tasks. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs. The Contractor shall comply with all State and local visibility regulations.

3.4.2 Odors

Odors from construction activities shall be controlled at all times. The odors shall not cause a health hazard and shall be in compliance with State regulations and/or local ordinances.

3.4.3 Sound Intrusions

The Contractor shall keep construction activities under surveillance and control to minimize environment damage by noise. The Contractor shall comply with the provisions of the State of Arizona rules.

3.4.4 Burning

Burning will not be allowed on the project site unless specified in other sections of the specifications or authorized in writing by the Contracting Officer. The specific time, location, and manner of burning shall be subject to approval.

3.5 CHEMICAL MATERIALS MANAGEMENT AND WASTE DISPOSAL

Disposal of wastes excluding waste as described in Section 02230 SITE CLEARING AND OBSTRUCTIONS REMOVAL shall be as directed below, unless otherwise specified in other sections and/or shown on the drawings.

3.5.1 Solid Wastes

Solid wastes shall be placed in containers which are emptied on a regular schedule. Handling, storage, and disposal shall be conducted to prevent contamination. Segregation measures shall be employed so that no hazardous or toxic waste will become co-mingled with solid waste. The Contractor shall transport solid waste off the site and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal. A Subtitle D RCRA permitted landfill shall be the minimum acceptable off-site solid waste disposal option. The Contractor shall verify that the selected transporters and disposal facilities have the necessary permits and licenses to operate.

3.5.2 Chemicals and Chemical Wastes

Chemicals shall be dispensed ensuring no spillage to the ground or water. Periodic inspections of dispensing areas to identify leakage and initiate corrective action shall be performed and documented. This documentation will be periodically reviewed by the Government. Chemical waste shall be collected in corrosion resistant, compatible containers. Collection drums shall be monitored and removed to a staging or storage area when contents are within 6 inches of the top. Wastes shall be classified, managed, stored, and disposed of in accordance with Federal, State, and local laws and regulations.

3.5.3 Contractor Generated Hazardous Wastes/Excess Hazardous Materials

Hazardous wastes are defined in 40 CFR 261, or are as defined by applicable State and local regulations. Hazardous materials are defined in 49 CFR 171 - 178. The Contractor shall, at a minimum, manage and store hazardous waste in compliance with 40 CFR 262. The Contractor shall take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing. The Contractor shall segregate hazardous waste from other materials and wastes, shall protect it from the weather by placing it in a safe covered location, and shall take precautionary measures such as berming or other appropriate measures against accidental spillage. The Contractor shall be responsible for storage, describing, packaging, labeling, marking, and placarding of hazardous waste and hazardous material in accordance with 49 CFR 171 - 178, State, and local laws and regulations. The Contractor shall transport Contractor generated hazardous waste off Government property within 60 days in accordance with the Environmental Protection Agency and the Department of Transportation laws and regulations. The Contractor shall dispose of hazardous waste in compliance with Federal, State and local laws and regulations. Spills of hazardous or toxic materials shall be immediately reported to the Contracting Officer. Cleanup and cleanup costs due to spills shall be the Contractor's responsibility. The disposition of Contractor generated hazardous waste and excess hazardous materials are the Contractor's responsibility.

3.5.4 Fuel and Lubricants

Storage, fueling and lubrication of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spill and evaporation. Fuel, lubricants and oil shall be managed and stored in accordance with all Federal, State, Regional, and local laws and regulations. Used lubricants and used oil to be discarded shall be stored in marked corrosion-resistant containers and recycled or disposed in accordance with 40 CFR 279, State, and local laws and regulations. Storage of fuel on the project site shall be accordance with all Federal, State, and local laws and regulations. Fueling and maintenance of vehicles and equipment shall take place out of the river terrace area.

3.6 RECYCLING AND WASTE MINIMIZATION

The Contractor shall participate in State and local government sponsored recycling programs. The Contractor is further encouraged to minimize solid waste generation throughout the duration of the project.

3.7 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

Existing known historical, archaeological, and cultural resources within the Contractor's work area are shown on the drawings. The Contractor shall

protect these resources and shall be responsible for their preservation during the life of the Contract. If during excavation or other construction activities any previously unidentified or unanticipated historical, archaeological, and cultural resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. Resources covered by this paragraph include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rock or coral alignments, pavings, wall, or other constructed features; and any indication of agricultural or other human activities. Upon such discovery or find, the Contractor shall immediately notify the Contracting Officer so that the appropriate authorities may be notified and a determination made as to their significance and what, if any, special disposition of the finds should be made. The Contractor shall cease all activities that may result in impact to or the destruction of these resources. The Contractor shall secure the area and prevent employees or other persons from trespassing on, removing, or otherwise disturbing such resources.

3.8 BIOLOGICAL RESOURCES

The Contractor shall minimize interference with, disturbance to, and damage to fish, wildlife, and plants including their habitat. The Contractor shall be responsible for the protection of threatened and endangered animal and plant species including their habitat in accordance with Federal, State, Regional, and local laws and regulations.

3.9 PREVIOUSLY USED EQUIPMENT

The Contractor shall clean all previously used construction equipment prior to bringing it onto the project site. The Contractor shall ensure that the equipment is free from soil residuals, egg deposits from plant pests, noxious weeds, and plant seeds. The Contractor shall consult with the USDA jurisdictional office for additional cleaning requirements.

3.10 MAINTENANCE OF POLLUTION FACILITIES

The Contractor shall maintain permanent and temporary pollution control facilities and devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.11 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel shall be trained in all phases of environmental protection and pollution control. The Contractor shall conduct environmental protection/pollution control meetings for all Contractor personnel prior to commencing construction activities. Additional meetings shall be conducted for new personnel and when site conditions change. The training and meeting agenda shall include: methods of detecting and avoiding pollution; familiarization with statutory and contractual pollution standards; installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental protection/pollution control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of archaeological sites, artifacts, wetlands, and endangered species and their habitat that are known to be in the area.

3.12 POST CONSTRUCTION CLEANUP

The Contractor shall clean up all areas used for construction in accordance

with Contract 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 area, structures, foundations of temporary structures, stockpiles of excess or waste materials not indicated to remain, and other vestiges of construction prior to final acceptance of the work.

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SECTION 01356

STORM WATER POLLUTION PREVENTION MEASURES

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4439	(1997) Standard Terminology for Geosynthetics
ASTM D 4491	(1996) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 1996)) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(1995) Determining Apparent Opening Size of a Geotextile
ASTM D 4873	(1995) Identification, Storage, and Handling of Geosynthetic Rolls

1.2 GENERAL

The Contractor shall plan and implement the storm water pollution prevention measures specified in this section in a manner which will meet the requirements of Section 01355 ENVIRONMENTAL PROTECTION, and the requirements of the National Pollution Discharge Elimination System (NPDES) permit.

1.3 PAYMENT

No separate payment will be made for work covered under this section. The Contractor shall be responsible for payment of fees associated with environmental permits, application, and/or notices obtained by the Contractor. All costs associated with this section shall be included in the contract price. The Contractor shall be responsible for payment of all fines/fees for violation or non-compliance with Federal, State, Regional and local laws and regulations.

1.4 NATIONAL POLLUTANT DISCHARGE ELMINATION SYSTEM (NPDES) PERMIT

The Contractor will obtain all necessary NPDES and Storm Water Pollution Prevention Plan (SWPPP) permits as required.

A. This project is subject to the National Pollutant Discharge Elimination System (NPDES) storm water requirements for construction sites under the Environmental Protection Agency (EPA) General Permit for Arizona. Under provisions of that permit, the Contractor shall be designated as permittee, and shall take all necessary measures to assure compliance with the NPDES General Permit for Arizona as well as all other applicable Federal, State and local laws, ordinances, statutes, rules and regulations pertaining to Storm water discharge. As the permittee, the Contractor is responsible for preparing, in a manner acceptable to the EPA, all documents required by this regulation, including but not necessarily limited to:

1. Storm Water Pollution Prevention Plan (SWPPP) for the project, including certification of compliance form. Contractor shall be required to develop, implement, update and revise the SWPPP, as necessary, in order to assure compliance with the EPA permit requirements. The SWPPP shall be retained on the project site at all times during construction.

2. Notice of Intent (NOI) to assure compliance with the NPDES General Permit for Arizona, including certification of signatures.

3. Notice of Termination (NOT) of coverage under NPDES General Permit for Arizona.

B. Preliminary copies of the NOI and the SWPPP shall be submitted to Contracting Officer during the pre-construction meeting and shall be subject to review by Contracting Officer prior to implementation.

C. Contractor shall submit the completed and duly signed NOI forms no later than forty-eight (48) hours prior to the initial start of construction on the project to the following agencies:

Storm water Notice of Intent (4203)
USEPA
401 M Street, SW
Washington, D.C. 20460

A copy of the completed NOI form shall be submitted to the following:

Storm Water Coordinator
Arizona Department of Environmental Quality
P.O. Box 600
Phoenix, AZ 85001-0600

Gary W. Boesch, PE
Stormwater Management Engineer
200 West Washington Street, 5th Floor
Phoenix, AZ 85003
(602) 495-5326

Failure by the Contractor (or Subcontractors of any tier) to submit NOI's within the mandated time frame shall result in delay of the construction start date, and no claim for extension of time will be granted for such delay. A copy of the completed NOI shall be posted at the construction site.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation;

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

SD-01 Preconstruction Submittals

Preliminary copies of the Notice of Intent, Notice of Termination and Stormwater Pollution Prevention Plan

SD-03 Product Data

Product data for storm water pollution prevention materials.

SD-07 Certificates

Mill Certificate or Affidavit;

Certificate attesting that the Contractor has met all specified requirements.

1.6 EROSION AND SEDIMENT CONTROLS

The controls and measures required by the Contractor are described below.

1.7 Structural Practices

Structural practices shall be implemented to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Structural practices shall be implemented in a timely manner during the construction process to minimize erosion and sediment runoff. Structural practices shall include the following devices.

1.8 Silt Fences

The Contractor shall provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Silt fences shall be properly installed to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading). Silt fences shall be installed in the locations indicated on the SWPPP. Final removal of silt fence barriers shall be upon approval by the Contracting Officer.

1.9 Straw Bales

The Contractor shall provide bales of straw 2nd-cut as a temporary structural practice to minimize erosion and sediment runoff. 2nd-cut straw are bales that come from wheat fields which typically have minimal weed growth and hence seeds. The 2nd-cut comes after the farmer goes through and removes the seed heads from the wheat. The material left (the stock without seeds) is the 2nd-cut which is baled and then ready for use. The purpose of using 2nd-cut straw is to minimize the introduction of seeds from exotic plants into the river environs. Bales shall be properly placed to effectively retain sediment immediately after completing each phase of work (e.g., clearing and grubbing, excavation, embankment, and grading) in each independent runoff area (e.g., after clearing and grubbing in a area between a ridge and drain, bales shall be placed as work progresses, bales

shall be removed/replaced/relocated as needed for work to progress in the drainage area). Areas where straw bales are to be used are shown on the drawings. Final removal of straw bale barriers shall be upon approval by the Contracting Officer. Rows of bales of straw shall be provided as follows:

a. Along the downhill perimeter edge of all areas disturbed.

b. Along the top of the slope or top bank of drainage ditches, channels, swales, etc. that traverse disturbed areas.

c. Along the toe of all cut slopes and fill slopes of the construction areas.

d. Perpendicular to the flow in the bottom of existing drainage ditches, channels, swales, etc. that traverse disturbed areas or carry runoff from disturbed areas. Rows shall be spaced as shown in the SWPPP.

e. Perpendicular to the flow in the bottom of new drainage ditches, channels, and swales. Rows shall be spaced as shown in the SWPPP.

f. At the entrance to culverts that receive runoff from disturbed areas.

PART 2 PRODUCTS

2.1 COMPONENTS FOR SILT FENCES

2.1.1 Filter Fabric

The geotextile shall comply with the requirements of ASTM D 4439, and shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. The filament shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of ester, propylene, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistance to deterioration due to ultraviolet and heat exposure. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 to 120 degrees F. The filter fabric shall meet the following requirements:

FILTER FABRIC FOR SILT SCREEN FENCE

PHYSICAL PROPERTY	TEST PROCEDURE	STRENGTH REQUIREMENT
Grab Tensile	ASTM D 4632	100 lbs. min.
Elongation (%)		30 % max.
Trapezoid Tear	ASTM D 4533	55 lbs. min.
Permittivity	ASTM D 4491	0.2 sec-1
AOS (U.S. Std Sieve)	ASTM D 4751	20-100

2.1.2 Silt Fence Stakes and Posts

The Contractor may use either wooden stakes or steel posts for fence

construction. Wooden stakes utilized for silt fence construction, shall have a minimum cross section of 2 inches by 2 inches when oak is used and 4 inches by 4 inches when pine is used, and shall have a minimum length of 5 feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of 5 feet.

2.1.3 Mill Certificate or Affidavit

A mill certificate or affidavit shall be provided attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified above. The mill certificate or affidavit shall specify the actual Minimum Average Roll Values and shall identify the fabric supplied by roll identification numbers. The Contractor shall submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the filter fabric.

2.1.4 Identification Storage and Handling

Filter fabric shall be identified, stored and handled in accordance with ASTM D 4873.

2.2 COMPONENTS FOR STRAW BALES

The straw in the bales shall be stalks from oats, wheat, rye, barley, rice, or from grasses such as byhalia, bermuda, etc., furnished in air dry condition. The bales shall have a standard cross section of 14 inches by 18 inches. All bales shall be either wire-bound or string-tied. The Contractor may use either wooden stakes or steel posts to secure the straw bales to the ground. Wooden stakes utilized for this purpose, shall have a minimum dimensions of 2 inches x 2 inches in cross section and shall have a minimum length of 3 feet. Steel posts (standard "U" or "T" section) utilized for securing straw bales, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of3 feet.

PART 3 EXECUTION

3.1 INSTALLATION OF SILT FENCES

Silt fences shall extend a minimum of 16 inches above the ground surface and shall not exceed 34 inches above the ground surface. Filter fabric shall be from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, filter fabric shall be spliced together at a support post, with a minimum 6 inch overlap, and securely sealed. A trench shall be excavated approximately 4 inches wide and 4 inches deep on the upslope side of the location of the silt fence. The 4-inch by 4-inch trench shall be backfilled and the soil compacted over the filter fabric. Silt fences shall be removed upon approval by the Contracting Officer.

3.2 INSTALLATION OF STRAW BALES

Straw bales shall be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales

are staked and chinked (gaps filled by wedging with straw), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier. Loose straw shall be scattered over the area immediately uphill from a straw bale barrier to increase barrier efficiency. Each bale shall be securely anchored by at least two stakes driven through the bale. The first stake or steel post in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or steel pickets shall be driven a minimum 18 inches deep into the ground to securely anchor the bales.

3.3 MAINTENANCE

The Contractor shall maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. The following procedures shall be followed to maintain the protective measures.

3.3.1 Silt Fence Maintenance

Silt fences shall be inspected in accordance with paragraph INSPECTIONS. Any required repairs shall be made promptly. Close attention shall be paid to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, the fabric shall be replaced promptly. Sediment deposits shall be removed when deposits reach one-third of the height of the barrier. When a silt fence is no longer required, it shall be removed. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade.

3.3.2 Straw Bale Maintenance

Straw bale barriers shall be inspected in accordance with paragraph INSPECTIONS. Close attention shall be paid to the repair of damaged bales, end runs and undercutting beneath bales. Necessary repairs to barriers or replacement of bales shall be accomplished promptly. Sediment deposits shall be removed when deposits reach one-half of the height of the barrier. Bale rows used to retain sediment shall be turned uphill at each end of each row. When a straw bale barrier is no longer required, it shall be removed. The immediate area occupied by the bales and any sediment deposits shall be shaped to an acceptable grade.

3.4 INSPECTIONS

3.4.1 General

Inspections of all Storm water pollution control devices on the project shall be performed by Contractor on a monthly basis and following each rainfall of 0.50 inches or more in a 24-hour period at the project site as required under provisions of the NPDES General Permit for Arizona. Contractor shall prepare reports on such inspections and retain the reports for a period of three years following the completion of the project.. Additionally, Contractor shall maintain all Storm water pollution control devices on the project in proper working order, which shall include cleaning and/or repair during the duration of the project.

3.4.2 Inspections Details

Disturbed areas shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the Storm Water Pollution Prevention Plan shall be observed to ensure that they are operating correctly. Discharge locations or points shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles exit the site shall be inspected for evidence of offsite sediment tracking.

3.4.3 Inspection Reports

For each inspection conducted, the Contractor shall prepare a report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the Storm Water Pollution Prevention Plan, maintenance performed, and actions taken. The report shall be furnished to the Contracting Officer within 24 hours of the inspection as a part of the Contractor's daily CQC REPORT. A copy of the inspection report shall be maintained on the job site.

3.5 Contractor Warrants

Contractor warrants that its employees and Subcontractors of any tier and their employees shall at all times comply with all applicable laws, ordinances, statutes, rules and regulations set forth by all federal, state and local governments and the Environmental Protection Agency in connection with NPDES Permitting requirements and laws and regulations pertaining to air, groundwater and surface water quality.

Contractor warrants that all storage of pesticides, fertilizers, herbicides and their application shall be consistent with the Best Management Plan as set forth in the City of Phoenix NPDES Permit No. AZ0024554, a copy of which is available for review at the Phoenix Area Office**, 3636 N. Central Ave., #740, Phoenix, AZ 85012-1936, Telephone (602) 640-2021, Ext. 272.**

Fines and penalties imposed by the EPA against Contracting Officer or the Contractor for Contractor's failure to comply with any of the requirements of NPDES General Permit of Arizona shall be borne by the Contractor.

Upon project completion, acceptance and demobilization, Contractor shall submit its completed, duly executed NOT form to the EPA, with a copy to the Arizona Department of Environmental Quality at the address listed in Section (C) above, thereby terminating all NPDES permit coverage for the project. Contractor shall then surrender to Contracting Officer copies of the SWPPP, inspection information and all other documents prepared and maintained by the Contractor in compliance of the NPDES General Permit. Contractor shall retain the originals of such documents for a period of three (3) years following the completion of the project.

Copies of all required forms and guidance for preparing the SWPPP are available in the "Drainage Design Manual for Maricopa County, Volume III Erosion Control." The manual is available at the Flood Control District, 2801 West Durango Street, Phoenix, Arizona 85009.

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SECTION 02300

EARTHWORK

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1140	(1997) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(1990; R 1996el) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2937	(1994) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods

ASTM D 4318	(1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.2 DEFINITIONS

1.2.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, SW, SP, SM, SW-SM. Satisfactory materials for grading shall be comprised of stones less than 3 inches, except as otherwise specified in Part 2 PRODUCTS of this specification section.

1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter. The Contracting Officer shall be notified of any waste materials as specified in Section 01355, ENVIRONMENTAL PROTECTION.

1.2.3 Cohesionless and Cohesive Materials

Cohesionless materials 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. Testing required for classifying materials shall be in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

1.2.4 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557abbreviated as a percent of laboratory maximum density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve shall be expressed as a percentage of the maximum density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224. To maintain the same percentage of coarse material, the "remove and replace" procedure as described in the NOTE 8 in Paragraph 7.2 of AASHTO T 180 shall be used.

1.2.5 Prepared Ground Surface

Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

1.2.6 Completed Course

A course or layer that is ready for next layer or next phase of Work.

1.2.7 Lift

Loose (uncompacted) layer of material.

1.2.8 Geosynthetics

Geotextiles, geogrids, or geomembranes.

1.2.9 Well-Graded

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.2.10 Influence Area

Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1 foot outside outermost edge at base of foundations or slabs.
2. 1 foot outside outermost edge at surface of roadways or shoulder.
3. 0.5 foot outside exterior at spring line of pipes or culverts.

1.2.11 Borrow Material

Material from required excavations or from designated borrow areas on or near site.

1.2.12 Imported Material

Materials obtained from sources offsite, suitable for specified use.

1.2.13 **Waste**

Tires, inert debris, construction debris, metal, hazardous waste, and other waste materal identified in **Article 1.2.8** of Section 01355, ENVIRONMENTAL PROTECTION.

1.2.14 Topsoil

Material suitable for topsoils obtained from areas on or offsite as defined in Section 02921 SEEDING.

1.3 SUBMITTALS

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

SD-01 Preconstruction Submittals

Excavation Plan.

SD-03 Product Data

SD-06 Test Reports

Testing

Within 24 hours of conclusion of physical tests, two copies of test results, including calibration curves and results of calibration tests.

SD-07 Certificates

Testing

Qualifications of the commercial testing laboratory or Contractor's testing facilities.

1.4 SEQUENCE OF WORK

Earth work shall not begin until all Environmental Protection measures are in place as specified in Section 01355, ENVIRONMENTAL PROTECTION.

1.5 SUBSURFACE DATA

Subsurface soil boring logs are shown on the drawings. The subsoil investigation report may be examined at the Contracting Officer'S office. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.6 CLASSIFICATION OF EXCAVATION

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.7 BLASTING

Blasting will not be permitted.

1.8 UTILIZATION OF EXCAVATED MATERIALS

Unsatisfactory materials removed from excavations shall be disposed of as specified in Section 01355, ENVIRONMENTAL PROTECTION. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding, and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed of in designated areas approved for surplus material storage or designated waste areas as directed. No excavated material shall be disposed of to obstruct the flow of the low flow channel or any side drainages, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

PART 2 PRODUCTS

2.1 EARTHFILL

a. Excavated satisfactory material from required excavations free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

b. Provide imported material of equivalent quality, if required to

accomplish Work.

c. Earthfill used in conjunction with soil reinforcing should contain a maximum of 12 percent by weight passing the No. 200 sieve. This material shall be non-corrosive to steel with a resistivity of not less than 2000 ohm-centermeters and a pH valve between 6.0 and 10.0.

d. The CONTRACTOR may elect to crush and use onsite concrete debris as earthfill for the project. The crushed material must meet the above gradation requirement. Imported crushed concrete material will not be allowed.

2.2 STRUCTURAL FILL

a. 1-inch minus crushed gravel or crushed rock.

b. Free from dirt, clay balls, and organic material.

c. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.3 PROTECTIVE **FILL** FOR GEOMEMBRANE LININGS

a. Rounded satisfactory materials free from clay, organic matter, or other deleterious material.

b. Gradation as determined in accordance with ASTM C 117 and ASTM C 136:

Sieve Size	Percent Passing by Weight
1/4-inch	100
No. 4	95-100
No. 200	0-5

2.4 GRANULAR DRAIN MATERIAL

A. As specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

2.5 GRANULAR FILTER MATERIAL

a. Clean, hard, durable gravel, free from foreign materials and washed.

b. Gradation as determined in accordance with ASTM C 117 and ASTM C 136:

Sieve Size	Percent Passing by Weight	
	Adjacent to Soil Bentonite	Adjacent to Natural Clay
3-inch	100	100
1-inch	60 to 100	90 to 100
½-inch	25 to 60	80 to 100
No. 4	0 to 20	70 to 90
No. 50		0 to 35
No. 200	0 to 5	0 to 5

2.6 WATER FOR MOISTURE CONDITIONING

a. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.7 BASE COURSE ROCK

a. As specified in Section 02722 AGGREGATE BASE COURSE.

2.8 FOUNDATION STABILIZATION ROCK

a. Crushed rock or pit run rock.
b. Uniformly graded from coarse to fine.
c. Free from excessive dirt and other organic material.
d. Maximum 2-1/2-inch particle size.

2.9 RIVER ROCK

Processed rounded material from excavations. Provided imported material as required to meet the needs of the project.

Rock Size	Percent Smaller by Weight
12-inch	95
6-inch	85
4-inch	50
3-inch	10
1-inch	2 to 10

2.10 AGGREGATE RIPRAP BEDDING

a. Gravel with Cobbles or Crushed Rock with Cobble-Sized Pieces:

1. Gradation, as determined in accordance with ASTM C 136:
   a. Well-graded from coarse to fine.
   b. All pieces pass a 6-inch square opening.
   c. Minimum 85 percent by weight passes 4-inch square opening.
   d. Minimum 10 percent by weight passes No. 4 U.S. standard sieve.

2. Abrasion Resistance: Maximum 35 percent wear when tested in accordance with ASTM C 535.

b. Free of roots and other organic or deleterious matter.

2.11 RIPRAP

a. Hard and durable quarry stone free from fractures, bedding planes, pronounced weathering, and earth or other adherent coatings.

b. Minimum Dimension of Individual Pieces: Not less than 1/3 maximum dimension.

c. Abrasion Resistance: Maximum 35 percent wear as determined in accordance with ASTM C535.

d. Bulk Density: Minimum 160 pounds per dry cubic foot.

e. Gradation: Smaller pieces shall generally fill voids between larger pieces without either excess or deficiency of one or more sizes of stone.

Rock Size	Percent Smaller by Weight	
	D50 = 6-inch	D50 = 18-inch
36-inch	100	95
24-inch	100	85
18-inch	95	50
12-inch	85	
6-1nch	50	15
4-inch	15	
3-inch	0 to 5	0 to 5

PART 3 EXECUTION

3.1 GENERAL EXCAVATION

The Contractor shall perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Grading shall be in conformity with the typical sections shown and the tolerances specified in paragraph FINISHING. Satisfactory excavated materials shall be transported to and placed in fill or embankment within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as specified in Section 01355, ENVIRONMENTAL PROTECTION or as directed. Such excavated material and the satisfactory material ordered as replacement shall be included in excavation. Surplus satisfactory excavated material not required for fill or embankment shall be disposed of in areas approved for surplus material storage or designated waste areas. Unsatisfactory excavated material shall be disposed of in designated waste or spoil areas as specified in Section 01355, ENVIRONMENTAL PROTECTION. During construction, excavation and fill shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

The Contractor shall prepare an Excavation Plan, Detailing:

a. Methods and sequencing of excavation.
b. Proposed locations of stockpiled excavated material.
c. Proposed onsite and offsite spoil disposal sites.
d. Numbers, types, and sizes of equipment proposed to perform excavations.

3.1.1 Ditches, Gutters, and Channel Changes

Excavation of ditches, gutters, and channel changes shall be accomplished by cutting accurately to the cross sections, grades, and elevations shown. Ditches and gutters shall not be excavated below grades shown. Excessive open ditch or gutter excavation shall be backfilled with satisfactory, thoroughly compacted earthfill. Material excavated shall be disposed of as shown or as directed, except that in no case shall material be deposited less than 4 feet from the edge of a ditch. The Contractor shall maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.1.2 Structures

Excavations shall be made to the lines, grades, and elevations shown, or as

directed. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. When concrete or masonry is to be placed in an excavated area, the bottom of the excavation shall not be disturbed. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed. Do not overexcavate without permission of the Contracting Officer.

3.2 EXCAVATION OF **WASTE**

The Contractor shall immediately notify the Contracting Officer if **waste as defined in Article 1.2.8 of Section 01355 ENVIRONMENTAL PROTECTION** is encountered during excavation. Excavation and disposal will be in accordance with requirements in Section 01355, ENVIRONMENTAL PROTECTION. Should **waste** extend below bottom or beyond the sides of the planned excavation the Contractor shall over excavate within the influence area to the following depth and distances, as shown on plans, or as directed.

Facility	Distance of Over Excavation (feet)	
	Inert **Material** or Construction Debris	Mixed, Household Waste, or Tires
Structures	5	Depth equal to twice foundation width
Roads	3	5
Reservoirs	3	5
Overbank Canals	2	3
Wetlands	4	5
Pipelines	2	3

All overexcavations at inert **material**, construction debris, or mixed waste locations shall be backfilled as specified for earth embankments fill unless otherwise directed by the Contracting Officer. Overexcavations at household waste locations shall be backfilled with liner material as specified in Section 01355, ENVIRONMENTAL PROTECTION, unless otherwise directed by the Contracting Officer.

3.3 TIRE REMOVAL

All tires and pieces of tires greater than 6 inches in size shall be removed from within the excavation limits and disposed offsite.

All tires removed during excavation activities or recovered from the ground surface shall be handled, stored, transported, and disposed of in accordance with applicable federal, state, and local regulations. Applicable state regulations include: Arizona Revised Statues (ARS) §§44-1301 et seq: §44-1301; §44-1302; §44-1303; §44-1304.01; §44-1305; §44-1306; §44-1307.

Tires shall be cleaned of all soil and other debris prior to removal from site.

3.4 SPECIAL OR HAZARDOUS WASTE

Special or Hazardous Waste: In the event that the Contractor encounters any suspected special or hazardous. waste materials are encountered, The Contractor will immediately notify the Contracting Officer. The Contracting Officer will direct the Contractor to implement the Special and Hazardous Waste Contingency Plan as specified in Section 01355, Environmental Protection.

3.5 SELECTION OF BORROW MATERIAL

Borrow material shall be satisfactory material selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from excavation areas within the limits of the project site, selected by the Contractor or from approved private sources. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.

3.6 BACKFILL

3.6.1 GENERAL

a. Keep placement surfaces free of water, **waste**, and foreign material during placement and compaction of fill and backfill materials.

b. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

c. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

d. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

    1. Fill or backfill to an elevation 2 feet above top of item to be laid.
    2. Excavate trench for installation of item.
    3. Install bedding, if applicable, as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.
    4. Install item.
    5. Backfill envelope zone and remaining trench, as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, before resuming filling or backfilling specified in this section.

e. Tolerances:
    1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
    2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

f. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

Moisture content of backfill shall be plus 2 to minus 4 percent optimum moisture.

3.6.2 Backfill Under and Around Structures

a. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place structural fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction.

b. Subsurface Drainage: Backfill with granular drain material, where shown. Place granular drain material in lifts of 8-inch maximum thickness and compact each lift to minimum of 90 percent relative compaction.

3.7 PREPARATION OF GROUND SURFACE FOR EMBANKMENTS

3.7.1 General Requirements

Ground surface on which fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, **waste**, and other unsatisfactory material; plowed, disked, or otherwise broken up to a depth of 12 inches; pulverized; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 95 percent laboratory maximum density. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. The prepared ground surface shall be scarified and moistened or aerated as required just prior to placement of embankment materials to assure adequate bond between embankment material and the prepared ground surface.

3.8 EMBANKMENTS

3.8.1 Earth Embankments

Earth embankments shall be constructed from satisfactory material meeting the requirements of earthfill free of organic material and rocks with any dimension greater than 3 inches. The material shall be placed in successive horizontal layers of loose material not more than 8 inchesin depth. Each layer shall be spread uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, each layer shall be plowed, disked, or otherwise broken up; moistened or aerated as necessary; thoroughly mixed; 95 percent laboratory maximum density. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical with those requirements specified in paragraph SUBGRADE PREPARATION. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.9 SUBGRADE PREPARATION

3.9.1 Construction

Subgrade shall be shaped to line, grade, and cross section, and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain specified compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with

satisfactory excavated material or other approved material as directed. Low areas resulting from removal of unsatisfactory material shall be brought up to required grade with earthfill materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified. The elevation of the finish subgrade shall not vary more than 0.05 foot from the established grade and cross section.

3.9.2 Compaction

Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.10 FINISHING

The surface of excavations, embankments, and subgrades shall be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. The degree of finish for graded areas shall be within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades shall be specified in paragraph SUBGRADE PREPARATION. Gutters and ditches shall be finished in a manner that will result in effective drainage. The surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.

3.11 PLACING FILL OVER GEOYNTHETICS

3.11.1 General

1. Place fill over geosynthetics with sufficient care so as not to damage them.
2. Place fill only by back dumping and spreading only.
3. Dump fill only on previously placed fill.
4. While operating equipment, avoid sharp turns, sudden starts or stops that could damage geosynthetics.

3.11.2 Hauling

Operate hauling equipment on minimum of 3 feet of covering.

3.11.3 Spreading

1. Spreading equipment shall be track mounted, low ground pressure, D-6 or lighter.
2. Operate spreading equipment on minimum of 12 inches of fill over geosynthetics.
3. Spread fill in same direction as unseamed overlaps to avoid separation of seams and joints.
4. Never push fill downslope. Spread fill over sideslopes by pushing up from slope bottom.
5. Flatten wrinkles of geotextiles, in direction of spreading. Correct wrinkles in geotextiles as specified in Section 02373 GEOTEXTILE.
6. Correct wrinkles in geomembranes as specified in Section 02661 POND AND RESERVOIR LINERS - LLDPE
7. Maintain proper overlap of unseamed geosynthetics.
8. Avoid overstressing geosynthetics and seams.

3.11.4 Compaction

Compact fill only after uniformly spread to full thickness shown.

3.11.5 Geosynthetic Damage

1. Mark punctures, tears, or other damage to geosynthetics, so repairs may be made.
2. Clear overlying fill as necessary to repair damage.
3. Repairs to geosynthetics shall be made by respective installers as specified in respective specification section for each geosynthetic.

3.12 PLACING RIPRAP BEDDING

a. Place riprap bedding over prepared subgrade to uniform thickness shown.

b. No mechanical compaction of riprap is required; however, work riprap bedding as necessary to distribute it and to eliminate detrimental voids. Avoid overworking or long pushes that result in segragation of particle sizes.

c. Grade surface of riprap bedding free from irregularities and to tolerances of 0.2 feet from established grade.

d. Place and grade riprap bedding in a manner that avoids subgrade disturbance displacement or damage to geotextile. Do not push riprap bedding down slope. If wrinkles form in geotextile as riprap bedding is placed, correct them as specified in Section 02373 GEOTEXTILE.

3.13 PLACING RIPRAP OR RIVER ROCK

a. Place riprap or river rock bedding to uniform thickness shown.

b. Intermix different sizes of pieces to eliminate segregation and to fill voids between larger pieces with smaller pieces and work surface free from irregularities.

c. Use placement and intermixing methods that avoid disturbing riprap bedding or damaging existing facilities, completed work, or adjacent property.

d. When placing river rock over shotcrete.

3.14 TESTING

Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved by the Contracting Officer. 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 ASTM D 1556. ASTM D 2922results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017; the calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. ASTM D 2937, Drive Cylinder Method shall be used only for soft, fine-grained, cohesive soils. When test

results indicate, as determined by the Contracting Officer, that compaction is not as specified, the material shall be removed, replaced and recompacted to meet specification requirements. Tests on recompacted areas shall be performed to determine conformance with specification requirements. Inspections and test results shall be certified by a registered professional civil engineer. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.14.1 Fill and Backfill Material Gradation

One test per 1,000 cubic yards stockpiled or in-place source material. Gradation of fill and backfill material shall be determined in accordance with ASTM C 136 ASTM D 422 ASTM D 1140.

3.14.2 In-Place Densities

a. One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 150 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per 100 linear feet, or fraction thereof, of each lift of embankment or backfill for roads.

3.14.3 Moisture Contents

In the stockpile, excavation, or borrow areas, a minimum of two tests per day per type of material or source of material being placed during stable weather conditions shall be performed. During unstable weather, tests shall be made as dictated by local conditions and approved by the Contracting Officer.

3.14.4 Optimum Moisture and Laboratory Maximum Density

Tests shall be made for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 1500 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.14.5 Tolerance Tests for Subgrades

Continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION shall be made during construction of the subgrades.

3.15 SUBGRADE AND EMBANKMENT PROTECTION

During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained to drain effectively at all times. The finished subgrade shall not be disturbed by traffic or other operation and shall be protected and maintained by the Contractor in a satisfactory condition until ballast, subbase, base, or pavement is placed. The storage or stockpiling of materials on the finished subgrade will not be permitted. No subbase, base course, ballast,

or pavement shall be laid until the subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on a muddy, spongy, or frozen subgrade.

-- End of Section --

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SECTION 02371

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SECTION 02371

WIRE MESH GABIONS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 370	(1997a) Mechanical Testing of Steel Products
ASTM A 641/A 641M	(1998) Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A 764	(1995) Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs
ASTM A 974	(1997) Welded Wire Fabric Gabions and Gabion Mattresses (Metallic Coated or Polyvinyl Chloride (PVC) Coated)
ASTM A 975	(1997) Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire With Poly(Vinyl Chloride) (PVC) Coating)
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM C 33	(1999ael) Concrete Aggregates
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 412	(1998a) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastometers - Tension
ASTM D 746	(1998) Brittleness Temperature of Plastics and Elastometers by Impact
ASTM D 792	(1998) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 1242	(1995a) Resistance of Plastic Materials to Abrasion
ASTM D 1499	(1999) Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of

	Plastics
ASTM D 2240	(2000) Rubber Property-Durometer Hardness
ASTM G 23	(1996) Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 144	(1992) Standard Test Method for Resistance of Rock to Freezing and Thawing

1.2 GENERAL REQUIREMENTS

The work under this specification includes furnishing, assembling, filling and tying open wire mesh rectangular compartmented gabions placed on a prepared surface of filter material, as specified, and in accordance with the lines, grades, and dimensions shown or otherwise established in the field.

1.3 SUBMITTALS

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

SD-04 Samples

Gabions or Mattresses
Alternative Wire Fasteners

Samples of the materials, used to fabricate the gabions or mattresses, shall be furnished to the Contracting Officer 60 days prior to assembly of units onsite so that testing may be performed by the Government in accordance with either ASTM A 974 or ASTM A 975 depending on which system is being furnished by the Contractor.

SD-06 Test Reports

Gabions or Mattresses
Alternative Wire Fasteners

For each shipment of wire gabions or mattresses delivered to the site, the Contractor shall furnish the Contracting Officer, in duplicate, test reports or records that have been performed during the last year on all material contained within the shipment meets the composition, physical, and manufacturing requirements stated in this specification.

SD-07 Certificates

Stone Fill
Filter Material

A certificate or affidavit signed by a legally authorized official of the supplier of the stone fill and the supplier of the

natural filter material that it meets the quality required and gradation limits specified.

1.4 DESCRIPTION

Gabions are double-twisted wire mesh containers of variable sizes, uniformly partitioned into internal cells, interconnected with other similar units, and filled with stone at the project site to form flexible, permeable, monolithic structures. Gabions shall be manufactured with all components mechanically connected at the production facility. The supply to the jobsite of unassembled individual wire mesh components (panels) forming gabions will not be permitted. Definitions of terms specific to this specification and to all materials furnished on the jobsite, with the exception of the rock to fill the baskets and the filter material, shall refer and be in compliance with ASTM A 975 for double twisted wire mesh Gabions.

1.5 DEFINITIONS

1.5.1 Double twisted wire mesh Gabions

They are classified according to the wire coating, which is applied prior to manufacturing the mesh. Coating styles are as follows:

Style 1, consists of double-twisted wire mesh made from wire which is zinc coated before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are produced from zinc-coated wire;

Style 2, consists of double-twisted wire mesh made from wire which is coated with Zn-5Al-MM before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are also produced from Zn-5Al-MM coated wire;

Style 3, consists of double-twisted wire mesh, lacing wire, and stiffeners as Style 1 and overcoated with PVC. Fasteners shall be of stainless steel wire;

Style 4, consists of double-twisted wire mesh made from wire which is aluminum-coated before being double twisted into mesh. Fasteners, lacing wire, and stiffeners are also produced from aluminum-coated wire.

Style 1 for the wire coating is normally recommended for:

a. permanent gabion structures, for works installed in non-aggressive or non-polluted environments, and this condition remains unaltered over time;

b. temporary gabion structures, for works in moderately aggressive environments, depending on the minimum design life of the structure.

Style 2 for the wire coating is normally recommended for:

a. permanent gabion structures, for works installed in moderately aggressive environments;

b. temporary gabion structures, for works in aggressive environments, depending on the minimum design life of the structure.

Style 3 for the wire coating is normally recommended for both permanent

and temporary gabion structures, for works installed in aggressive or polluted environments, or when the aggressiveness of the site is moderately unpredictable or variable from low to high.

Style 4 for the wire coating is very seldom used in the gabion industry. Its life expectancy shall be adequately documented to guarantee its consistency and reliability.

The determination of the rate of aggressiveness (non-aggressive, moderately, or highly aggressive) shall be made on a project-to-project basis, due to the many variables involved and the lack of criteria of general validity. It is normally recommended for the choice to be based on all the available data and on the experience of existing gabion structures in similar environments.

1.6 Government Testing and Studies

1.6.1 Samples

Samples of materials used to fabricate the Gabions shall be furnished to the Contracting Officer 60 days prior to start of installation. Samples will be tested in accordance with specification. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Double twisted wire mesh Gabions

Double twisted wire mesh Gabions shall be Style 3 manufactured with a non-raveling mesh made by twisting continuous pairs of wires through three half turns (commonly called double twisted) to form a hexagonal-shaped opening. Gabion sizes, wire diameters, mesh opening sizes, and tolerances shall comply with the requirements of ASTM A 975 (Tables 1, 3, 4, 5, 6, and Sections 9). Gabions shall meet the following test requirements:

Metallic coating - The coating weights shall conform to the requirements of ASTM A 641/A 641M, Class 3.

PVC for Coating - The PVC coating shall show no cracks or breaks after the wires are twisted in the fabrication of the mesh. The initial properties of PVC coating material shall have a demonstrated ability to conform to the following requirements:

a. Specific Gravity - In the range from 1.30 to 1.35 dN/dm3, when tested in accordance with test method ASTM D 792;

b. Tensile Strength - Not less than 2985 psi when tested in accordance with test method ASTM D 412;

c. Modulus of Elasticity - Not less than 2700 psi when tested in accordance with test method ASTM D 412;

d. Hardness - Shore "D" between 50 and 60, when tested in accordance

with test method ASTM D 2240;

e. Brittleness Temperature - Not higher than 15 degrees F, or lower temperature when specified by the purchaser, when tested in accordance with test method ASTM D 746.

f. Resistance to Abrasion - The percentage of the weight loss shall be less than 12%, when tested in accordance with test method ASTM D 1242;

g. Salt Spray Exposure and Ultra Violet Light Exposure - The PVC shall show no effect after 3,000 h of salt spray exposure in accordance with ASTM B 117. The PVC shall show no effect of exposure to ultra violet light with test exposure of 3,000 h, using apparatus Type E and 145 degrees F, when tested in accordance with practice ASTM D 1499 and ASTM G 23;

h. Evaluation of Coating After Salt Spray and Ultraviolet Exposure Test - After the salt spray test and exposure to ultraviolet light, the PVC coating shall not show cracks nor noticeable change of color, or blisters or splits. In addition, the specific gravity, tensile strength, hardness and resistance to abrasion shall not change more than 6%, 25%, and 10% respectively, from their initial values.

Wire Tensile Strength - The tensile strength of the wire used for the double twisted mesh, lacing wire, and stiffener, when tested in accordance with Test Methods and definitions ASTM A 370, shall be in accordance with the requirements of ASTM A 641/A 641M for soft temper wire.

Mesh strength and panel to panel joint strength - The minimum strength requirements of the mesh, selvedge wire to mesh connection, panel to panel connection, and punch test, when tested in accordance with ASTM A 975 Section 13.1, shall be as shown in Table 1. The strength values reported in lb/ft are referred to the unitary width of the specimen. The panel to panel test shall demonstrate the ability of the fastening system to achieve the required strength, and indicate the number of wire revolutions for the lacing wire or the ring spacing for ring fasteners used. The same number of wire revolutions or ring spacing shall be used in the field installation.

TABLE 1

Minimum Strength Requirements of Mesh and Connections

Test description	Gabions, metallic coated lb/ft	Gabions, PVC coated lb/ft
Tensile strength parallel to twist	3500	2900
Tensile strength perpendicular to twist	1800	1400
Connection to selvedges	1400	1200
Panel to panel (using	1400	1200

TABLE 1

Minimum Strength Requirements of Mesh and Connections

Test description	Gabions, metallic coated lb/ft	Gabions, PVC coated lb/ft
lacing wire or ring fasteners		

Test description	Gabions, metallic coated lb	Gabions, PVC coated lb
Punch Test	6000	5300

2.1.2 Alternative Wire Fasteners for Gabions

Subject to approval of the Contracting Officer, alternative fastening systems may be used in lieu of lacing wire. Alternative fasteners to lacing wire recommended for woven wire gabions and mattresses, according to ASTM A 975, are steel ring fasteners for metallic coated gabions and mattresses, or stainless steel rings for PVC coated gabions and mattresses. Ring fasteners for woven wire gabions and mattresses shall comply with the minimum requirements indicated in paragaph Ring Fasteners below, and they shall develop a minimum panel to panel joint strength as indicated in TABLE 1. The Contractor shall provide a complete description of the fastener system and a description of a properly installed fastener, including drawings or photographs if necessary. The Contractor shall provide test results that demonstrate that the alternative-fastening system meets the requirements of the specifications, according to the following criteria:

a. That the proposed fastener system can consistently produce a panel to panel joint strength as indicated in the TABLE 1 for double twisted wire mesh gabions;

b. That the proposed fastener system does not cause damage to the protective coating on the wire;

c. That the Contractor has the proper equipment and trained employees to correctly install the fasteners;

d. That proper installation can be readily verified by visual inspection.

Samples of wire fasteners with their certified test records shall be submitted at least 60 days in advance to the Contracting Officer for approval. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

2.1.2.1 Ring Fasteners

The tensile strength of the zinc-coated steel wire, zinc-5% aluminum coated mischmetal alloy-coated steel wire and aluminum-coated steel wire used for fasteners shall be in accordance with the requirements of ASTM A 764, Type A, B, or C, Table 2 or Table 3. Any fastener system shall give the number of fasteners required to comply with TABLE 1, in accordance with ASTM A 975

(Section 13.1.2) for woven wire gabions and mattresses. Ring fasteners shall not be installed more than 4 inches apart. Each fastener type shall be closed and the free ends of the fastener shall overlap a minimum of 1 inch. The manufacturer or supplier shall state the number of fasteners required for all vertical and horizontal connections for single and multiple basket joining. Approved ring fasteners including fasteners made of stainless steel shall be subject to the salt spray test and pull-apart resistance test and shall be documented by actual testing of panel to panel connections within the last year by validated laboratories.

a. Salt Spray Test - A set of two identical rectangular gabion panels, each with a width about 10-1/2 mesh openings along a selvedge wire, shall be joined by properly installed wire fasteners along the two selvedge wires so that each fastener confines two selvedge and two mesh wires. If the fasteners are also to be used to joint two individual empty gabion baskets, two additional selvedge wires which are each mechanically wrapped with mesh wires shall be included so that each fastener confines four selvedge and four mesh wires. The set of the jointed panels shall be subject to salt spray test, ASTM B 117, for a period of not less than 48 hours. At the end of the test, the fasteners, the selvedge, or mesh wires confined by the fasteners shall show no rusty spots on any part of the surface excluding the cut ends. A properly installed fastener shall meet the following requirements:

    1) Each interlocking fastener shall be in a locked and closed position.

    2) Each ring fastener shall be closed, and the free ends of the fastener shall overlap a minimum of 1 inch.

b. Pull-Apart Resistance Test - A new set of the jointed panels, which are prepared by the same method as specified in the salt spray test but without being subject to the 48-hour salt spray test, shall be mounted on a loading machine with grips or clamps such that the panels are uniformly secured along the full width. The grips or clamps shall be designed to transmit only tension forces. The load will then be applied at a uniform rate of 50 lbs/sec until failure occurs. The failure is defined as when the maximum load is reached and a drop of strength is observed with subsequent loading or the opening between any two closest selvedge wires, applicable to a fastener confining either two or four selvedge wires, becomes greater than 2 inches at any place along the panel width. The strength of the jointed panels at failure shall have a minimum as indicated in TABLE 1.

2.1.3 Testing

Test records made within one year by certified laboratories and Government agencies will be used to determine the acceptability of the fastening system. Samples of wire fasteners and samples of material for fabricating the gabions and mattresses with their certified test records shall be submitted at least 60 days in advance to the Contracting Officer for approval. The Government reserves the right to test additional samples to verify the submitted test records at the Government's expense. When the first test results indicate that the fasteners do not meet the specified requirements, the additional test will be at the Contractor's expense. The fasteners will be rejected after two tests failing to meet the requirements.

2.1.4 Stone Fill

2.1.4.1 General

For gabions, the ability to function properly depends upon their stability, which is partly depending upon the rocks filling them. Rock sizes should be chosen to prevent them from falling through the mesh of the gabions. The rock has also to withstand natural weathering processes during the life of the project that would cause it to breakdown to sizes smaller than the wire mesh opening dimensions. Rock to fill gabions shall be durable and of suitable quality to ensure permanence in the structure and climate in which it is to be used.

a. Delivery. Rock shall be delivered to the work site in a manner to minimize its reduction in sizes (breakdown) during the handling of the rock, and be placed and secured within the assembled and interconnected gabion.

b. Sources. The sources from which the Contractor proposes to obtain the material shall be selected well in advance of the time when the material will be required in the work. The inclusion of more than 5% by weight of dirt, sand, clay, and rock fines will not be permitted. Rock may be of a natural deposit of the required sizes, or may be crushed rock produced by any suitable method and by the use of any device that yields the required size limits chosen in TABLE 4.

c. Properties. Rocks shall be Salt River rock and shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure.

d. Non-listed Source. The Contractor may, as an option, propose to furnish stone from one non-listed source. The Government may make such investigations and tests as necessary to determine whether acceptable stone can be produced from the proposed source. Suitable samples of stone fill material shall be collected in the presence of a Government representative and submitted to the Contracting Officer for approval prior to delivery of any such material to the work site. Unless otherwise specified, all test samples shall be obtained and delivered at the Contractor's expense to the project site at least 60 days in advance of the time when placing of the stone-filled gabions is expected to begin. Suitable tests and/or service records will be used to determine the acceptability of the stone. In the event suitable test reports and service records are not available, as in the case of newly operated sources, the material may be subjected to petrography analysis, specific gravity, absorption, wetting and drying, freezing and thawing, and such other tests as may be considered necessary to demonstrate to the satisfaction of the Contracting Officer that the materials are acceptable for use in the work. All tests will be made by or under the supervision of the Government and at its expense.

2.1.4.2 Stone Quality

Stone fill, crushed stone, shall meet the quality requirements of ASTM C 33, and freezing and thawing requirements of COE CRD-C 144 for the region of the United States in which the structure will be constructed.

2.1.4.3 Gradation

Gradation of stone for gabions shall be performed every 100 tons placed under this contract in accordance with ASTM C 136. Sizes of rock to fill gabions are chosen on the basis of the mesh sizes, the structure's thickness, and within the limits shown in TABLE 4. Within each range of

sizes, the rock shall be large enough to prevent individual pieces from passing through the mesh openings. Each range of sizes may allow for a variation of 5% oversize rock by weight, or 5% undersize rock by weight, or both.

a. Oversize Rock. In all cases, the sizes of any oversize rock shall allow for the placement of three or more layers of rock within each gabion compartment.

b. Undersize Rock. In all cases, undersize rock shall be placed within the interior of the gabion compartment and shall not be placed on the exposed surface of the structure. There shall be a maximum limit of 5% undersize or 5% oversize rock, or both, within each gabion compartment. The required rock gradation is reported in Table 4.

TABLE 4
Required rock gradation for gabions

Type of structure	Thickness (height) inch	Rock sizes inch
Gabions	Less than 12	4 - 8
Gabions	12 or higher	4 - 12

2.1.5 Filter Material

Filter fabrics shall meet the provisions of Section 02373 GEOTEXTILE.

PART 3 EXECUTION

3.1 MATERIAL DELIVERY

Gabions shall be delivered with all components mechanically connected at the production facility. All gabions are supplied in the collapsed form, either folded or bundled or rolled, for shipping. Bundles are banded together at the factory for ease of shipping and handling.

a. Gabions shall be delivered to the jobsite labeled in bundles. Labels shall show the dimensions of the gabions included, the number of pieces and the color code.

3.2 FOUNDATION PREPARATION

After excavation or stripping, to the extent indicated on the drawings or as directed by the Contracting Officer, all remaining loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free-draining materials. Otherwise, the depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. Any debris that will impede the proper installation and final appearance of the gabion layer shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to placing the material, the Contracting Officer shall inspect the prepared foundation surface, and no material shall be placed thereon until that area has been approved.

3.3 FILTER PLACEMENT

Filter material shall be placed as shown on plans in a manner satisfactory to the Contracting Officer. Any damage to the foundation surface during the filter placement shall be repaired before proceeding with the work. Compaction of the filter materials will not be required, but it shall be finished to present a reasonably even surface free from mounds or windrows.

3.4 ASSEMBLY

3.4.1 Double twisted wire mesh Gabions

The gabions shall be opened and unfolded one by one on a flat, hard surface. Gabion units over 6 foot in length usually have an extra shipping fold, which must be removed. The sides, ends and diaphragms shall be lifted up into a vertical position to form an open box shape. The back and the front panels of the gabion shall be connected to the end panels and center diaphragms. The top corner of the end panels and center diaphragms have a selvedge wire extending approximately 4 inches out from the corner edge. The end panels and the diaphragms shall be raised to a vertical position and the selvedge wire shall be wrapped around the edge wire of the top and back panels.

3.5 LACING OPERATIONS

3.5.1 Double Twisted Wire Mesh Gabions

Either lacing wire or ring fasteners are permitted to lace double twisted wire mesh Gabions.

a. When using lacing wire, a piece of wire 1.2 to 1.5 times the length of the edge to be laced shall be cut off. If the edge of the basket is 3 foot long, no more than 4 to 5 feet of wire shoul be uses at a time to lace. For vertical joints, starting at the bottom end of the panel, the lacing wire shall be twisted and wrapped two times around the bottom selvedge and double and single loops shall be alternated through at intervals not bigger than 4 to 6 inches. The operation shall be finished by looping around the top selvedge wire. The use of pliers to assemble the units with lacing wire is normally recommended.

b. When steel wire ring fasteners are used, the rings shall be installed at the top and bottom connections of the end and center diaphragms. The ring spacing shall be based on the minimum pull apart strength as specified in TABLE 1. In any case, the maximum ring spacing along the edges shall not exceed 6 inches. The use of either a mechanical or a pneumatic fastening tool for steel wire ring fasteners is required. Ring fasteners shall be galvanized, stainless steel or Zn-5% aluminum-mischmetal alloy coated.

3.6 INSTALLATION AND FILLING

Empty gabion units shall be assembled individually and placed on the approved surface to the lines and grades as shown or as directed, with the sides, ends, and diaphragms erected in such a manner to ensure the correct position of all creases and that the tops of all sides are level. All gabion units shall be properly staggered horizontally and vertically as shown in the construction drawings. Finished gabion structures shall have no gaps along the perimeter of the contact surfaces between adjoining units. All adjoining empty gabion units shall be connected along the perimeter of their contact surfaces in order to obtain a monolithic structure. All lacing wire terminals shall be securely fastened. All

joining shall be made through selvedge-to-selvedge or selvedge-to-edge wire connection; mesh-to-mesh or selvedge-to-mesh wire connection is prohibited except in the case where baskets are offset or stacked and selvedge-to-mesh or mesh-to-mesh wire connection would be necessary. As a minimum, a fastener shall be installed at each mesh opening at the location where mesh wire meets selvedge or edge wire.

a. The initial line of basket units shall be placed on the prepared filter layer surface and adjoining empty baskets set to line and grade, and common sides with adjacent units thoroughly laced or fastened. They shall be placed in a manner to remove any kinks from the mesh and to a uniform alignment. The basket units then shall be partially filled to provide anchorage against deformation and displacement during the filling operation. The stone shall be placed in the units as specified in paragraph Stone Fill, subparagraph Gradation, part b.

b. Undue deformation and bulging of the mesh shall be corrected prior to further stone filling. Care shall be taken, when placing the stone by hand or machine, to assure that the PVC coating on gabions will not be damaged. All visible faces shall be filled with some hand placement to ensure a neat and compact appearance and that the void ratio is kept to a minimum.

c. Gabions shall be uniformly overfilled by about 1 to 2 inches to compensate for future rock settlements. Gabions can be filled by any kind of earth-filling equipment, such as a backhoe, gradall, crane, etc. The maximum height from which the stones may be dropped into the baskets shall be 4 feet. If PVC coated materials are used, no work shall take place unless the ambient temperature is above 20 degrees F.

3.6.1 Double twisted wire mesh Gabions

After the foundation has been prepared, the pre-assembled gabions shall be placed in their proper location to form the structure. Gabions shall be connected together and aligned before filling the baskets with rock. All connections (panel-to-panel) and basket-to-basket shall be already carried out as described in paragraph ASSEMBLY. Stone fill shall have a gradation of 4 to 12 inches, as described in paragraph Gradation, and shall be placed in 1 foot lifts. Cells shall be filled to a depth not exceeding 1 foot at a time. The fill layer should never be more than 1 foot higher than any adjoining cell. Stiffeners or internal cross ties shall be installed in all front and side of the gabions at 1/3 and 2/3 of the height for 3 feet or higher gabions, as the cell is being filled. Stiffeners shall be installed in the center of the cells. In 1.5 foot high units, stiffeners or internal crossties are not required. Internal cross ties, or alternatively the preformed stiffeners, shall be looped around three twisted wire mesh openings at each basket face and the wire terminals shall be securely twisted to prevent their loosening. The number of voids shall be minimized by using a well-graded stone in order to achieve a dense, compact stone fill. All corners shall be securely connected to the neighboring baskets of the same layer before filling the units. When more than one layer of gabions is required, in order for the individual units to become incorporated into one continuous structure, the next layer of gabions shall be connected to the layer underneath after this layer has been securely closed. Gabions shall be uniformly overfilled by about 1 to 2 inches to compensate for future rock settlements.

3.6.2 Non-rectangular Shapes

Gabion units can conform to bends up to a radius of curvature of 60 to 70 feet without alterations. Units shall be securely connected together first, and be placed to the required curvature, holding them in position by staking the units to the ground with hardwood pegs before filling. For other shapes, bevels and miters can be easily formed by cutting and folding the panels to the required angles.

3.7 CLOSING

Lids shall be tightly secured along all edges, ends and diaphragms in the same manner as described for assembling. Adjacent lids may be securely attached simultaneously. The panel edges shall be pulled to be connected using the appropriate closing tools where necessary. Single point leverage tools, such as crowbars, may damage the wire mesh and shall not be used. All end wires shall then be turned in.

-- End of Section --

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DIVISION 02 - SITE WORK

SECTION 02821

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SECTION 02821

FENCING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 121	(1999) Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 153/A 153M	(2000) Zinc-Coating (Hot Dip) on Iron and Steel Hardware
ASTM A 392	(1996) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 491	(1996) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 780	(2000) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 824	(1995) Metallic-Coated Steel Marcelled Tension Wire for Use With Chain Link Fence
ASTM C 94/C 94M	(2000) Ready-Mixed Concrete
ASTM F 626	(1996a) Fence Fittings
ASTM F 883	(1997) Padlocks
ASTM F 900	(1994) Industrial and Commercial Swing Gates
ASTM F 1043	(2000) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1997) Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 1184	(1994) Industrial and Commercial Horizontal Slide Gates

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office

that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-07 Certificates

Chain Link Fence

Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the chain link fence and component materials meet the specified requirements.

DELETED

1.3 APPROVAL OF POLYVINYL CHLORIDE-COATED FENCE MATERIALS

Polyvinyl chloride-coated fence materials shall be throughly inspected for cracking, peeling, and conformance with the specifications by the Contracting Officer's Representative prior to installation. Any fence materials rejected by the Contracting Officer's Representative shall be replaced by the contractor with approved materials at no additional cost to the Government.

PART 2 PRODUCTS

2.1 FENCE FABRIC

Fence fabric shall conform to the following:

2.1.1 Chain Link Fence Fabric

ASTM A 392, Class 1, zinc-coated steel wire with minimum coating weight of 1.2 ounces of zinc per square foot of coated surface, or ASTM A 491, Type I, aluminum-coated steel wire. Fabric shall be fabricated of 9 gauge wire woven in 2 inch mesh. Polyvinyl chloride coating for fabric and all other fence components shall be manufacturer's standard in color. Fabric height shall be 6 feet. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

2.2 GATES

ASTM F 900 and/or ASTM F 1184. Gate shall be the type and swing shown. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Gate frames shall conform to strength and coating requirements of ASTM F 1043, for Group IC, steel pipe with external coating

Type A or Type B, nominal pipe size (NPS) 1-1/2. Gate frames shall be polyvinyl chloride-coated steel pipe (Group IA)with external coating Type A, a nominal pipe size (NPS) 1-1/2, conforming to ASTM F 1043. Gate fabric shall be as specified for chain link fabric. Gate leaves more than 8 feet wide shall have either intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 8 feet wide shall have truss rods or intermediate braces. Intermediate braces shall be provided on all gate frames with an electro-mechanical lock. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position. For high security applications, each end member of gate frames shall be extended sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence.

2.3 POSTS

2.3.1 Metal Posts for Chain Link Fence

ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B and Group II , roll-formed steel sections, shall meet the strength and coating requirements of ASTM F 1043. Group III, ASTM F 1043 steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same designation throughout the fence. Gate post shall be for the gate type specified subject to the limitation specified in ASTM F 900 and/or ASTM F 1184.

2.4 BRACES AND RAILS

ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043. Group II, formed steel sections, size 1-21/32 inch, conforming to ASTM F 1043, may be used as braces and rails if Group II line posts are furnished.

2.5 WIRE

2.5.1 Tension Wire

Tension wire shall be Type I or Type II, Class 2 coating, in accordance with ASTM A 824.

2.6 ACCESSORIES

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Barbed wire shall be 2 strand, 12-1/2 gauge wire, zinc-coated, Class 3 in accordance with ASTM A 121 or aluminum coated Type I in accordance with ASTM A 121. Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified. Threaded hardware shall be painted to match polyvinyl chloride coatings.

2.7 CONCRETE

ASTM C 94/C 94M, using 3/4 inch maximum size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

2.8 PADLOCKS

Padlocks shall conform to ASTM F 883, Type PO1, Options A, B, and G. EPB, Size 1-3/4 inch. All padlocks shall be keyed alike.

PART 3 EXECUTION

3.1 INSTALLATION

Fence shall be installed at locations as directed by the Contracting Officer. The area on either side of the fence line shall be cleared a minimum of 5 feet either side. Line posts shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 500 feet. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780.

3.2 EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a 1 inch clearance between the bottom of the fabric and finish grade.

3.3 POST INSTALLATION

3.3.1 Posts for Chain Link Fence

Posts shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 18 inches in solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Diameters of holes in solid rock shall be at least 1 inch greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Driven posts shall be set to a minimum depth of 3 feet and shall be protected with drive caps when being set. For high security fences, fence post rigidity shall be tested by applying a 50 pound force on the post, perpendicular to the fabric, at 5 feet above ground; post

movement measured at the point where the force is applied shall be less than or equal to 3/4 inch from the relaxed position; every tenth post shall be tested for rigidity; when a post fails this test, further tests on the next four posts on either side of the failed post shall be made; all failed posts shall be removed, replaced, and retested at the Contractor's expense.

3.4 RAILS

3.4.1 Top Rail

Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail.

3.4.2 Bottom Rail

The bottom rail shall be bolted to double rail ends and double rail ends shall be securely fastened to the posts. Bolts shall be peened to prevent easy removal. Bottom rail shall be installed before chain link fabric.

3.5 BRACES AND TRUSS RODS

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 6 feet in height. A center brace or 2 diagonal truss rods shall be installed on 12 foot fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences 6 feet high or less if a top rail is installed.

3.6 TENSION WIRES

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

3.7 CHAIN LINK FABRIC

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 15 inch intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 15 inch intervals and fastened to all rails and tension wires at approximately 24 inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be 1 plus or minus 1/2 inch above the ground. For high security fence, after the fabric installation is complete, the fabric shall be exercised by applying a 50 pound push-pull force at the center of the fabric between posts; the use of a 30 pound pull at the center of the panel shall cause fabric deflection of not more than 2-1/2 inches when pulling fabric from the post side of the fence; every second fence panel shall meet this requirement; all failed panels shall be resecured and

retested at the Contractor's expense.

3.8 GATE INSTALLATION

Gates shall be installed at the locations as directed by the Contracting Officer. Hinged gates shall be mounted to swing as directed. Latches, stops, and keepers shall be installed as required. Lift gates shall be installed as recommended by the manufacturer. Padlocks shall be attached to gates or gate posts with chains. Hinge pins, and hardware shall be welded or otherwise secured to prevent removal.

3.9 GROUNDING

Fences crossed by overhead powerlines in excess of 600 volts shall be grounded as specified in Section 16450, GROUNDING. Fences shall be grounded on each side of all gates, at each corner, at the closest approach to each building located within 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Grounding locations shall not exceed 650 feet. Each gate panel shall be bonded with a flexible bond strap to its gate post. Fences crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 150 feet on each side of crossing. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 3/4 inch by 10 foot long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6 inches below the grade. Where driving is impracticable, electrodes shall be buried a minimum of 12 inches deep and radially from the fence. The top of the electrode shall be not less than 2 feet or more than 8 feet from the fence. Ground conductor shall be clamped to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. After installation the total resistance of fence to ground shall not be greater than 25 ohms.

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SECTION 02915

TRANSPLANTING EXTERIOR PLANT MATERIAL

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A300	(1995) Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance

AMERICAN NURSERY AND LANDSCAPE ASSOCIATION (ANLA)

ANLA Z60.1	(1996) Nursery Stock

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4972	(1995a) pH of Soils
ASTM D 5268	(1992; R 1996) Topsoil Used for Landscaping Purposes

1.2 SUBMITTALS

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

SD-02 Shop Drawings

Finished Grade and Topsoil; G, RE
Underground Utilities; G, RE
Delivered Topsoil; G, RE
Obstructions Below Ground; G< RE

Following Contractor's review and approval, Contractor shall submit to the Contracting Officer one reproducible transparency (vellum) and two prints of each Landscape Salvage Drawing to a scale for review.

Finished grade status; location of underground utilities and facilities; and availability of topsoil from the stripping and stock piling operation.

SD-03 Product Data

Super Absorbent Polymers; G, RE

Manufacturer's literature including physical characteristics, application and installation instructions.

Equipment; G, RE

A listing of equipment to be used for the transplanting operation,including size model, year and type of mechanical tree transplanting equipment.

Equipment Lists: Following Contractor's review and approval, submit to the Contracting Officer 6 complete lists of major items of landscape equipment and materials necessary to safely and in compliance with all Federal, State and City of Phoenix regulations for the salvaging, transporting and planting exterior planting materials. This list shall be submitted within 30 calendar days after date of Agreement. Submit all items at one time. Partial list will not be acceptable. Submittals shall include the Manufacturer's Specifications, weights, space requirements, physical dimensions, rating of equipment and supplemental information requested by the Contracting Officer. Where a submittal sheet describes items in addition to that item being submitted, delete such items. Clearly note equipment and materials which deviate from those shown or specified in size, weight, required clearances, and location of access. Modifications to the Work as shown or specified in submittals shall be indicated and shall be provided by the Contractor as a part of the Work.

Transplanting Plan; G,RE

Methods to be used for each plant species to be transplanted ensuring survivability.

Maintenance Record

Maintenance work performed, quantity of plant losses, and replacements; and diagnosis of unhealthy plant material.

A written record shall be furnished to the Contracting Officer of the maintenance work performed each week including quantity of plant losses, replacements, and diagnosis of any unhealthy plant materials and the prescribed treatment.

SD-06 Test Reports

Soil Test; G
Percolation Test; G
Recycled Compost; G

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

SD-07 Certificates

Topsoil; G
Fertilizer; G

Soil Conditioner; G
pH Adjuster; G
Pesticide; G

Prior to delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following.

1) Certification of recycled content or,
2) Statement of recycled content.
3) Certification of origin including the name, addresses and telephone number of manufacturer.

SD-10 Operation and Maintenance Data

Maintenance Instructions; G

Instruction for care of installed plant material during initial establishment period and long term care.

1.3 GENERAL REQUIREMENTS

The Contractor shall meet the following requirements and shall submit the necessary written documentation to the Contracting Officer at the preconstruction conference as herein specified:

a. Must be an Arizona licensed landscape Contractor, in good standing.

b. Submit a list of a minimum of two native plant salvage projects which satisfactorily completed and involved the salvaging of native tree species.

c. The list shall include the dates of the project work, type of equipment used, description of the project and work performed, the name and phone number of a contact person representing the agency, company or owner for which the work was completed.

d. Crews must have the capabilities to perform the work. Submit a list of the native tree relocation contractors key personnel, minimum one, who will supervise and perform the actual relocation operations. The person listed must be on site and in responsible charge during all operations.

e. The Contractor must demonstrate the ability to mobilize for the scale and timely completion of the work. The Contractor shall submit a list of available equipment, location of equipment and personnel or replacement personnel with equal qualifications which will remain on the job throughout the duration of the project and that replacement personnel will be subject to approval by the Contracting Officer.

f. Must have reviewed the plans, specifications and special provisions and visited the site prior to bidding.

All County, State and Federal permits which may be applicable to the Transplanting of Exterior Plant Material shall be obtained and paid for by the Contractor.

The specified existing indigenous materials shall be salvaged and maintained as a part of this contract per the City of Phoenix regulations.

The existing plants shall be salvaged in a manner consistent with professional practice.

The Contractor shall obtain a native plant salvage permit from the City of Phoenix. The following information shall be provided by the Contractor prior to issuance of the permit:

a. Location of where the plants are to be delivered.

b. Methodology for side-boxing of Native Specimens consistent with professional practice.

c. A visual inspection/audit of existing plants itemized to be salvaged on the demolition plans.

The Contractor shall preserve and protect all existing vegetation (such as trees, shrubs, cacti and grass), within the project limits which does not unreasonably interfere with the salvage operation as may be determined by the Contracting Officer. The Contractor shall be responsible for replacement in kind and to the satisfaction of the Contracting Officer for all unauthorized cutting, removing or altering or existing vegetation, including damage due to careless operation of equipment, stockpiling of materials or tracking of terrain by equipment.

Holes, cavities, trenches and depressions resulting from the plant removals, except in areas to be excavated, shall be backfilled with suitable material which shall be compacted to a density of not less than 95 per cent of the maximum density as determined in accordance with the requirements of the applicable test methods specified herein or as directed by the Contracting Officer.

Trees shall be pruned and removed by side boxing.

Pruning shall be done to remove a certain amount of foliage which is proportionate to the amount of root system eliminated during the boxing operation, and to remove a portion of the low-breaking trunks to provide an aesthetic framework of branches that preserves the size and character of the plant and enhance the vertical form of multi trunk specimens. The Contractor shall identify the major limits to be retained and remove approximately 60% to 80% of the remaining medium and smaller sized branches.

After pruning, the Contractor shall determine the size of box to be used based on the following guidelines:

Trunk Diameter	Box Size
0 - 150 mm (0 - 6")	610 - 1070 mm (24" - 42")
150 - 300 mm (6" - 12")	1220 - 1520 mm (48" - 60")
300 - 450 mm (12"- 18")	1680 - 2130 mm (66" - 84")
450 mm (18") and up	2290 mm (90") and up

Pine trees can also be salvaged by use of a tree spade if the boxing operation is not preferred by the Contractor. Contractor shall submit to Contracting Officer specific and detailed information regarding tree spading equipment and operations. No tree spading shall occur until approved by the Contracting Officer.

The box size shall be written on flagging tape to alert boxing crew.

Salvage Plan: The Contractor shall submit a Salvage Plan for the review and approval of the Contracting Officer prior to the beginning of any ground breaking work by the Contractor. The Salvage Plan shall contain but not be limited to the following items and shall conform to the details shown on the project plans and these Special Provisions.

a. Methods for coordinating the salvage with anticipated phasing and sequencing of construction.

b. Existing locations of each item to be salvaged.

c. Identification numbers of each salvage item.

d. List of mechanical and hand equipment to be used to accomplish all salvage work.

e. Shop drawing(s) of all guying, staking, transport bracing and cradle details.

f. Description (in detail) of the materials, procedures and all other methods to accomplish all salvage work.

The Salvage Plan shall be contained in a three ring binder(s) and the plant list for salvaging shall be typed on 8-1/2 inch x 11 inch sheets.

Calibrated measurements of salvaged stock shall occur at the time of removal from the project site and at the time of delivery to the City of Phoenix designated nursery.

Calibrated measurement of the salvaged material shall include the diameter at the breast height (dbh). Calibrated measurements for local and/or collected stock less than 6 feet in height shall include the diameter at midpoint. Calibrated measurements shall be completed by methods and tools approved by the Contracting Officer. The method shall demonstrate that the original points of measurement will be easily located with pinpoint accuracy when future measurements are made throughout the duration of the contract. The minimum acceptable measurable distance of displacement between original points of measurement and all future measurements shall be 0.4 inches. The recorded calibrated measurements, photographs and visual inspections will be used as tools and methods by the Contracting Officer to determine if the health and/or vigor of the salvaged material is in reasonably close conformity to the appearance it displayed prior to its initial removal.

The plant inventory listed on the plans is the design inventory used to establish the quantities as shown on the bidding schedule. The Contractor shall reinventory the plants on the project site with the Contracting Officer by means of a site walk through and prepare an adjusted plant inventory. The purpose of the reinventory and walk through will be to review specific clearing limits where adjustments can be made to prevent removal of unrequired plants, addition of plants that may have been omitted during the design inventory, reevaluation of the health of plants and to make any other adjustments as required. The Contractor will be required to salvage or protect in place, all plant material identified in the final adjusted inventory. The adjusted inventory shall become part of the Salvage Plan. No separate payment will be made for the walk through and preparation of the adjusted inventory.

The Contracting Officer has complete authority to accept or decline the proposed salvaging of the plants identified on the salvage plan and those species identified in the re-inventory process.

The Contractor shall mark the north exposed surface of all material to be salvaged by an acceptable method to the Contracting Officer. The mark or its installation process shall not damage or deface the salvaged material. The mark must be capable of withstanding poor weather and expected working conditions without the possibility of erasure or detachment throughout the duration of the contract.

The Contractor shall be responsible for ensuring that all collected materials to be salvaged are identified with identification numbers assigned by the Contractor in the plant inventory prior to removal of the salvaged plants. The Contractor shall also be responsible for tagging all materials. This will also include preparing tags with new identification numbers for salvaged material added to the adjusted inventory as directed by the Contracting Officer. All new and replacement tags shall be double faced aluminum tags. The tags or their installation process shall not damage or deface the collected materials. Tags shall remain in place throughout the removal and delivery to the Phoenix nursery. No separate payment will be made by the City for the tagging or retagging of collected material.

The top of the root ball to be exposed shall be measured and the outline marked to facilitate digging. A trench shall be dug around the plant using the outline established in the previous step as the inside dimensions. Roots shall be carefully cut flush with the side of the root ball as they are encountered. As trenching progresses, the root ball shall be gradually cut inward to accommodate the taper of the box. When trenching reaches the depth of the box, box sides shall be placed in the trench and checked to fit around root ball. The root ball shall be trimmed as necessary. Box sides shall be attached around the root ball with nails. Box sides shall be secured with banding. Dirt shall be packed tightly into any space between box sides and root ball. The tree box shall be watered thoroughly and dirt repacked as needed for a minimum of 2 weeks before bottoming.

To minimize movement of the plant and its root system during transportation supporting topwood shall be placed. Wood (2 x 4 or 2 x 6) shall be measured and cut to fit the width of box. Carpet or tree wrap shall be provided to prevent scarring. Cross members and additional supporting wood shall be placed as necessary based on size and orientation of tree. A minimum of two boards in each direction shall be nailed across the top of root ball.

The bottoming operation shall cut the remaining roots and minimize the loss of soil from the bottom of the root ball. A stake shall be placed a safe distance from the trench in the direction plant is to be tipped. A "come along" shall be attached on one end of chain. The other end of chain shall be wrapped around box and secured. The chain shall be cinched until taut. The bottom of the root ball shall be gradually undercut. Tap roots shall be cut cleanly as encountered. The tautness of chain shall be tested frequently. The box shall be tipped over in direction of stake, when feasible. When the box begins to tip, a safety brace shall be placed against the bottom of box to prevent box from falling in case of stake or chain failure. As box is tipped back, bottom strips shall be nailed to the box sides. When the tree is fully tipped and bottom completely covered, boards shall be nailed across the others. Depending on soil conditions, pre-assembled bottoms may be feasible. Banding shall be placed underneath

cross members. The box shall be lowered down to its original orientation. The banding shall be brought up along sides and over top of box. The banding shall be tightened and secured with crimper.

1.4 TRANSPLANTING PLAN

A transplanting plan shall be submitted and shall delineate methods and times for root pruning, digging, balling, removing, storing, transporting, planting, watering, and maintenance to ensure survivability. The plan shall also include equipment, anti-desiccant and pesticides to be used. A listing of the plant material to be transplanted shall be provided by common name and botanical name as listed under "Nomenclature" in ANLA Z60.1 ; classification; caliper; and height.

1.5 PLANT MATERIAL SURVIVABILITY

Plant material survivability shall be determined by growing condition; root pruning and transplanting method to maintain a healthy root system; and recovery of leaves or needles with the crown in good balance with the trunk free from disfigurement or abrasion.

1.6 DECIDUOUS TREES

A "P1" height to caliper relationship shall be maintained in accordance with ANLA Z60.1. Height of branching shall bear a relationship to the size and species of tree and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

1.6.1 Single stem

The trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader. The form of growth desired shall be as indicated.

1.6.1.1 Multi-stem

All countable stems, in aggregate, shall be maintained. To be considered a stem, there shall be no division of the trunk which branches a minimum 6 inches from the ground surface. The form of growth desired shall be as indicated by the Contracting Officer'S.

1.6.1.2 Specimen

The tree shall be well branched and pruned naturally according to the species. The form of growth desired, which may not be in accordance with natural growth habit, shall be as indicated.

1.6.2 Deciduous Shrubs

Deciduous shrubs shall have the height and number of primary stems recommended by ANLA Z60.1. Plant material shall bear a relationship to the size and species of plant with the crown in good balance with the trunk, well shaped, and with sufficient well-spaced side branches. The form of growth desired shall be as indicated.

1.6.3 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material shall have the height-to-spread ratio recommended by ANLA Z60.1. Plant material shall bear a relationship to the size and species of plant with the crown in good balance with the trunk,

well shaped, and with sufficient well-spaced side branches. The form of growth desired shall be as indicated.

1.6.4 Ground Cover and Vines

Ground cover and vine plant material shall have the minimum number of runners and length of runner recommended by ANLA Z60.1. Plant material shall have heavy, well developed and balanced crown with vigorous, well developed root system. The form of growth desired shall be as indicated.

1.6.5 Protection During Transplanting

Plant material shall be protected during transplanting to prevent desiccation and damage to the branches, trunk, and root system. Branches shall be protected by tying-in. Exposed branches shall be covered during transport. The root area shall be treated with gels containing mycorrhizal fungi inoculum. Plant material shall be undamaged, well shaped, vigorous and healthy with a well-branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion after transplanting. Plant material showing desiccation, abrasion, sun scald injury or structural branching damage shall be replaced at no cost to the government. Pine trees at the gateway area that are transplanted and do not survive shall be replaced with a Blue Palo Verde (cercidium floridum) or an Ironwood (olneya tesota) of equal or greater caliper to the dead pine tree (DBH measurement) when approved.

1.7 DELIVERY OF MATERIALS

1.7.1 Delivered Topsoil

Prior to the delivery of any topsoil, the availability of topsoil shall be verified in paragraph TOPSOIL. A soil test shall be provided by the Contractor to the Contracting Officer for delivered topsoil.

1.7.2 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided by the Contractor to the CONTRACTING officer for bulk deliveries.

1.7.3 Pesticide Material

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration number and the manufacturer's registered uses. All pesticides shall be stored, protected and secured according to all applicable Federal, State and local regulations.

1.8 PLANT MATERIAL IDENTIFICATION

Plant material to be transplanted shall be tagged and/or shown on drawings. Transplanted plant material shall be delivered with attached, durable, waterproof labels and weather-resistant ink or imprinted tags, stating the correct botanical plant name and size.

1.9 INSPECTION OF MATERIALS

Materials shall be inspected for compliance with paragraph PRODUCTS, paragraph PLANT MATERIAL SURVIVABILITY and paragraph PLANT MATERIAL IDENTIFICATION. Open soil amendment containers or wet soil amendments shall be rejected. Topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, waste or other material larger than 1-1/2 inch diameter shall be rejected. Topsoil that contains viable plant material and plant parts shall be rejected. Unacceptable material shall be removed from the job site one (1) day after rejection.

1.10 STORAGE OF MATERIALS

Storage of material shall be in designated areas. Soil amendments shall be stored in dry locations and away from contaminants. Chemical treatment material shall be stored and protected according to all Federal, State and local regulations and manufacturer's instructions and not with planting operation material. All pesticides shall be stored, protected and secured according to all applicable Federal, State and local regulations.

1.11 HANDLING OF MATERIALS

Materials shall not be dropped from vehicles. Plant material shall be transported without scarring trunks or deforming crown branching. Materials found to be in unacceptable condition shall be replaced at no additional cost to the Government.

1.12 TIME LIMITATION

The time limitation for boxing salvaged material is a minimum of two (2) weeks, the time limitation in removing, transporting, to installing transplanted plant material at designated City of Phoenix nursery shall be the same day. The time limitation between installing the plant material and placing the mulch shall be a maximum 48 hours.

1.13 WARRANTY

Transplanted plant material shall have a warranty for survivability as defined in paragraph PLANT MATERIAL SURVIVABILITY, and plant growth to be in a vigorous growing condition for a minimum 6 month period for plants other than specimen trees and a minimum 12 month calendar time period for specimen trees. The warranty of plant growth shall be provided regardless of the contract time period. When the transplanted plant material is determined to be unhealthy in accordance with paragraph PLANT ESTABLISHMENT PERIOD, it shall be replaced once under this warranty.

PART 2 PRODUCTS

2.1 TOPSOIL

Topsoil shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil stripped and stockpiled onsite in accordance with Section 02300 EARTHWORK. When additional topsoil is required beyond the available topsoil from the stripping operation, topsoil shall be delivered and amended as recommended by the soil test for the plant material specified at no cost to the Government. All topsoil shall meet Arizona residential soil cleanup levels and standards. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, waste or other material over a minimum 1-1/2 inch diameter. Topsoil shall be free from viable plants and plant parts.

2.2 SOIL AMENDMENTS

Soil amendments shall consist of pH adjuster, fertilizer, organic material and soil conditioners meeting the following requirements. Vermiculite is not permitted. All soil amendment applications shall comply with Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications. Corrective measures to add soil amendments shall be as outlined by the Contractor and approved by the Contracting Officer at no additional charge to the Government.

2.2.1 pH Adjuster

The pH adjuster shall be an agricultural grade sulfur material. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

2.2.2 Fertilizer

The nutrients ratio shall be 16 percent nitrogen, 20 percent phosphorus, and 0 percent potassium. Fertilizer shall be controlled release, commercial grade, suitable for use on newly transplanted plant material; free flowing, pellet or tablet form; uniform in composition; and consistent with a prescribed nitrogen-phosphorus-potassium ratio.

Application of Soil Amendments, Conditioners, and Fertilizer shall comply with Sections 01355, ENVIRONMENTAL PROTECTION and 01356A, STORM WATER POLLUTION PREVENTION MEASURES of these specifications. Fertilizer shall be applied around the drip perimeter of each tree to be salvaged and tilled to the depth of six (6) inches, at the following rates: 12 pounds of 16-20-0 and 2 pounds of 21-0-0 per 1,000 square feet, Gypsum at the rate of 18 pounds per tree, ferrous sulfate (hydrated) at the rate of 9 pounds per tree, and decomposed wood derivative at the rate of 5 cubic feet per tree. Following fertilization, the treated areas are to be watered in thoroughly such that soils are wet to a minimum depth of 12 inches at least once prior to transplanting operations.

2.2.3 Organic Material

Organic material shall consist of either decomposed wood derivatives or recycled compost.

2.2.3.1 Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, or other wood waste material free of stones, sticks, and toxic substances harmful to plants, and stabilized with nitrogen.

2.2.3.2 Recycled Compost

Compost shall be a well-decomposed, stable, weed free organic matter source. It shall be derived from food, agricultural, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 3/8 inch screen, possess between a minimum 5.5 to a maximum 8.0 pH, and have a moisture content between a minimum 35 and a maximum 55 percent by weight. The material shall not contain more than a maximum 1 percent by weight of

man-made foreign matter. Compost shall be cleaned of plastic materials a minimum 2 inches in length.

2.2.4 Soil Conditioner

Soil conditioner shall be sand, super absorbent polymers, calcined clay, or gypsum for single use or in combination to meet topsoil requirements for the plant material specified.

2.2.4.1 Sand

Sand shall be clean and free of toxic materials. Gradation: A minimum 95 percent by weight shall pass a No. 10 sieve and a minimum 10 percent by weight shall pass a No. 16 sieve. Greens and shall be balanced with the inclusion of trace minerals and nutrients.

2.2.4.2 Super Absorbent Polymers

To improve water retention in soils, super absorbent polymers shall be sized at a maximum 1000 microns. Polymers shall be added as a soil amendment as directed by the Contracting Officer and be cross-linked polyacrylamide with an absorption capacity of a minimum 250 to a maximum 400 times its weight.

2.2.4.3 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum 95 percent calcium sulfate by volume.

2.3 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region. Rotted manure is not recommended to be used as a mulch because it would encourage surface rooting of the plant material and weeds.

2.3.1 Inorganic Mulch

Decomposed Granite color shall be "Apache Brown" as produced by Granite Express or approved equal. Please see plans for location of inert materials. The approved granite colors shall come from a single source. All granite material shall be sampled for color and gradation by the Contracting Officer. All samples must be approved for color and gradation prior to placement.

Granite shall be placed as shown on the plans.

Decomposed granite shall be shall be as follows: 1/4 inch minus for all stabilized surfaces and 2 inches minus for all other designated granite areas.

The grading requirements for decomposed granite within the project as identified on the plans shall be as follows:

DECOMPOSED GRANITE 1/4" MINUS

Sieve Size	Percent Passing
1/4 inch	100
No. 40	5-20

DECOMPOSED GRANITE 2" MINUS

Sieve Size	Percent Passing
2 inch	100
1/2 inch	60-80
1/4 inch	45-65
No. 40	5-20

Rock mulch around all drain inlets, swales, for erosion control shall be crushed and angular in form. The grading requirements shall be as follows:

ROCK MULCH

Rock Size	Percent Passing
4 inch	100
2 inch	25-75
1 inch	0-10

The color of the rock mulch shall match the color of the adjacent decomposed granite.

Prior to placing decomposed granite, and rock mulch, the areas shall be totally free of grasses and weeds. When using herbicides, the work shall be in accordance with all applicable Federal, State and Local Municipality rules and regulations. All dead grass and weeds shall be removed and disposed of by the Contractor as approved by the Contracting Officer. The Contractor shall repair eroded areas and compact soil as approved by the Contracting Officer. The finish subgrade for the Decomposed Granite and Rock Mulch areas shall be compacted to 85-90% of the maximum density. The Contractor shall employ the use of all necessary grading equipment, earth moving and compacting machinery, water applications, and approved methods to adequately compact the grade on which the decomposed granite and rock mulch are to be placed. Compaction shall be completed to the approval of the Contracting Officer prior to the placement of any inert materials. Contractor shall apply per manufacturer instructions and Contracting Officer approval to the finish grade the first of two (2) applications of an approved pre-emergent herbicide. The first application shall be applied to the subgrade prior to placing the specified granite or rock mulch.

The finish subgrade, before placement of the decomposed granite and or rock mulch, shall be compacted to a density of 85% - 90% of the maximum density as determined in accordance with the requirements of the City of Phoenix Materials Testing Manual, as directed and approved by the Contracting Officer.

All vehicles used for spreading, grading and raking the decomposed granite and or rock mulch shall have one set of wheels with flotation tires having a minimum width of 18 inches to allow equal compaction of the rock mulch.

After rough spreading and rough grading of the decomposed granite and or rock mulch within the designated areas, the decomposed granite and or rock mulch shall be raked to evenly blend the different gradation sizes in the decomposed granite and or rock mulch. Following approval of the Contracting Officer, the decomposed granite and or rock mulch shall be saturated with water to an optimum moisture level. The Contracting Officer will approve the amount of water necessary to aid in the compaction of the decomposed granite and or rock mulch.

The decomposed granite and or rock mulch shall be placed to a minimum depth of two inches, except in planting pits. Where decomposed granite and or rock mulch is within the planting pits, the maximum depth shall be one inch.

During the final spreading and final grading operations, all surfaces within the decomposed granite and or rock mulch areas shall be passed over by the spreading and grading equipment a minimum of two times. All equipment operations for spreading, grading, raking, chemical application, water settling, and any other operations shall be done in a manner that uniformly maximizes the vehicle(s) wheel compaction over all the surface.

The pre-emergent herbicide shall be applied in compliance with Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES and activated in the manner recommended by the manufacturer to prevent germination of noxious weeds, and shall be 'Gallery' 'Surflan' or approved equal. The pre-emergent herbicide shall be applied to the decomposed granite, and rock mulch areas and shall occur at a minimum of two (2) times during the Phase I portion of the contract. The first application shall be applied to the subgrade prior to placement of the granite and the second application shall occur before the final water settling operation of the granite areas.

After placing, spreading and grading the decomposed granite and or rock mulch, the Contractor shall water settle the total thickness of the decomposed granite and or rock mulch, removing the fine material from the surface. The water settling operation shall be completed at the minimum rate of one-half inch of water and shall occur within 21 days after application of the pre-emergent herbicide.

Rock furnished by the Contractor shall be obtained from a single source.

The Contractor shall prepare a sample area of approximately 100 square feet of both the decomposed granite and rock mulch for the Contracting Officer's approval. The sample area may be part of the area requiring decomposed granite or rock mulch and this sample once approved, will be used by the Contracting Officer to determine the acceptability of the remaining work under this item.

2.3.2 Organic Mulch

Organic mulch materials shall be native to the project site and consist of recycled mulch, shredded bark, wood chips, or ground bark.

2.3.2.1 Recycled Mulch

Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 2-1/2 x 2-1/2 inch screen. It shall be cleaned of all sticks a minimum 1 inch in diameter and plastic materials a minimum 3 inch length. The material shall be treated to retard the growth of mold and fungi. Other recycled mulch may include peanut shells, pecan shells or cocoa bean shells.

2.3.2.2 Shredded Bark

Locally shredded material shall be treated to retard the growth of mold and fungi.

2.4 WOOD STAKING MATERIAL

Wood stakes shall be hardwood or fir; a minimum No. 2 grade, rough sawn; free from knots, rot, cross grain, or other defects that would impair their strength.

2.4.1 Bracing Stake

Wood bracing stakes shall be a minimum 2 x 2 inch square and a minimum 8 feet long with a point at one end. Stake shall be set without damaging rootball.

2.4.2 Wood Ground Stakes

Wood ground stakes shall be a minimum of 2 x 2 inch square and a minimum 3 feet long with a point at one end.

2.4.3 Deadmen

Wood deadmen shall be a minimum 4 x 4 x 36 inches long.

2.5 METAL STAKING AND GUYING MATERIAL

Metal shall be aluminum or steel consisting of recycled content made for holding plant material in place.

2.5.1 Bracing Stakes

Metal bracing stakes may be hollow or solid and shall be a minimum 1 inch diameter and a minimum 8 feet long. Stake shall be set without damaging rootball and be capable of supporting the tree adequately.

2.5.2 Metal Ground Stakes

Metal ground stakes shall be a minimum 1/2 inch diameter and a minimum 3 feet long.

2.5.3 Earth Anchor

Metal earth anchors shall be a minimum 1/2 inch diameter and a minimum2 feet long.

2.5.4 Guying Material

Metal guying material shall be a minimum 12 gauge wire. Multi-strand cable shall be woven wire. Guying material tensile strength shall conform to the size of tree to be held firmly in place.

2.5.5 Turnbuckle

Metal turnbuckles shall be galvanized or cadmium-plated steel, and shall be a minimum 3 inches long with closed screw eyes on each end. Screw thread tensile strength shall conform to the size of tree to be held firmly in place.

2.6 PLASTIC STAKING AND GUYING MATERIAL

Plastic shall consist of recycled plastic product made for holding plant material firmly in place. Plastic shall not be used for deadmen.

2.6.1 Plastic Bracing Stake

Plastic bracing stakes shall be a minimum 2 inch diameter and a minimum 8 feet long. Stake shall be set without damaging rootball.

2.6.2 Plastic Ground Stakes

Plastic ground stakes shall be a minimum 2 inch diameter and a minimum 3 feet long.

2.6.3 Plastic Guying Material

Plastic guying material shall be designed with a maximum 900 pound force per foot elastic limit for the purpose of firmly holding plant material in high wind velocities.

2.6.4 Chafing Guard

Plastic chafing guards shall be used to protect tree trunks and branches when metal is used as guying material. The material shall be the same color throughout the project site. Length shall be a minimum 1.5 times the circumference of the plant trunk at its base.

2.7 RUBBER GUYING MATERIAL

Rubber chafing guards, consisting of recycled material, shall be used to protect tree trunks and branches when metal guying material is applied. The material shall be the same color throughout the project. Length shall be a minimum 1.5 times the circumference of the plant trunk at its base.

2.8 FLAG

Plastic flag material shall be used on guying material. It shall be a minimum 6 inches long. Tape color shall be consistent and visually complimentary to the entire project area. The tape color shall meet pedestrian visual safety requirements for day and night.

2.9 MYCORRHIZAL FUNGI INOCULUM

Mycorrhizal fungi inoculum shall be composed of multiple-fungus inoculum as recommended by the manufacturer for the cactus plant material specified or as directed by the Contracting Officer.

2.10 WATER

All water for transplanting will be furnished according to Section 01200, GENERAL REQUIREMENTS unless irrigation system is approved for use by the Contracting Officer.

2.11 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification a soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved. Applications of any pesticide shall comply with Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications.

PART 3 EXECUTION

3.1 TRANSPLANTED PLANT MATERIAL TIME AND CONDITIONS

3.1.1 Deciduous Plant Material Time

Deciduous plant material shall be transplanted from March 15 to October 15.

3.1.2 Evergreen Plant Material Time

Evergreen plant material shall be transplanted from March 15 to October 15.

3.1.3 Transplanting Conditions

All transplanting operations shall be performed only during periods when beneficial results can be obtained. When excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to all transplanting operations, proposed transplanting times shall be submitted for approval. The installing site for the plant material shall be prepared and excavated in accordance with paragraph INSTALLING SITE PREPARATION and paragraph INSTALLING SITE EXCAVATION, prior to removing the plant material.

3.1.4 Underground Utilities

The location of underground utilities and facilities at both the removal and installing sites shall be verified and marked. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

3.1.5 Protecting Existing Vegetation

Existing trees, shrubs, and plant beds at both the removal and installing site that are to be preserved shall be barricaded along the dripline. The area shall be barricaded and protected from damage by a tree barricade or other measure. Damage to existing plant material shall be mitigated by the Contractor at no additional cost to the Government. Damage shall be accessed by a state certified arborist or other approved professional using the National Arborist Association's tree valuation guideline.

3.1.6 Installing Site Tests

3.1.6.1 Percolation Test

Test for percolation shall be done to determine positive drainage of plant pits and beds at the installing site. A positive percolation shall consist of a minimum 1 inch per 3 hours; when a negative percolation test occurs, a shop drawing shall be submitted indicating the corrective measures.

3.1.6.2 Soil Test

Delivered topsoil, excavated plant pit soil, and stockpiled topsoil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, and mechanical analysis. **All topsoil shall also comply with Arizona residential cleanup levels. Sample collection for stockpiled topsoil shall be at different levels in the stockpile.** The soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test shall determine the quantities and type of soil amendments required to meet local growing conditions for the plant material to be transplanted. Soil test shall occur for every 10,000 cubic yards of delivered topsoil, **excavated**

plant pit soil, and on-site stockpiled topsoil. Every soil test shall be staggered between overbank and terrace area or as directed by the Contracting Officer. Contractor shall supply recommendation to Contracting Officer based on soils test result.

3.1.7 Plant Material Preparation and Handling

3.1.7.1 Root Pruning

Large canopy and specimen plant material shall be root pruned a minimum of one year before transplanting. Minimum root ball sizes shall be in accordance with ANLA Z60.1. Medium sized plant material shall be spaded or hand dug prior to removal. A sharp spade shall be used to cut straight down a minimum of 18 inches deep.

3.1.7.2 Plant Material Preparation

Plant material designated for transplanting shall be watered thoroughly several days before root pruning, digging or moving. Broken or interfering growth shall be pruned. Large canopy and specimen plant material shall be wire balled and burlapped. Trees shall be lifted by the use of tree straps. Canopy and evergreen trees up to a maximum 12 inches caliper shall be transplanted by the largest available tree spade in order to reduce shock. The installing site for the plant material shall be prepared and excavated in accordance with paragraphs: Transplanting Plant Material Time and Conditions, Installing Site Preparation, and Installing Site Excavation, prior to moving the plant material.

3.1.7.3 Tree Spading

The following minimum size spades shall be used for trees sized as measured at caliper; 6 inches above the ground for trees 4 inches in diameter or smaller, 12 inches above the ground for trees with a larger diameter.

Tree Spade Size	Deciduous Tree	Evergreen Tree
Minimum 44 inch	Minimum 2 inch to Maximum 3 inch caliper	Minimum 5 feet to Maximum 7 feet height
Minimum 66 inch	Minimum 3 inch to Maximum 5 inch caliper	Minimum 7 feet to Maximum 10 feet height
Minimum 85 inch	Minimum 6 inch to Maximum 8 inch caliper	Minimum 12 feet to Maximum 15 feet height

3.1.7.4 Caliper

The caliper shall be measured at a minimum 6 inch height above the ground surface for trees up to a maximum 4 inch caliper. The caliper shall be measured at a minimum 12 inch height above the ground surface for trees with a larger caliper.

3.2 INSTALLING SITE PREPARATION

3.2.1 Finished Grade and Topsoil

The Contractor shall verify that finished grades are as indicated on drawings, and that the placing of topsoil, the smooth grading, and the

compaction requirements have been completed in accordance with Section 02300 EARTHWORK, prior to the commencement of the transplanting operation.

3.2.2 Layout

Plant material installing sites and bed outlines shall be staked on the project site before any excavation is made. Plant material locations may be adjusted to meet field conditions as directed and approved by the Contracting Officer.

3.3 INSTALLING SITE EXCAVATION

3.3.1 Obstructions Below Ground

When obstructions below ground affect the work, shop drawings showing proposed adjustments to plant material location, and planting method shall be submitted for approval.

3.3.2 Plant Pits

Plant pits shall be dug to a depth equal to the height of the root ball as measured from the base of the ball to the base of the plant trunk. Plant pits shall be dug a minimum of 3 to a maximum 5 times the diameter of the root system to allow for root expansion. The pit shall be constructed with sides sloping towards the base as a cone, to encourage well-aerated soil to be available to the root system for favorable root growth. Cylindrical pits with vertical sides shall not be used. Pits shall be dug immediately before water testing plant pits for drainage and gaining Contracting Officer's approval.

3.4 INSTALLATION

3.4.1 Setting Plant Material

Plant material shall be set plumb and held in position until sufficient soil has been firmly placed around root system or ball. In the event that waste material is discovered within the plant pit, Contractor shall contact CONTRACTION OFFICER'S REPRESENTATIVE immediately and comply with Section 01355, ENVIRONMENTAL PROTECTION of these specifications. In relation to the surrounding grade, the plant material shall be set even with the grade at which it was grown. The root system shall be spread out and arranged in its natural position. Damaged or girdled roots shall be removed with a clean cut. The beginning of the root flare shall be visible at soil level when the tree is planted, since it is critical not to plant the tree too deep. The following shall be performed:

a. Plumb tree and backfill half of the hole.
b. Water the hole to collapse air pockets and form a soupy mixture.
c. Backfill and gently firm soil.
d. Clear soil mounded against trunk.

3.4.2 Backfill Soil Mixture

The backfill soil mixture may be a mix of topsoil and soil amendments suitable for the plant material specified. When practical, the excavated soil from the plant pit that is not amended provides the best backfill and shall be used. Fertilizer shall not be used in the backfill soil mixture.

3.4.3 Adding Mycorrhizal Fungi Inoculum

Mycorrhizal fungi inoculum shall be added as recommended by the manufacturer for the plant material specified.

3.4.4 Backfill Procedure

Prior to backfilling, all metal, wood, synthetic products, or treated burlap devices shall be removed from the ball or root system avoiding damage to the root system. The backfill procedure shall remove air pockets from around the root system. Biodegradable burlap and tying material shall be carefully opened and folded back from the top a minimum 1/3 depth from the top of the root ball. For plant material in biodegradable containers the container shall be split prior to setting the plant with container. The plant material shall be carefully removed from containers that are not biodegradable.

3.4.4.1 Earth Berm

An earth berm that is of the same diameter of the plant pit as specified in Article 3.3.2, consisting of backfill soil mixture, shall be formed with a minimum 4 inch height around the edge of the plant pit to aid in water retention and to provide soil for settling adjustments.

3.4.5 Plant Bed

Plant material shall be set in plant beds according to the drawings. Backfill soil mixture shall be placed on previously scarified subsoil to completely surround the root balls, and shall be brought to a smooth and even surface, blending to existing areas. Earth berms shall be provided. Polymers shall be spread uniformly over the plant bed and in the planting pit as recommended by the manufacturer and thoroughly incorporated into the soil to a maximum 4 inch depth.

3.4.6 Watering

A regular watering schedule shall be established. Slow deep watering shall be used. Plant pits and plant beds shall be watered immediately after backfilling, until completely saturated. Run-off and puddling shall be prevented. Watering of other plant material or adjacent areas shall be prevented.

3.4.7 Staking and Guying

Staking will be required when trees are unstable or will not remain set due to their size, shape, or exposure to high wind velocity.

3.4.7.1 One Bracing Stake

Trees 4 to 6 feet high shall be firmly anchored in place with one bracing stake. The bracing stake shall be placed on the side of the tree facing the prevailing wind. The bracing stake shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly to the stake with a double strand of guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. A chafing guard shall be used when metal is the guying material.

3.4.7.2 Two Bracing Stakes

Trees from 6 to 8 feet height shall be firmly anchored in place with 2 bracing stakes placed on opposite sides. Bracing stakes shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly between the stakes with a double strand of guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. Chafing guards shall be used when metal is the guying material.

3.4.7.3 Three Ground Stakes

Trees over a minimum 8 feet height and less than a maximum 6 inch caliper shall be held firmly in place with 3 bracing or ground stakes spaced at equal intervals around the tree. Ground stakes shall be avoided in areas to be mowed. Stakes shall be driven into firm ground outside the earth berm. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. For trees over a minimum 3 inch diameter at breast height, turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used when metal is the guying material.

3.4.8 Deadmen or Earth Anchors

Trees over a minimum 6 inch caliper shall be held firmly in place with wood deadmen buried a minimum 3 feet in the ground or metal earth anchors. Multi-strand cable guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. Turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used.

3.4.9 Flags

A flag shall be securely fastened to each guy line between the tree, stake, deadmen, or earth anchor. The flag shall be visible to pedestrians.

3.5 FINISHING

3.5.1 Plant Material

Prior to placing mulch, the installed area shall be uniformly edged to provide a clear division line between the planted area and the adjacent turf area, shaped as indicated. The installed area shall be raked and smoothed while maintaining the earth berms.

3.5.2 Placing Mulch

The placement of mulch shall occur a maximum of 48 hours after planting. Mulch, used to reduce soil water loss, regulate soil temperature and prevent weed growth, shall be spread to cover the installed area with a minimum 4 inch uniform thickness. Mulch shall be kept out of the crowns of shrubs, ground cover, and vines and shall be kept off buildings, sidewalks and other facilities.

3.5.3 Pruning

Pruning shall be accomplished by trained and experienced personnel. The pruning of trees shall be in accordance with ANSI A300. Only dead or broken material shall be pruned from installed plants. The typical growth habit of individual plant material shall be retained. Clean cuts shall be made flush with the parent trunk. Improper cuts, stubs, dead and broken

branches shall be removed. "Headback" cuts at right angles to the line of growth will not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off".

3.6 MAINTENANCE DURING TRANSPLANTING OPERATION

Installed plant material shall be maintained in a healthy growing condition. Maintenance operations shall begin immediately after each plant is installed to prevent desiccation and shall continue until the plant establishment period commences. Installed areas shall be kept free of weeds, grass, and other undesired vegetation. The maintenance includes maintaining the mulch, watering, and adjusting settling.

3.7 APPLICATION OF PESTICIDE

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program. All applications shall comply with Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications.

3.7.1 Technical Representative

The State certified, pest management applicator shall be the technical representative, shall be present at all meetings concerning treatment measures for pest or disease control,and may be present during treatment application.

3.7.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations and Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended as it prevents the pesticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

3.8 RESTORATION AND CLEAN UP

3.8.1 Restoration

All pavements and facilities that have been damaged from the transplanting operation shall be restored to original condition at the Contractor's expense.

3.8.2 Backfill Removal Site Plant Pits

The Contractor shall ensure that all remaining holes from the removal site have been backfilled, tamped and finished to meet existing grade after settling.

3.8.3 Clean Up

Excess and waste material shall be removed from both removal site and the installed site and shall be disposed offsite at an approved landfill or recycling center. Adjacent paved areas shall be cleared.

3.9 PLANT ESTABLISHMENT PERIOD

3.9.1 Commencement

The plant establishment period for maintaining transplanted exterior plant material in a healthy growing condition shall commence on the first day of transplanting work under this contract and shall continue until accepted by the Contracting Officer but shall not be for less than 12 months after the last day of transplanting required by this Contract. Written calendar time period shall be furnished by the Contractor to the Contracting Officer for the plant establishment period. When there is more than one plant establishment period, the boundaries of the planted area covered for each period shall be described. The plant establishment period shall be coordinated with Sections 02921 SEEDING; and 02930 EXTERIOR PLANTING.

3.9.2 Maintenance During Establishment Period

Maintenance of plant material shall include straightening plant material, straightening stakes; tightening guying material; correcting girdling; supplementing mulch; pruning dead or broken branch tips; maintaining plant material labels; watering; eradicating weeds, insects and disease; post-fertilization; and removing and replacing unhealthy plants.The plant material shall be watered as necessary to prevent desiccation and to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is estimated to be the equivalent of 1 inch absorbed water per week, delivered in the form of rain or augmented by watering. Run-off, puddling and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or existing plant material shall be prevented.

3.9.2.1 Weeding

Weeds in the installed areas shall not be allowed to reach a maximum 3 inches height before being completely removed, including the root system.

3.9.2.2 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

3.9.2.3 Post-Fertilization

The plant material shall be top dressed at least once during the period of establishment with controlled release fertilizer (paragraph SOIL AMENDMENTS) applied at the rate of 2 pounds per 100 square feet of plant pit or bed area. Dry fertilizer adhering to plants shall be flushed off. The application shall be timed prior to the advent of winter dormancy. All fertilizer applications shall comply with Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications.

3.9.2.4 Plant Pit Settling

When settling occurs to the backfill soil mixture, additional backfill soil shall be added to the plant pit or plant bed until the backfill level is

equal to the surrounding grade. Serious settling that affects the setting of the plant in relation to the maximum depth at which it was grown requires replanting in accordance with paragraph INSTALLATION. The earth berm shall be maintained.

3.9.2.5 Removal Site Settlement

All plant pits at the removal site shall meet existing grade after settling. Correction shall be provided as required and in accordance with paragraph BACKFILL REMOVAL SITE PLANT PITS.

3.9.2.6 Maintenance Record

A record shall be furnished describing the maintenance work performed, the quantity of plant losses, diagnosis of the plant loss, and the quantity of replacements made on each site visit.

3.9.3 Acceptable Plant Material

Plant material shall be undamaged, well shaped, vigorous and healthy with a well branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion after transplanting and in accordance with paragraph PLANT MATERIAL SURVIVABILITY. Plant material showing desiccation, abrasion, sun-scald injury or structural branching damage shall be replaced at no cost to the Government.

3.9.4 Unhealthy Or Dead Plant Material

3.9.4.1 Transplant Shock

Deciduous plants showing symptoms of leaf scorch, a yellowing or bronzing of the tissue between the veins or along the margins of leaves or wilting; leaf rolling or curling may be need to be replaced, if required by the Contracting Officer. Evergreen plant stress is exhibited by overall grey-green color followed by light tan. The Contractor shall evaluate the severity of the symptom and shall provide recommendations.

3.9.4.2 Dead Plant Material

A tree shall be considered dead when the main leader has died back, or up to a maximum 25 percent of the crown has died. A shrub shall be considered unhealthy or dead when up to a maximum 25 percent of the plant has died. This condition shall be determined by scraping on a branch an area 1/16 inch square, maximum, to determine if there is a green cambium layer below the bark. The Contractor shall determine the cause for dead plant material and shall provide recommendations for replacement. Dead plant material shall be removed immediately and shall be replaced as soon as seasonal conditions permit.

3.9.4.3 Replacement Plant Material

Replacement plant material shall be installed in accordance with paragraph INSTALLATION. Plant material shall be replaced in accordance with paragraph WARRANTY. An extended plant establishment period shall not be required for replacement plant material.

3.9.5 Maintenance Instructions

Written instructions shall be furnished containing drawings and other

necessary information for year-round care of the installed plant material; including, when and where maintenance should occur, and the procedures for plant material replacement.

3.9.6 End of Establishment Period Clean Up

The Contractor shall remove all guying, bracing and staking at the end the establishment period with the approval of the Contracting Officer. All materials removed as a result of this operation shall be disposed offsite at an approved landfill. Any damage resulting from this operation shall be restored to its original condition at the Contractor's expense.

-- End of Section --

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SECTION 02930

EXTERIOR PLANTING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A300	(1995) Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance

AMERICAN NURSERY AND LANDSCAPE ASSOCIATION (ANLA)

ANLA Z60.1	(1996) Nursery Stock

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4972	(1995a) pH of Soils
ASTM D 5268	(1992; R 1996) Topsoil Used for Landscaping Purposes

1.2 SUBMITTALS

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

SD-02 Shop Drawings

Shop Drawings; G, RE

Scale drawings defining areas to receive plant materials.

Finished Grade, Topsoil and Underground Utilities; G, RE

Finished grade status; location of underground utilities and facilities; and availability of topsoil from the stripping and stock piling operation.

SD-03 Product Data

Chemical Treatment Material; G, RE

Contractor shall supply Manufacturer's literature including physical characteristics, application and installation instructions for chemical treatment material. All chemical treatment shall comply with Sections 01355, ENVIRONMENTAL PROTECTION and 01356,

STORM WATER POLLUTION PREVENTION MEASURES of these specifications.

Maintenance Record; G

Maintenance work performed, quantity of plant losses, and replacements; and diagnosis of unhealthy plant material.

A written record shall be furnished to the Contracting Officer of the maintenance work performed each week including quantity of plant losses, replacements, and diagnosis of any unhealthy plant materials and the prescribed treatment.

Equipment; G, RE

A listing of equipment to be used for the planting operation.

Equipment Lists: Following Contractor's review and approval, submit to the Contracting Officer 6 complete lists of major items of landscape equipment and materials, within 30 calendar days after date of Agreement. Submit all items at one time. Partial list will not be acceptable. Submittals shall include the Manufacturer's Specifications, weights, space requirements, physical dimensions, rating of equipment and supplemental information requested by the Contracting Officer. Where a submittal sheet describes items in addition to that item being submitted, delete such items. Clearly note equipment and materials which deviate from those shown or specified in size, weight, required clearances, and location of access. Modifications to the Work as shown or specified in submittals shall be indicated and shall be provided by the Contractor as a part of the Work.

Delivery; G, RE

Delivery schedule.

All trees and shrubs identified on the plans for this project will be supplied and delivered to the project by the Government. The Government supplier for the trees and shrubs is Mountain States Wholesale Nursery of Litchfield Park, Arizona. The contact is Jean Cote. All aquatic plant material shall be supplied by the Contractor per Section 02846, WETLANDS PLANTING of these specifications.

Plant Establishment Period; G, RE

Calendar time period for the plant establishment period. When there is more than one establishment period, the boundaries of the planted areas covered for each period shall be described by the Contractor and approved by the Contracting Officer.

Application of Pesticide; G

Contractor shall submit pesticide treatment plan with sequence of treatment work with dates and times. The pesticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area treated, amount applied; and the name and state license number of the state certified applicator shall be included.

SD-04 Samples

Delivered Topsoil; G

Samples taken from several locations at the source.

Soil Amendments; G

A 10 pound sample.

Mulch; G

A 10 pound sample.

SD-06 Test Reports

Soil Test; G
Percolation Test; G

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

SD-07 Certificates

Plant Material; G
Topsoil; G
pH Adjuster; G
Fertilizer; G
Organic Material; G
Soil Conditioner; G
Organic Mulch; G
Mycorrhizal Fungi Inoculum; G
Pesticide; G

Prior to delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following.

a. Plant Material: Classification, botanical name, common name, size, quantity by species, and location where grown.

b. Topsoil: Particle size, pH, organic matter content, textural class, soluble salts, chemical and mechanical analyses.

c. pH Adjuster: Sieve analysis and calcium carbonate equivalent.

d. Fertilizer: Chemical analysis and composition percent.

e. Organic Material: Composition and source.

f. Soil Conditioner: Composition and source.

g. Organic Mulch: Composition, source, and treatment against

fungi growth.

h. Mycorrhizal Fungi Inoculum: Plant material treated.

i. Pesticide. EPA registration number and registered uses.

SD-10 Operation and Maintenance Data

Maintenance Instructions; G

Instruction for year-round care of installed plant material.

1.3 GENERAL REQUIREMENTS

The water used during Plant Establishment to properly maintain the plant material will be furnished in accordance with Section 01200 GENERAL REQUIREMENTS. No additional water service will be provided and the Contractor shall not create a new water service without the Contracting Officers' approval. The Contractor shall be responsible for all equipment and labor necessary to load, transport and unload water for watering plants.

The Contractor shall notify the Contracting Officer and obtain prior approval for the use of any chemicals for weed eradication or control. See Chemical Treatment Material of this specification.

During the second half of the Landscaping Establishment period, the Contractor shall provide plant material replacements from Contracting Officer approved location as follows:

Original Size	Replacement Size
1 gallon	5 gallon
5 gallon	15 gallon
15 gallon	15 gallon
24 inch box	36 inch box

Ocotillos, Prickly pear, and shall be replaced with one size range up from their original planting size.

Plant material replacement shall be considered incidental to the landscaping establishment and shall be made at no charge to the Government.

The Contractor shall apply four (4) applications of an approved pre-emergent herbicide on only those areas of the terrace designated on the plans to receive decomposed granite or rock mulch. The application shall be as specified here in including but not limited to the following schedule of applications: Initial application immediately following subgrade preparation for Granite areas during the granite preparation phase of the project. The second application shall occur at time of granite placement and prior to water settling operation of the project. The third application shall occur six (6) months into the maintenance period of the contract period of the Project. And the forth and final application 30 days prior to completion of the projects maintenance period. The watering of the pre-emergent shall be according to the manufacturer's recommendation and shall be included in each application. The pre-emergent herbicide shall be applied in accordance with all manufacturer specifications and application data and in conformance with all Federal, State and local regulations and Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications. Contractor

shall submit data to the Contracting Officer for approval prior to placement and use of pre-emergents.

Supply of the trees and shrubs for this project by the Government does not relieve the Contractor of his responsibility for establishment, maintenance, and warranty of all plants that will be specified elsewhere in these Specifications.

Immediately prior to planting, all ocotillo, and other cactus shall require a thorough application of agricultural streptomycin bactericide to the roots of the stock. Agricultural streptomycin shall have a minimum active ingredient of 21.2% (equivalent to 17% streptomycin) and 78.8% inert ingredients.

All pesticide applications shall comply with Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications.

Treatment for disease or pest shall be in accordance with all Federal, State and City of Phoenix rules and regulations and Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications. As feasible, Contractor should seek cultural and biological control solutions which do not depend on chemical applications for the eradication of insects, mites, snails, nematodes, and small animals (squirrels and gophers). Trapping should be utilized unless prescribed in writing by a licensed pest control advisor. Performed method shall be approved by the Contracting Officer prior to initiation of any pesticide treatment or pesticide program.

Soil amendments shall be applied per the directions and application rates specified. Soil shall be prepared using a mixture of 70% excavated site soil and 30% soil conditioner and amendments. Clods or stones exceeding 2 inches in diameter and foreign matter deemed objectionable by the Contracting Officer will not be allowed. All excess soil excavated from the plant pits that has clods or stones 2 inches and larger shall be disposed of on the project site and foreign material shall be removed from site in accordance with Section 01355, ENVIRONMENTAL PROTECTION. Amendment materials shall be mixed with the soil conditioner after they are delivered to the project site. No pre-mixing will be allowed prior to delivery to the project site. No additional payment will be made for this work and is considered as part of the planting operation.

The type and application rate of organic mulch materials shall be as specified on the plans, supplied soils test or within these specifications.

1.4 SOURCE INSPECTIONS

The nursery or source of plant material and the source of delivered topsoil shall be subject to inspection.

1.5 DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.5.1 Delivery

A delivery schedule for plant material delivery from the Government's supplier (Mountain States Wholesale Nursery) shall be coordinated with said nursery and Contracting Officer and shall be prepared when the Contractor is prepared to accept, maintain, protect and take possession and responsibility of plant material. A delivery schedule shall be provided at

least 10 calendar days prior to the first day of delivery to the Contracting Officer.

1.5.1.1 Plant Material Identification

Plant material shall be identified with attached, durable, waterproof labels and weather-resistant ink, stating the correct botanical plant name and size.

1.5.1.2 Delivered Topsoil

Prior to the delivery of any topsoil, the availability of topsoil shall be verified in paragraph TOPSOIL. A soil test shall be provided for delivered topsoil.

1.5.1.3 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries. All soil amendments shall comply with Specification Section 01355, ENVIRONMENTAL PROTECTION.

1.5.1.4 Pesticide Material

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration number and the manufacturer's registered uses. All pesticides shall be stored, protected and secured according to all applicable Federal, State and local regulations.

1.5.2 Inspection

Plant material as **furnished by the Government** shall be well shaped, vigorous and healthy with a healthy, well branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion. Plant material shall be checked for unauthorized substitution and to establish nursery grown status. Plant material showing desiccation, abrasion, sun-scald injury, disfigurement, or unauthorized substitution shall be rejected. The plant material shall exhibit typical form of branch to height ratio; and meet the caliper and height measurements specified. Plant material that measures less than specified, or has been poled, topped off or headed back, shall be rejected. Container-grown plant material shall show new fibrous roots and the root mass shall contain its shape when removed from the container. Plant material with broken or cracked balls; or broken containers shall be rejected. Bare-root plant material that is not dormant or is showing roots were pulled from the ground shall be rejected. Upon acceptance of plant material to the project site Contractor assumes full responsibility for the plant material. Other materials shall be inspected for compliance with paragraph PRODUCTS. Open soil amendment containers or wet soil amendments shall be rejected. Topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, waste or other material larger than 1-1/2 inch diameter shall be rejected. Topsoil that contains viable plant material and plant parts shall be rejected. Unacceptable material shall be immediately removed from the job site one (1) day after rejection.

1.5.3 Storage

1.5.3.1 Plant Material Storage

Plant material not installed on the day of arrival at the site shall be stored and protected in designated areas located on the project site as approved by the Contracting Officer. Plant material shall not be stored longer than 30 days. Plant material shall be protected from direct exposure to wind and sun. Bare-root plant material shall be heeled-in. All plant material shall be kept in a moist condition by watering with a fine mist spray until installed.

1.5.3.2 Other Material Storage

Storage of other material shall be in designated secure areas and shall comply with all Federal, State and local regulations and shall comply with Section 01355, ENVIRONMENTAL PROTECTION. Soil amendments shall be stored in dry locations and away from contaminants. Chemical treatment material shall be stored and secured according to all Federal, State and local regulations and manufacturer's instructions and not with planting operation material.

1.5.4 Handling

Plant material shall not be injured in handling. Cracking or breaking the earth ball of balled and burlapped plant material shall be avoided. Plant material shall not be handled by the trunk or stems. Materials shall not be dropped from vehicles.

1.5.5 Time Limitation

Except for container-grown plant material, the time limitation from digging to installing plant material shall be a maximum 30 days. The time limitation between installing the plant material and placing the mulch shall be a maximum 24 hours.

1.6 WARRANTY

Furnished plant material shall have a warranty for plant growth to be in a vigorous growing condition for a minimum 12 month period. A minimum 12 month calendar time period for the warranty of plant growth shall be provided regardless of the contract time period. When plant material is determined to be unhealthy in accordance with paragraph PLANT ESTABLISHMENT PERIOD, it shall be replaced once under this warranty. Replacement plant material shall only be allowed **from a source** approved by the Contracting Officer.

PART 2 PRODUCTS

2.1 PLANT MATERIAL

2.1.1 Plant Material Classification

The plant material **furnished by the Government** shall be nursery grown stock conforming to ANLA Z60.1 and shall be the species specified.

2.1.2 Plant Schedule

The plant schedule shall provide botanical names as included in one or more of the publications listed under "Nomenclature" in ANLA Z60.1.

2.1.3 Substitutions

Substitutions will not be permitted without written request and approval from the Contracting Officer.

2.1.4 Quality

Well shaped, well grown, vigorous plant material having healthy and well branched root systems in accordance with ANLA Z60.1 shall be provided by the City of Phoenix. Plant material shall be provided free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plant material shall be free of shock or damage to branches, trunk, or root systems, which may occur from the digging and preparation for shipment, method of shipment, or shipment. Plant quality is determined by the growing conditions; method of shipment to maintain health of the root system; and growth of the trunk and crown as follows. The following information is provided so that the Contractor can inspect and accept full responsibility for all plant material delivered to the site by the Government. The information that follows are the guidelines that the Contractor should use in evaluating the supplied plant material.

2.1.5 Growing Conditions

Plant material shall be native to or well-suited to the growing conditions of the project site. Plant material shall be grown under climatic conditions similar to those at the project site. All plant material sources must be approved by the Contracting Officer.

2.1.6 Method of Shipment to Maintain Health of Root System

2.1.6.1 Bare-Root (BR) Plant Material

Minimum root spread shall be in accordance with ANLA Z60.1. A well branched root system characteristic of the species specified shall be provided. Roots shall not be pulled from the ground. Bare-root plant material shall be inoculated with mycorrhizal fungi during germination in the nursery. Before shipment the root system shall be dipped in gels containing mycorrhizal fungi inoculum. Bare-root plant material shall be dormant. The root system shall be protected from drying out.

2.1.6.2 Container-Grown (C) Plant Material

Container size shall be in accordance with ANLA Z60.1. Plant material shall be grown in a container over a duration of time for new fibrous roots to have developed and for the root mass to retain its shape and hold together when removed from the container. Container-grown plant material shall be inoculated with mycorrhizal fungi during germination in the nursery. Before shipment the root system shall be dipped in gels containing mycorrhizal fungi inoculum. The container shall be sufficiently rigid to hold ball shape and protect root mass during shipping.

2.1.7 Growth of Trunk and Crown

2.1.7.1 Deciduous Trees

A height to caliper relationship shall be provided in accordance with ANLA Z60.1. Height of branching shall bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

a. Single stem: The trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader.

b. Multi-stem: All countable stems, in aggregate, shall average the size specified.

c. Specimen: The tree provided shall be well branched and pruned naturally according to the species. The form of growth desired, which shall be in accordance with its natural growth habit.

2.1.7.2 Deciduous Shrubs

Deciduous shrubs shall have the height and number of primary stems recommended by ANLA Z60.1. Acceptable plant material shall be well shaped, with sufficient well-spaced side branches, and recognized by the trade as typical for the species grown in the region of the project.

2.1.7.3 Ground Cover and Vine Plant Material

Ground cover and vine plant material shall have the minimum number of runners and length of runner recommended by ANLA Z60.1. Plant material shall have heavy, well developed and balanced crown with vigorous, well developed root system and shall be furnished in containers.

2.1.8 Plant Material Size

All plant material shall be furnished by the City of Phoenix in sizes indicated. Plant material larger in size than specified may be provided at no additional cost to the Government.

2.1.9 Plant Material Measurement

Plant material measurements shall be in accordance with ANLA Z60.1.

2.2 TOPSOIL

Topsoil for use on all turf and planting areas and as part of the backfill shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil stripped and stockpiled onsite in accordance with Section 02300 EARTHWORK. When additional topsoil is required beyond the available topsoil from the stripping operation, topsoil shall be delivered and amended as recommended and in compliance with Section 02921 SEEDING, Article 2.2 Topsoil.

2.2.1 Materials

When a source of topsoil is not designated, the contractor shall furnish a source in accordance with the requirements herein and the requirements of Arizona Residential Soil Cleanup levels and standards. Topsoil from sources furnished by the contractor shall conform to the following requirements:

a. Prior to hauling any topsoil to the project site, the contractor shall furnish a written soil analysis, prepared by a laboratory approved by the Contracting Officer, for each source of topsoil proposed for use. The soil analysis shall indicate the pH, soluble salts, percent calcium carbonate, exchangeable sodium in percent and parts per million, plasticity index and size gradation. A minimum of three samples per

each 10,000 cubic yards, with at least three samples per source, shall be tested. All tests shall be performed in accordance with the following requirements and test procedures listed in the Table below. The contractor shall bear the expense of any topsoil testing from proposed sources.

b. Topsoil shall be fertile, friable soil obtained from well drained arable land which has or is producing healthy crops, grasses or other vegetation. It shall be free draining, non-toxic and capable of sustaining healthy plant growth.

c. Topsoil shall be reasonably free of subsoil, refuse, roots, heavy clay, clods, noxious weed seeds, phytotoxic materials, coarse sand, large rocks, sticks, brush, litter and other deleterious substances.

d. For acceptance purposes, each approximate 20,000 cubic yards or topsoil material delivered from a given source to the project site shall be considered a lot. For each lot of topsoil, six representative samples shall be taken at random locations designated by the Contracting Officer. Topsoil shall be sampled after final placement. Each source of topsoil shall be tested separately. The samples from each lot shall be tested by the Contracting Officer for pH, soluble salts, calcium carbonate, exchangeable sodium in percentage and parts per million, P.I., and gradation in accordance with the test procedures listed in the Table below.

e. The average test result obtained for each characteristic from each lot shall meet the following requirements:

Characteristics	Test Method	Requirement Average of 6 Samples
pH	ARIZ 237	6.0 - 8.3
Soluble Salts: (PPM)	ARIZ 237	2000 Maximum
Calcium Carbonate	ARIZ 732	8% Maximum
Exchangeable Sodium:	ARIZ 729	5% Maximum
Exchangeable Sodium: (PPMP)	ARIZ 729	300 Maximum
P.I.	AASHTO T 90	5 - 20
Gradation:	ARIZ 201	% Passing
2 inch		100
1/2 inch		85 - 100
No. 40		35 - 100

f. If the average test result for a lot fails to meet all the specifications listed above, the material from that lot shall be rejected. In lieu of removal and replacement, the contractor may propose for the Contracting Officer's consideration a method of treatment of the in-place material to obtain specification compliance. Provided the Contracting Officer approves, the topsoil shall be treated at no additional cost to the Department.

g. The lot shall then be resampled and tested for specification compliance by the Contracting Officer.

h. If the pH of the topsoil for a lot exceeds 8.3, the topsoil shall either be removed and replaced, or be treated as provided for in the preceding paragraph. Any treatment for pH shall be sufficient to obtain an average pH between 6.0 and 8.0, inclusive. The treatment for pH shall follow the recommendations of a recognized soil analyst and

shall be subject to the approval of the Contracting Officer. Any treatment for pH shall be at no additional cost to the Department. Additional acceptance testing after treatment for pH will not be required.

2.2.2 Construction Requirements

Topsoil shall be spread uniformly on the designated turf areas and areas directed by the Contracting Officer to the depths or contours shown on the plans. The contractor shall avoid over-compaction in spreading and shaping operations. Scarification shall be required for over-compacted areas and haul roads. When topsoil is placed over subgrade material as plating, the subgrade shall be scarified or disked to a six-inch depth prior to placement of the topsoil.

2.3 SOIL AMENDMENTS

Soil amendments shall consist of pH adjuster, fertilizer, organic material and soil conditioners meeting the following requirements. Vermiculite is not recommended. All soil amendments and applications shall comply with Sections 01355 ENVIRONMENTAL PROTECTION and 01356 STORM WATER POLLUTION PREVENTION MEASURES of these specifications.

2.3.1 pH Adjuster

The pH adjuster shall be an agricultural sulfur material. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

2.3.2 Fertilizer

Fertilizer shall be controlled release commercial grade; free flowing, pellet or tablet form; uniform in composition; and consist of a nitrogen-phosphorus-potassium ratio. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU). Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.

2.3.3 Organic Material

Organic material shall consist of either decomposed wood derivatives, or recycled compost.

2.3.3.1 Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, or other wood waste material free of stones, sticks, and toxic substances harmful to plants, and stabilized with nitrogen.

2.3.3.2 Recycled Compost

Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from food, agricultural, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 3/8 inch screen, possess a pH of 5.5 to 8.0, and have a moisture content between 35-55

percent by weight. The material shall not contain more than 1 percent or less by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 2 inches in length. The Contractor shall comply with EPA requirements in accordance with Section 01355, ENVIRONMENTAL PROTECTION

2.3.4 Soil Conditioner

Soil conditioner shall be sand, super absorbent polymers, calcined clay, or gypsum for single use or in combination to meet topsoil requirements for the plant material specified.

2.3.4.1 Sand

Sand shall be clean and free of toxic materials. Gradation: A minimum 95 percent by weight shall pass a No. 10 sieve and a minimum 10 percent by weight shall pass a No. 16 sieve. Greensand shall be balanced with the inclusion of trace minerals and nutrients.

2.3.4.2 Super Absorbent Polymers

To improve water retention in soils, super absorbent polymers shall be sized according to manufacturer's recommendations. Polymers shall be added as a soil amendment and be cross-linked polyacrylamide with an absorption capacity of 250-400 times its weight.

2.3.4.3 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum 95 percent calcium sulfate by volume.

2.4 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region. Rotted manure is not recommended to be used as a mulch because it would encourage surface rooting of the plant material and weeds.

2.4.1 Inorganic Mulch

Decomposed Granite color shall be "Apache Brown" as produced by Granite Express or approved equal. Please see plans for location of inert materials. The approved granite colors shall come from a single source. All granite material shall be sampled for color and gradation by the Contracting Officer. All samples must be approved for color and gradation prior to placement.

Granite shall be placed as shown on the plans.

Decomposed granite shall be shall be as follows: 1/4 inch minus for all stabilized surfaces and 2 inches minus for all other designated granite areas.

The grading requirements for decomposed granite within the project as identified on the plans shall be as follows:

DECOMPOSED GRANITE 1/4" MINUS

Sieve Size	Percent Passing
1/4 inch	100
No. 40	5-20

DECOMPOSED GRANITE 2" MINUS

Sieve Size	Percent Passing
2 inch	100
1/2 inch	60-80
1/4 inch	45-65
No. 40	5-20

Rock mulch around all drain inlets, swales, for erosion control shall be crushed and angular in form. The grading requirements shall be as follows:

ROCK MULCH

Rock Size	Percent Passing
4 inch	100
2 inch	25-75
1 inch	0-10

The color of the rock mulch shall match the color of the adjacent decomposed granite.

Prior to placing decomposed granite, and rock mulch, the areas shall be totally free of grasses and weeds. When using herbicides, the work shall be in accordance with all applicable Federal, State and Local Municipality rules and regulations. All dead grass and weeds shall be removed and disposed of by the contractor as approved by the Contracting Officer. The contractor shall repair eroded areas and compact soil as approved by the Contracting Officer. The finish subgrade for the Decomposed Granite and Rock Mulch areas shall be compacted to 85-90% of the maximum density. The contractor shall employ the use of all necessary grading equipment, earth moving and compacting machinery, water applications, and approved methods to adequately compact the grade on which the decomposed granite and rock mulch are to be placed. Compaction shall be completed to the approval of the Contracting Officer prior to the placement of any inert materials. Contractor shall apply per manufacturer instructions and Engineers approval to the finish grade the first of two (2) applications of an approved pre-emergent herbicide. The first application shall be applied to the subgrade prior to placing the specified granite or rock mulch.

The finish subgrade, before placement of the decomposed granite and or rock mulch, shall be compacted to a density of 85% - 90% of the maximum density as determined in accordance with the requirements of the City of Phoenix Materials Testing Manual.

All vehicles used for spreading, grading and raking the decomposed granite and or rock mulch shall have one set of wheels with flotation tires having a minimum width of 18 inches to allow equal compaction of the rock mulch.

After rough spreading and rough grading of the decomposed granite and or rock mulch within the designated areas, the decomposed granite and or rock mulch shall be raked to evenly blend the different gradation sizes in the decomposed granite and or rock mulch. Following approval of the Contracting Officer, the decomposed granite and or rock mulch shall be saturated with water to an optimum moisture level. The Contracting Officer

will approve the amount of water necessary to aid in the compaction of the decomposed granite and or rock mulch.

The decomposed granite and or rock mulch shall be placed to a minimum depth of two inches, except in planting pits. Where decomposed granite and or rock mulch is within the planting pits, the maximum depth shall be one inch.

During the final spreading and final grading operations, all surfaces within the decomposed granite and or rock mulch areas shall be passed over by the spreading and grading equipment a minimum of two times. All equipment operations for spreading, grading, raking, chemical application, water settling, and any other operations shall be done in a manner that uniformly maximizes the vehicle(s) wheel compaction over all the surface.

The pre-emergent herbicide shall be applied in compliance with Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications and activated in the manner recommended by the manufacturer to prevent germination of noxious weeds, and shall be 'Gallery' 'Surflan' or approved equal. The pre-emergent herbicide shall be applied to the decomposed granite, and rock mulch areas and shall occur at a minimum of two (2) times during the Phase I portion of the contract. The first application shall be applied to the subgrade prior to placement of the granite and the second application shall occur before the final water settling operation of the granite areas.

After placing, spreading and grading the decomposed granite and or rock mulch, the contractor shall water settle the total thickness of the decomposed granite and or rock mulch, removing the fine material from the surface. The water settling operation shall be completed at the minimum rate of one-half inch of water and shall occur within 21 days after application of the pre-emergent herbicide.

Rock furnished by the contractor shall be obtained from a single source.

The contractor shall prepare a sample area of approximately 100 square feet of both the decomposed granite and rock mulch for the Contracting Officer's approval. The sample area may be part of the area requiring decomposed granite or rock mulch and this sample once approved, will be used by the Contracting Officer to determine the acceptability of the remaining work under this item.

2.4.2 Organic Mulch

Organic mulch materials shall be native to the project site and consist of recycled mulch, shredded bark, wood chips, or ground bark.

2.4.2.1 Recycled Mulch

Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 2-1/2 x 2-1/2 inch screen. It shall be cleaned of all sticks a minimum 1 inch in diameter and plastic materials a minimum 3 inch length. The material shall be treated to retard the growth of mold and fungi. Other recycled mulch may include peanut shells, pecan shells or coco bean shells.

2.4.2.2 Shredded Bark

Locally shredded material shall be treated to retard the growth of mold and fungi.

2.5 WOOD STAKING MATERIAL

Wood stakes shall be hardwood or fir; rough sawn; free from knots, rot, cross grain, or other defects that would impair their strength.

2.5.1 Bracing Stake

Wood bracing stakes shall be a minimum 2 x 2 inch square and a minimum 8 feet long with a point at one end. Stake shall be set without damaging rootball.

2.5.2 Wood Ground Stakes

Wood ground stakes shall be a minimum of 2 x 2 inch square and a minimum 3 feet long with a point at one end.

2.5.3 Deadmen

Wood deadmen shall be a minimum 4 x 4 x 36 inches long.

2.6 METAL STAKING AND GUYING MATERIAL

Metal shall be aluminum or steel consisting of recycled content made for holding plant material in place.

2.6.1 Bracing Stakes

Metal bracing stakes shall be a minimum 1 inch diameter and a minimum 8 feet long. Stake shall be set without damaging rootball.

2.6.2 Metal Ground Stakes

Metal ground stakes shall be a minimum 1/2 inch diameter and a minimum 3 feet long.

2.6.3 Earth Anchor

Metal earth anchors shall be a minimum 1/2 inch diameter and a minimum 2 feet long.

2.6.4 Guying Material

Metal guying material shall be a minimum 12 gauge wire. Multi-strand cable shall be woven wire. Guying material tensile strength shall conform to the size of tree to be held firmly in place.

2.6.5 Turnbuckle

Metal turnbuckles shall be galvanized or cadmium-plated steel, and shall be a minimum 3 inches long with closed screw eyes on each end. Screw thread tensile strength shall conform to the size of tree to be held firmly in place.

2.7 PLASTIC STAKING AND GUYING MATERIAL

Plastic shall consist of recycled plastic product made for holding plant material firmly in place. Plastic shall not be used for deadmen.

2.7.1 Plastic Bracing Stake

Plastic bracing stakes shall be a minimum 2 inch diameter and a minimum 8 feet long. Stake shall be set without damaging rootball.

2.7.2 Plastic Ground Stakes

Plastic ground stakes shall be a minimum 1 inch diameter and a minimum 3 feet long.

2.7.3 Plastic Guying Material

Plastic guying material shall be designed specifically for the purpose of firmly holding plant material in high wind velocities.

2.7.4 Chafing Guard

Plastic chafing guards shall be used to protect tree trunks and branches when metal is used as guying material. The material shall be the same color throughout the project site. Length shall be a minimum 1.5 times the circumference of the plant trunk at its base.

2.8 RUBBER GUYING MATERIAL

Rubber chafing guards, consisting of recycled material, shall be used to protect tree trunks and branches when metal guying material is applied. The material shall be the same color throughout the project. Length shall be a minimum 1.5 times the circumference of the plant trunk at its base.

2.9 FLAG

Plastic flag material shall be used on guying material. It shall be a minimum 6 inches long. Tape color shall be consistent and visually complimentary to the entire project area. The tape color shall meet pedestrian visual safety requirements for day and night.

2.10 TREE ROOT BARRIERS

Tree root barriers shall be metal or plastic consisting of recycled content. Barriers shall utilize vertical stabilizing members to encourage downward tree root growth. Barriers shall limit, by a minimum 90 percent, the occurrence of surface roots. Tree root barriers which are designed to be used as plant pit liners will be rejected.

2.11 MYCORRHIZAL FUNGI INOCULUM

Mycorrhizal fungi inoculum shall be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.

2.12 WATER

All water for exterior planting will be furnished according to Section 01200 GENERAL REQUIREMENTS unless the automatic irrigation system is approved for use by the Contracting Officer.

2.13 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification a soil

fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved. Applications of any pesticide shall comply with Sections 01355 ENVIRONMENTAL PROTECTION and 01356 STORM WATER POLLUTION PREVENTION MEASURES of these specifications.

PART 3 EXECUTION

3.1 INSTALLING PLANT MATERIAL TIME AND CONDITIONS

3.1.1 Deciduous Plant Material Time

Deciduous plant material shall be installed from March 15 to October 15 unless approved by the Contracting Officer.

3.1.2 Evergreen Plant Material Time

Evergreen plant material shall be installed from March 15 to October 15 unless approved by the Contracting Officer.

3.1.3 Plant Material Conditions

Planting operations shall be performed only during periods when beneficial results and water can be obtained. When excessive moisture, or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted for approval.

3.1.4 Tests

3.1.4.1 Percolation Test

Test for percolation shall be done to determine positive drainage of plant pits and beds. A positive percolation shall consist of a minimum 1 inch per 3 hours; when a negative percolation test occurs, a shop drawing shall be submitted indicating the corrective measures.

3.1.4.2 Soil Test

Delivered topsoil, excavated plant pit soil, and stockpiled topsoil shall be tested in accordance with "Arizona Residential Cleanup" levels and standards, ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, and mechanical analysis. Sample collection onsite shall be random over the entire site. Sample collection for stockpiled topsoil shall be at different levels in the stockpile. The soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test shall determine the quantities and type of soil amendments required to meet local growing conditions for the plant material specified. Any corrective measures as outlined by the Contractor and approved by the Contracting Officer shall occur at no additional charge to the Government.

3.2 SITE PREPARATION

3.2.1 Finished Grade, Topsoil and Underground Utilities

The Contractor shall verify that finished grades are as indicated on drawings, and that the placing of topsoil, the smooth grading, and the compaction requirements have been completed in accordance with Section 02300

EARTHWORK, prior to the commencement of the planting operation. The location of underground utilities and facilities in the area of the planting operation shall be verified. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

3.2.2 Layout

Plant material locations shall be staked on the project site before any excavation is made. Plant material locations may be adjusted to meet field conditions.

3.2.3 Protecting Existing Vegetation

Existing trees and shrubs that are to be preserved shall be barricaded along the dripline to protect them during planting operations. Contractor shall protect existing materials or face the fines per Section 01355 ENVIRONMENTAL PROTECTION.

3.3 EXCAVATION

3.3.1 Obstructions Below Ground

When obstructions below ground affect the work, shop drawings showing proposed adjustments to plant material location, type of plant and planting method shall be submitted for approval. In the event that waste material is discovered within the plant pit the Contractor shall contact the Contracting Officer immediately and comply with Sections 01355, ENVIRONMENTAL PROTECTION and 01356 STORM WATER POLLUTION PREVENTION MEASURES of these specifications.

3.3.2 Plant Pits

Plant pits for ball and burlapped or container plant material shall be dug to a depth equal to the height of the root ball as measured from the base of the ball to the base of the plant trunk. Plant pits for bare-root plant material shall be dug to a depth equal to the height of the root system. Plant pits shall be dug three times wider than the ball or root system to allow for root expansion. The pit shall be constructed with sides sloping towards the base as a cone, to encourage well aerated soil to be available to the root system for favorable root growth. Cylindrical pits with vertical sides shall not be used.

3.4 INSTALLATION

3.4.1 Setting Plant Material

Plant material shall be set plumb and held in position until sufficient soil has been firmly placed around root system or ball. In relation to the surrounding grade, the plant material shall be set even with the grade at which it was grown.

3.4.1.1 Bare-Root Plant Material

Bare-root plant material shall be placed in water a minimum 30 minutes prior to setting.

3.4.2 Backfill Soil Mixture

The backfill soil mixture may be a mix of topsoil and soil amendments

suitable for the plant material specified. When practical, the excavated soil from the plant pit that is not amended provides the best backfill and shall be used.

3.4.3 Adding Mycorrhizal Fungi Inoculum

Mycorrhizal fungi inoculum shall be added as directed by the Contracting Officer for the plant material specified.

3.4.4 Backfill Procedure

Prior to backfilling, all metal, wood, synthetic products, or treated burlap devices shall be removed from the ball or root system avoiding damage to the root system. The backfill procedure shall remove air pockets from around the root system. Additional requirements are as follows.

3.4.4.1 Bare-Root Plant Material

The root system shall be spread out and arranged in its natural position. Damaged roots shall be removed with a clean cut. The backfill soil mixture shall be carefully worked in amongst the roots and watered to form a soupy mixture. Air pockets shall be removed from around the root system, and root to soil contact shall be provided.

3.4.4.2 Container-Grown and Balled and Potted Plant Material

The plant material shall be carefully removed from containers that are not biodegradable. Prior to setting the plant in the pit, a maximum 1/4 depth of the root mass, measured from the bottom, shall be spread apart to promote new root growth. For plant material in biodegradable containers the container shall be split prior to setting the plant with container. Backfill mixture shall be added to the plant pit in 6 inch layers with each layer tamped.

3.4.4.3 Earth Berm

An earth berm that is of the same size and diameter of the plant pit specified in Article 3.3.2, consisting of backfill soil mixture, shall be formed with a minimum 4 inch height around the edge of the plant pit to aid in water retention and to provide soil for settling adjustments.

3.4.5 Plant Bed

Plant material shall be set in plant beds according to the drawings. Backfill soil mixture shall be placed on previously scarified subsoil to completely surround the root balls, and shall be brought to a smooth and even surface, blending to existing areas. Earth berms shall be provided. Polymers shall be spread uniformly over the plant bed and in the planting pit as recommended by the manufacturer and thoroughly incorporated into the soil to a maximum 4 inch depth.

3.4.6 Watering

Plant pits and plant beds shall be watered immediately after backfilling, until completely saturated. A regular watering schedule shall be established. Slow deep watering shall be used. Run-off and puddling shall be prevented.

3.4.7 Staking and Guying

Staking will be required when trees are unstable or will not remain set due to their size, shape, or exposure to high wind velocity.

3.4.7.1 One Bracing Stake

Trees 4 to 6 feet high shall be firmly anchored in place with one bracing stake. The bracing stake shall be placed on the side of the tree facing the prevailing wind. The bracing stake shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly to the stake with a double strand of guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. A chafing guard shall be used when metal is the guying material.

3.4.7.2 Two Bracing Stakes

Trees from 6 to 8 feet height shall be firmly anchored in place with 2 bracing stakes placed on opposite sides. Bracing stakes shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly between the stakes with a double strand of guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. Chafing guards shall be used when metal is the guying material.

3.4.7.3 Three Ground Stakes

Trees over a minimum 8 feet height and less than a maximum 6 inch caliper shall be held firmly in place with 3 bracing or ground stakes spaced equidistantly around the tree. Ground stakes shall be avoided in areas to be mowed. Stakes shall be driven into firm ground outside the earth berm. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. For trees over maximum 3 inch diameter at breast height, turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used when metal is the guying material.

3.4.8 Deadmen or Earth Anchors

Trees over a minimum 6 inch caliper shall be held firmly in place with wood deadmen buried a minimum 3 feet in the ground or metal earth anchors. Multi-strand cable guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. Turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used.

3.4.9 Flags

A flag shall be securely fastened to each guy line equidistant between the tree and the stake, deadmen, or earth anchor. The flag shall be visible to pedestrians.

3.5 FINISHING

3.5.1 Plant Material

Prior to placing mulch, the installed area shall be raked and shaped as indicated while maintaining the earth berms.

3.5.2 Placing Mulch

The placement of mulch shall occur a maximum 48 hours after planting. Mulch, used to reduce soil water loss, regulate soil temperature and prevent weed growth, shall be spread to cover the installed area with a minimum 2 inch uniform thickness. Mulch shall be kept out of the crowns of shrubs, ground cover, and vines and shall be kept off buildings, sidewalks and other facilities.

3.5.3 Pruning

Pruning shall be accomplished by trained and experienced personnel and only as directed by the Contracting Officer. The pruning of trees shall be in accordance with ANSI A300. Only dead or broken material shall be pruned from installed plants. The typical growth habit of individual plant material shall be retained. Clean cuts shall be made flush with the parent trunk. Improper cuts, stubs, dead and broken branches shall be removed. "Headback" cuts at right angles to the line of growth will not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off".

3.6 MAINTENANCE DURING PLANTING OPERATION

Installed plant material shall be maintained in a healthy growing condition. Maintenance operations shall begin immediately after each plant is installed to prevent desiccation and shall continue until the plant establishment period commences. Installed areas shall be kept free of weeds, grass, and other undesired vegetation. The maintenance includes maintaining the mulch, watering, and adjusting settling.

3.7 APPLICATION OF PESTICIDE

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program. All pesticide shall comply with Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications and all Federal, State and City regulations.

3.7.1 Technical Representative

The State certified pest management applicator shall be the technical representative, and shall be present at all meetings concerning treatment measures for pest or disease control. They may be present during treatment application.

3.7.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended as it prevents the pesticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use,

the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

3.8 RESTORATION AND CLEAN UP

3.8.1 Restoration

Pavements and facilities that have been damaged from the planting operation shall be restored to original condition at the Contractor's expense.

3.8.2 Clean Up

Excess and waste material shall be removed from the installed area and shall be disposed offsite. Adjacent paved areas shall be cleared.

3.9 PLANT ESTABLISHMENT PERIOD

3.9.1 Commencement

The plant establishment period for maintaining exterior plantings in a healthy growing condition shall commence on the first day of exterior planting work under this contract and shall continue through the remaining life of the contract and end 12 months after substantial completion and acceptance by the Contracting Officer of exterior planting required by this contract. Written calendar time period shall be furnished for the plant establishment period. When there is more than one plant establishment period, the boundaries of the planted area covered for each period shall be described. The plant establishment period shall be coordinated with Section 02921 SEEDING. The plant establishment period shall be modified for inclement weather shut down periods, or for separate completion dates for areas.

3.9.2 Maintenance During Establishment Period

Maintenance of plant material shall include straightening plant material, straightening stakes; tightening guying material; correcting girdling; supplementing mulch; pruning dead or broken branch tips; maintaining plant material labels; watering; eradicating weeds, insects and disease; post-fertilization; and removing and replacing unhealthy plants.

3.9.2.1 Watering Plant Material

The plant material shall be watered as necessary to prevent desiccation and to maintain an adequate supply of moisture within the root zone. Run-off, puddling and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or existing plant material shall be prevented.

3.9.2.2 Weeding

Weeds in the installed areas shall not be allowed to reach a maximum 3 inches height before being completely removed, including the root system.

3.9.2.3 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

3.9.2.4 Post-Fertilization

The plant material shall be topdressed at least once during the period of establishment with controlled release fertilizer, reference paragraph SOIL AMENDMENTS. Apply at the rate of 2 pounds per 100 square feet of plant pit or bed area. Dry fertilizer adhering to plants shall be flushed off. The application shall be timed prior to the advent of winter dormancy.

3.9.2.5 Plant Pit Settling

When settling occurs to the backfill soil mixture, additional backfill soil shall be added to the plant pit or plant bed until the backfill level is equal to the surrounding grade. Serious settling that affects the setting of the plant in relation to the maximum depth at which it was grown requires replanting in accordance with paragraph INSTALLATION. The earth berm shall be maintained. All fertilizer applications shall comply with Sections 01355, ENVIRONMENTAL PROTECTION and 01356, STORM WATER POLLUTION PREVENTION MEASURES of these specifications.

3.9.2.6 Maintenance Record

A record shall be furnished describing the maintenance work performed, the quantity of plant losses, diagnosis of the plant loss, and the quantity of replacements made on each site visit.

3.9.3 Unhealthy Plant Material

A tree shall be considered unhealthy or dead when the main leader has died back, or up to a maximum 25 percent of the crown has died. A shrub shall be considered unhealthy or dead when up to a maximum 25 percent of the plant has died. This condition shall be determined by scraping on a branch an area 1/16 inch square, maximum, to determine if there is a green cambium layer below the bark. The Contractor shall determine the cause for unhealthy plant material and shall provide recommendations for replacement. Unhealthy or dead plant material shall be removed immediately and shall be replaced as soon as seasonal conditions permit.

3.9.4 Replacement Plant Material

Unless otherwise directed, plant material shall be provided for replacement in accordance with paragraph PLANT MATERIAL. Replacement plant material shall only be provided from Contracting Officer approved locations and installed in accordance with paragraph INSTALLATION, and recommendations in paragraph PLANT ESTABLISHMENT PERIOD. Plant material shall be replaced in accordance with paragraph WARRANTY. An extended plant establishment period shall not be required for replacement plant material.

3.9.5 Maintenance Instructions

Written instructions shall be furnished containing drawings and other necessary information for year-round care of the installed plant material; including, when and where maintenance should occur, and the procedures for plant material replacement.

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SECTION 15060

PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

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

MANUFACTURER'S STANDARDIZATION SOCIETY (MSS)

MSS SP 58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP 69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP 89	(1998) Pipe Hangers and Supports - Fabrication and Installation Practices

1.2 DEFINITIONS

Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.3 SUBMITTALS

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

SD-02 Shop Drawings

Piping Support System; G, RE

SD-10 Operation and Maintenance Data

Piping Support System; G, RE.

Maintenance information on piping support system.

1.4 QUALIFICATIONS

Piping support systems shall be designed and shop drawings prepared and sealed by a registered Professional Engineer in the State of Arizona.

1.5 DESIGN REQUIREMENTS

1.5.1 General

a. Seismic Load: Seismic performance category forces with seismic loads in accordance with local codes.

b. Design, size, and locate piping support systems throughout facility, whether shown or not.

c. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.

d. Meet requirements of MSS SP 58, MSS SP 69, and MSS SP 89, or as modified by this section.

1.5.2 Pipe Support Systems

a. Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation.

b. Maximum Support Spacing and Minimum Rod Size:

(1) Ductile Iron Piping (Note that this spacing may require the use of higher load pipe clamps and more than a single point anchor point in concrete):

Pipe Size	Maximum Support Hanger Spacing	Minimum Rod Size/ Single Rod Hangers
1" & smaller	6 feet	1/4"
1-1/2" through 2-1/2"	8 feet	1/4"
3" & 4"	10 feet	3/8"
6"	12 feet	3/8"
8"	12 feet	1/2"
10" & 12"	14 feet	5/8"
14"	16 feet	3/4"
16" & 18"	16 feet	7/8"
20"	18 feet	1"
24"	18 feet	1-1/4"
30" & larger	As shown on Drawings	As shown on Drawings

(2) Plastic Piping:

a) Maximum support spacing: As recommended by manufacturer for flow temperature in pipe.

b) Minimum Hanger Rod Sizing: Same as listed for steel pipe.

1.5.3 Framing Support System:

a. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.

b. Column Members: Size in accordance with manufacturer's recommended method.

c. Support Loads: Calculate using weight of pipes filled with water.

d. Maximum Spans:

(1) Steel and Ductile Iron Pipe, 3-Inch Diameter and Larger: 10-foot centers, unless otherwise shown.

(2) Other Pipelines and Special Situations: May require supplementary hangers and supports.

e. Electrical Conduit Support: Include in design of framing support system.

1.5.4 Anchoring Devices:

Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

1.5.5 Vertical Sway Bracing:

10-foot maximum centers, or as shown.

1.5.6 Existing Support Systems:

Use existing supports systems to support new piping only if Contractor can show that they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.1 GENERAL

a. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs.

b. Special support and hanger details are shown for cases where standard catalog supports are inapplicable.

2.2 SADDLE SUPPORTS

2.2.1 Pedestal Type

Schedule 40 pipe stanchion, saddle, and anchoring flange.

a. Nonadjustable Saddle: MSS SP 58 and MSS SP 69, Type 37 with U-bolt.

b. Adjustable Saddle: MSS SP 58 and MSS SP 69, Type 38 without clamp.

2.3 PIPE CLAMPS

Riser Clamp: MSS SP 58 and MSS SP 69, Type 8.

2.4 CHANNEL TYPE SUPPORT SYSTEMS

a. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, 1-1/2-inch wide, minimum FRP.

b. Members and Connections: Design for all loads with safety factor of 5.

2.5 ACCESSORIES

2.5.1 Insulation Shields

Type: Galvanized steel or stainless steel, MSS SP 58 and MSS SP 69, Type 40.

2.5.2 Welding Insulation Saddles

Type: MSS SP 58 and MSS SP 69, Type 39.

2.5.3 Vibration Isolation Pads

Type: Neoprene Waffle.

2.6 INTERMEDIATE PIPE GUIDES

2.6.1 Piping 6 Inches and Smaller

Type: Pipe clamp with oversized pipe sleeve to provide minimum 1/8-inch clearance.

2.6.2 Piping 8 Inches and Larger

a. Type: Specially formed U-bolts with double nuts to provide 1/4-inch minimum clearance around pipe.

b. U-Bolt Stock Size:

(1) 8-Inch Pipe: 5/8 inch.
(2) 10-Inch Pipe: 3/4 inch.
(3) 12- Through 16-Inch Pipe: 7/8 inch.
(4) 18- Through 30-Inch Pipe: 1 inch.

2.7 PIPE ALIGNMENT GUIDES

a. Type:

(1) Piping 8 Inches and Smaller: Spider or sleeve type.
(2) Piping 10 Inches and Larger: Roller type.

2.8 PIPE ANCHORS

Type: Anchor chair with U-bolt strap.

2.9 ANCHORING SYSTEMS

Size: Sized by equipment manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

a. Install support systems in accordance with MSS SP 69 and MSS SP 89, unless shown otherwise.

b. Support piping connections to equipment by pipe support and not by equipment.

c. Support large or heavy valves, fittings, and appurtenances independently of connected piping.

d. Support no pipe from pipe above it.

e. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.

f. Do not install pipe supports in equipment access areas or bridge crane runs.

g. Install lateral supports for seismic loads at all changes in direction.

h. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.

i. Repair mounting surfaces to original condition after attachments are made.

3.1.2 Standard Pipe Supports

a. Horizontal Piping Supported From Floors:

(1) Stanchion Type:
a) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
b) Use yoked saddles for piping whose centerline elevation is 18 inches or greater above floor and for exterior installations.
c) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.

(2) Floor Mounted Channel Supports:
a) Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
b) Attach channel framing to floors with anchor bolts.
c) Attach pipe to channel with clips or pipe clamps.

(3) Concrete Cradles: Use for piping larger than 3 inch along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.

b. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.

3.1.3 Intermediate and Pipe Alignment Guides

a. Provide pipe alignment guides (or pipe supports that provide same function) at expansion joints and loops.

b. Guide piping on each side of expansion joint or loop at 4- and 14-pipe diameters from each joint or loop.

c. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

3.1.4 Accessories

a. Insulation Shield: Install on insulated nonsteel piping. Oversize rollers and supports.

b. Vibration Isolation Pad: Install under base flange of pedestal type

pipe supports adjacent to equipment, and where required to isolate vibration.

c. Dielectric Barrier:

(1) Install between carbon steel members and copper or stainless steel pipe.
(2) Install between stainless steel supports and nonstainless steel ferrous metal piping.

d. Electrical Isolation: Install 1/4-inch by 3-inch neoprene rubber wrap between submerged metal pipe and oversized clamps.

3.2 FIELD FINISHING

Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09971 COATING OF EQUIPMENT.

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SECTION 15081

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SECTION 15081

EXTERIOR PIPING INSULATION

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 240/A 240M	(2000) Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM B 209	(2000) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 534	(1999) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM D 226	(1997a) Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

1.2 SYSTEM DESCRIPTION

Provide field-applied insulation for exterior water piping.

1.3 SUBMITTALS

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

SD-03 Product Data

Insulation

Provide manufacturer's written statements indicating amount of recycled material.

Jacket

Provide manufacturer's written information.

SD-08 Manufacturer's Instructions

field-applied insulation

Installation manual for field-applied insulation

1.4 RECYCLED MATERIALS

Provide thermal insulation containing recycled materials to the extent practicable, provided that the material meets all other requirements of this section. The minimum recycled material content of the following insulation are:

Rock Wool - 75 percent slag by weight
Fiberglass - 20-25 percent glass cullet by weight
Phenolic Rigid Foam - 5 percent recovered material
Plastic Rigid Foam - 9 percent recovered material
Polyisocyanurate/Polyurethane - 9 percent recovered material
Rigid Foam - 9 percent recovered material

PART 2 PRODUCTS

2.1 TYPE P3-ELASTOMERIC

Type P3-Elastomeric (ASTM C 534, -40 degrees F to 220 degrees F)

1. Flexible, closed cell elastomeric, nominal 6 PCF density, K factor 0.27 maximum at 75 degrees F mean.

2.2 ALUMINUM JACKET

ASTM B 209, Temper H14, minimum thickness of 0.016 inch, with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside diameters less than 8 inches. Provide corrugated surface jackets for jacket outside diameters 8 inches and larger. Provide stainless steel bands, minimum width of 0.5 inch. Provide factory prefabricated aluminum covers for insulation on fittings, valves, and flanges.

2.3 ASPHALT-SATURATED FELT

ASTM D 226, without perforations, minimum weight of 10 pounds per 100 square feet.

2.4 STAINLESS STEEL JACKET

ASTM A 167 or ASTM A 240/A 240M; Type 304, minimum thickness of 0.010 inch, smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 0.5 inch. Provide factory prefabricated stainless steel covers for insulation on fittings, valves, and flanges.

PART 3 EXECUTION

3.1 APPLICATION OF PIPING INSULATION

a. Install insulation products in accordance with the manufacturer's written instructions, and in accordance with recognized industry practices.

b. Install insulation on pipe systems subsequent to testing and acceptance of test.

c. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.

d. Clean and dry pipe surfaces prior to insulation. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

e. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal all butt ends of chilled water and condensate drain piping insulation at fittings with white vapor barrier coating.

f. Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job-fabricated units (at Installer's option). Finish cold pipe fittings with white vapor barrier coating and hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.

g. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

h. Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation.

i. Insulation on piping that is to be heat traced shall be installed after installation of heat tape.

j. Insulate valve bodies, flanges, and pipe couplings.

k. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

l. Do not insulate flexible pipe couplings and expansion joints.

m. Install in accordance with manufacturer's instructions and as specified herein.

n. Install insulation after piping system has been pressure tested and leaks corrected.

o. Apply insulation over clean, finish painted and dry surfaces.

p. Do not allow insulation to cover nameplates or code inspection stamps.

q. Run insulation continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.

r. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions, strainer end plates, etc.

s. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

t. Connection to Existing Piping: Cut back existing insulation to remove the portion damaged by piping revisions. Install new insulation.

u. Cold Surfaces: Provide a continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

v. Placement:

1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
2. Insulate valves and fittings with sleeved or cut pieces of same material.
3. Seal and tape joints.

w. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

3.2 INSTALLATION OF DUCTWORK INSULATION

a. General: Install insulation products in accordance with the manufacturer's written instructions and in accordance with recognized industry practices.

b. Install insulation materials with smooth and even surfaces.

c. Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

d. Maintain integrity of vapor-barrier on ductwork insulation and protect it to prevent puncture and other damage. Tape all punctures.

e. Seal all longitudinal and circumferential joints with FSK tape, and finish with fiberglass mesh fabric embedded in vapor barrier mastic.

f. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.

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SECTION 15955

PIPING LEAKAGE TESTING

PART 1 GENERAL

1.1 SUBMITTALS

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

SD-06 Test Reports

Testing Plan; G, RE

Submit prior to testing and include at least the information that follows:

Testing dates
Piping systems and section(s) to be tested
Test type
Method of isolation
Calculation of maximum allowable leakage for piping section(s) to be tested

SD-07 Certificates

Testing equipment; G, RE
Certified Test Report; G, RE

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 PREPARATION

a. Notify Contracting Officer in writing 5 days in advance of testing. Perform testing in presence of Contracting Officer.

b. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
4. New Piping Connected to Existing Piping:
(a) Isolate new piping with grooved-end pipe caps, spectacle

blinds, blind flanges, or as acceptable to Contracting Officer.

5. Items that do not require testing include: Piping between wetwells and wetwell isolation valves, Equipment seal drains.
6. Test Pressure: As specified by equipment manufacturer.

c. Test section may be filled with water and allowed to stand under low pressure prior to testing.

d. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Contracting Officer.

3.2 HYDROSTATIC TEST FOR PRESSURE PIPING

3.2.1 Fluid

Clean water of such quality to prevent corrosion of materials in piping system.

3.2.2 Exposed Piping

a. Perform testing on installed piping prior to application of insulation.

b. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.

c. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

d. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.

e. Examine joints and connections for leakage.

f. Correct visible leakage and retest as specified.

g. Leave pipe full of water after repair of leaks.

3.2.3 Buried Piping

a. Test after backfilling has been completed.

b. Expel air from piping system during filling.

c. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

d. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.

e. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

f. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{133,200}$$

where:

L = Allowable leakage, in gallons per hour.
S = Length of pipe tested, in feet.
D = Nominal diameter of pipe, in inches.
P = Test pressure during leakage test, in pounds per square inch.

g. Correct leakage greater than allowable, and retest as specified.

3.3 HYDROSTATIC TEST FOR GRAVITY PIPING

3.3.1 Testing Equipment Accuracy

Plus or minus 1/2-gallon of water leakage under specified conditions.

3.3.2 Maximum Allowable Leakage

0.16 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

3.3.3 Gravity Sanitary and Roof Drain Piping

Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systemsin 15-foot vertical sections as piping is installed.

3.3.4 Exfiltration Test:

a. Hydrostatic Head:
   1. At least 6 feet above maximum estimated groundwater level in section being tested.
   2. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.

b. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

3.3.5 Defective Piping Sections

Replace, and retest as specified.

3.4 FIELD QUALITY CONTROL

3.4.1 Test Report Documentation

a. Test date.
b. Description and identification of piping tested.
c. Test fluid.
d. Test pressure.
e. Remarks, including:
   1. Leaks (type, location).
   2. Repair/replacement performed to remedy excessive leakage.

f. Signed by Contractor and Contracting Officer to represent that test has

been satisfactorily completed.

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DIVISION 16 - ELECTRICAL

SECTION 16010

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SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 REFERENCES

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

1.2 RELATED SECTIONS

Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.3 DESIGN REQUIREMENTS

All equipment anchoring and mounting shall be in accordance with manufacturer's requirements for the seismic zone criteria given in the project area.

1.4 ELECTRICAL SCOPE OF WORK

a. Electrical work associated with the following:

   1. Production Wells:
      (a) RSPW-1
      (b) RSPW-2 (Modifications)
   2. Water Distribution Pumping Station (including Sprinklers and Drip Irrigation System).
   3. Canal Transfer Pump Stations.
   4. Staging Area (including Rest Rooms, Parking Lot, Gateway and Tunnel).

b. Minimum work consists of but is not restricted to the following activities:

   1. Obtain all permits and pay all fees associated with the electrical work performed under this contract.
   2. Provide conduits, wiring/cables, electrical equipment (including service entrance equipment per electrical utilities requirements, switchboards, adjustable frequency drives, motor starters, transformers, electrical panels, lighting, and associated electrical works.
   3. Power all vendor supplied panels, control panels, motors, and ancillary equipment.
   4. Coordinate with local electrical Utilities and meet their requirements.

5. Provide complete grounding system for electrical installation.
6. Provide personnel and equipment to facilitate start-up and testing of all electrical work, and process equipment under this Contract.
7. After completion of all work, provide Contracting Officer with an O&M manual, which identifies electrical components installed under this Contract including: part number, catalog cut sheets and vendor names for future purchase of equipment. O&M manual shall also include "As-built" power and control drawings which accurately show final electrical equipment layout, installationlocation, conduit routing, and operation schemes for all electrical equipment and maintenance procedures.

c. All electrical equipment shall be UL, FM, or CSA approved for their respective installation prior to delivery to the construction site.

d. All work shall be accomplished in accordance with the latest requirements of NFPA 70, Arizona State, and local codes.

1.5 ELECTRICAL UTILITIES

a. Following electrical Utilities provide power in the project areas:

1. APS: Provides power to the North side of the Salt River.
Contact and Address: Dave McCasland
Senior Engineer
Customer Construction Central
10001 N 23rd Ave., Bldg F-2
Phoenix, AZ 85021
Tel: 602-371-6006

2. SRP: Provides power to the South side of the Salt River.
Contact and Address: Cindy Scott
Project Leader
New Business/Commercial Design
& Construction
Mail Station Wv 208
P.O. Box 52025
Phoenix, AZ 85072-2025
Phone: (602) 236-0684

PART 2 PRODUCTS

2.1 GENERAL

a. Provide materials and equipment listed by UL wherever standards have been established by that agency.

b. Equipment Finish:

1. Provide manufacturers' standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 EXECUTION

3.1 GENERAL

a. Electrical Drawings show general locations of equipment, devices, and

raceway, unless specifically dimensioned.

b. Install work in accordance with NECA Standards of Installation, unless otherwise specified.

3.2 LOAD BALANCE

a. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

b. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

c. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.3 CHECKOUT AND STARTUP

3.3.1 Voltage Field Test

a. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.

b. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

c. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day.

1. Submit Voltage Field Test Report within 5 days of test.

d. Unbalance Corrections:

1. Make written request to Contracting Officer to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
2. Obtain a written certification from a responsible power company official that the voltage variations and unbalance are within their normal standards if corrections are not made.

3.3.2 Equipment Line Current Tests

a. Check line current in each phase for each piece of equipment.

b. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.

c. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

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SECTION 16015

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SECTION 16015

ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.1 REFERENCES

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE 399	Recommended Practice for Industrial and Commercial Power System Analysis

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C57.12.00	Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

1.2 SUBMITTALS

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

SD-02 Shop Drawings

Short Circuit Study; G, RE

Provide five copies of study in hard cover, three-ring binders.

Protective Device Coordination Study; G, RE

Submit within 60 days after approval of the short circuit study.

1.3 QUALITY ASSURANCE

Short circuit study and protective device coordination study shall be prepared by a professional electrical engineer registered in the State of Arizona, in accordance with IEEE 242 and IEEE 399.

1.4 SEQUENCING AND SCHEDULING

a. An initial, complete short circuit study must be submitted and reviewed before Contracting Officer will approve Shop Drawings for equipment for incoming service equipment, motor control centers, and adjustable

frequency drives.

b. An initial, complete protective device coordination study must be submitted within 60 days after approval of initial short circuit study.

c. The short circuit and protective device coordination studies shall be updated prior to project substantial completion. Utilize characteristics of as-installed equipment and materials.

1.5 GENERAL

a. Equipment and component titles used in the studies shall be identical to the equipment and component titles indicated on the drawings.

b. Perform studies using digital computer or by written computations.

c. Perform complete fault calculations for each proposed and ultimate source combination.

d. Source combination may include present and future power company supply circuits, large motors, or generators.

e. Utilize proposed and existing load data for the study obtained from contract documents and record documents.

f. Existing Equipment:

1. Include fault contribution of existing motors in the study.
2. Obtain required existing equipment data.

g. Provide device coordination time-current curves for low voltage distribution system(s).

h. Provide individual protective device time-current characteristics on transparencies.

1.6 SHORT CIRCUIT STUDY

1.6.1 General

a. Use cable impedances based on copper conductors.
b. Use bus impedances based on copper bus bars.
c. Use cable and bus resistances calculated at .
d. Use 600-volt cable reactances based on use of typical dimensions of THHN/THWN conductors.
e. Use transformer impedances 92.5 percent of "nominal" impedance based on tolerances specified in ANSI C57.12.00.
f. Provide:
1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagrams.
4. Source impedance data, including electric utility system and motor fault contribution characteristics.
5. Impedance diagrams.
6. Zero sequence impedance diagrams.
7. Typical calculation.
8. Tabulations of calculated quantities.
9. Results, conclusions, and recommendations.
g. Calculate short circuit interrupting and momentary (when applicable)

duties for an assumed three-phase bolted fault at each:
1. Switchboards.
2. Motor control centers.
3. All branch circuit panelboards.
4. Other significant locations throughout the system.
5. Future load contributions as shown on one-line diagram.

h. Provide bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.

i. Provide bolted line-to-line fault current study for areas as defined for three-phase bolted fault short circuit study.

j. Verify:
1. Equipment and protective devices are applied within their ratings.
2. Adequacy of switchboard and motor control centers bus bars to withstand short circuit stresses.
3. Adequacy of transformer windings to withstand short circuit stresses.
4. Cable and busway sizes for ability to withstand short circuit heating, besides normal load currents.

1.7 PROTECTIVE DEVICE COORDINATION STUDY

a. Proposed protective device coordination time-current curves for distribution system, graphically displayed on conventional log-log curve sheets.

b. Each curve sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet.

c. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

d. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

e. Plot Characteristics on Curve Sheets:

1. Electric utility's fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
2. Low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
3. Low voltage equipment circuit breaker trip devices, including manufacturers tolerance bands.
4. Pertinent transformer full-load currents at 100 and 600 percent.
5. Transformer magnetizing inrush currents.
6. Transformer damage curves.
7. ANSI transformer withstand parameters.
8. Significant symmetrical and asymmetrical fault currents.
9. Ground fault protective device settings.
10. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center.

f. Primary Protective Device Settings for Delta-Wye Connected Transformer:

1. Secondary Line-to-Ground Fault Protection: Primary protective

device operating band within the transformer's characteristics curve, including a point equal to 58 percent of ANSI C57.12.00 withstand point.

2. Secondary Line-To-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.

1.8 TABULATIONS

1.8.1 General Data

a. Short circuit reactances of rotating machines.
b. Cable and conduit material data.
c. Bus data
d. Transformer data.
e. Circuit resistance and reactance values.

1.8.2 Short Circuit Data

a. Fault impedances.
b. X to R ratios.
c. Asymmetry factors.
d. Motor contributions.
e. Short circuit kVA.
f. Symmetrical and asymmetrical fault currents.

1.8.3 Recommended Protective Device Settings

a. Relays:
   1. Current tap.
   2. Time dial.
   3. Instantaneous pickup.

b. Circuit Breakers:
   1. Adjustable pickup.
   2. Adjustable time-current characteristic.
   3. Adjustable instantaneous pickup.

1.9 STUDY ANALYSES

a. Written Summary:

   1. Scope of studies performed.
   2. Explanation of bus and branch numbering system.
   3. Prevailing conditions.
   4. Selected equipment deficiencies.
   5. Results of short circuit and coordination studies.
   6. Comments or suggestions.

b. Suggest changes and additions to equipment rating and/or characteristics.

c. Notify Contracting Officer in writing of existing circuit protective devices improperly rated for new fault conditions.

PART 2 PRODUCTS (NOT APPLICABLE

PART 3 EXECUTION

3.1 GENERAL

a. Adjust relay and protective device settings according to values established by coordination study.

b. Make minor modifications to equipment as required to accomplish conformance with the short circuit and protective device coordination studies.

c. Notify Contracting Officer in writing of any required major equipment modifications.

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SECTION 16050

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-- End of Section Table of Contents --

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C62.11	Standard for Metal-Oxide Surge Arrestors for AC Circuits
ANSI Z55.1	Gray Finishes for Industrial Apparatus and Equipment

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 570/A 570M	(1998) Steel, Sheet, and Strip, Carbon, Hot-Rolled, Structural Quality

NATIONAL ELECTRICAL CONTRACTOR'S ASSOCIATION, INC. (NECA)

NECA 5055	Standard of Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA ICS 2	(1993) Industrial Control Devices, Controllers, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA KS 1	(1996) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA LA 1	(1992) Surge Arrestors
NEMA PB 1	(1995) Panelboards
NEMA ST 20	(1992) Dry-Type Transformers for General

	Applications
NEMA WD 1	(1999) General Requirements for Wiring Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES, INC. (UL)

UL 67	(1993; Rev thru Oct 1999) Panelboards
UL 486E	(1994; Rev thru Feb 1997) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 489	(1996; Rev thru Dec 1998) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 943	(1993; Rev thru May 1998) Ground-Fault Circuit-Interrupters
UL 1059	(1993; 3rd Edition) Terminal Blocks
UL 1561	(1999) Dry-Type, General Purpose and Power Transformers

1.2 SUBMITTALS

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

SD-02 Shop Drawings

Device boxes; G, RE
Junction and Pull Boxes used at, or below, grade; G, RE
Large Junction and Pull Boxes; G, RE
Terminal Junction Boxes; G, RE
Panelboards and Circuit Breaker Data; G, RE
Wiring Devices; G, RE
Control Devices; G, RE
Control Relays; G, RE
Timers; G, RE
Fuses; G, RE
Magnetic Contactors; G, RE
Transformers; G, RE
Service and Metering Equipment; G, RE

1.3 QUALITY ASSURANCE

UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.4 SPARE PARTS

Furnish, tag, and box for shipment and storage the following spare parts:

Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

PART 2 PRODUCTS

2.1 PRIMARY SERVICE EQUIPMENT

Provide electric service in accordance with electrical utility requirements. Equipment shall include, but not be limited to:

1. Conduit riser.
2. Conduit, wire, and miscellaneous hardware.

2.2 OUTLET AND DEVICE BOXES

a. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

b. Cast Metal:

1. Box: Malleable iron.
2. Cover: Gasketed, weatherproof, malleable iron, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.

c. Nonmetallic:

1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.

2.3 JUNCTION AND PULL BOXES

a. Outlet Boxes Used as Junction or Pull Box: As specified under Article OUTLET AND DEVICE BOXES.

b. Conduit Bodies Used as Junction Boxes: As specified under Article FITTINGS in Section 16110 RACEWAYS.

c. Large Steel Box:

1. NEMA 250, Type12.
2. Box: 14-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces, with final ANSI Z55.1, No. 61 gray enamel on exterior surfaces.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A 167, Type 316 stainless steel.

d. Large Nonmetallic Box:

1. NEMA 250, Type 4X.
2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A 167, Type 316 stainless steel.

5. Conduit hubs and mounting lugs.

e. Concrete Box:

1. Box: Reinforced, cast concrete.
2. Cover: Cast iron. Provide steel traffic rated cover in traffic areas.
3. Cover Marking: ELECTRICAL, SIGNAL, or as shown.

2.4 WIRING DEVICES

2.4.1 Switches

a. NEMA WD 1.
b. Specification grade, totally enclosed, ac type, with quiet tumbler switches and screw terminals.
c. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
d. Rating: 20 amps, 120/277 volts.
e. Color:
1. Office Areas: Ivory.
2. Other Areas: Brown.
f. Integral grounding terminal on mounting strap.

2.4.2 Receptacle, Single and Duplex

a. NEMA WD 1.
b. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
c. High strength, thermoplastic base color.
d. Color:
1. Restroom Areas: Ivory.
2. Other Areas: Brown.
e. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
f. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
g. One-piece mounting strap with integral ground contact.

2.4.3 Receptacle, Ground Fault Circuit Interrupter

a. Duplex, specification grade, tripping at 5 mA.
b. Color: Brown.
c. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
d. Size: For 2-inch by 4-inch outlet boxes.
e. Standard Model: NEMA WD 1, with screw terminals and provisions for testing.
f. Feed-Through Model: NEMA WD 1, with feed-through screw terminals and provisions for testing.

2.5 DEVICE PLATES

2.5.1 General

Sectional type plates not permitted.

2.5.2 Cast Metal

a. Material: Malleable ferrous metal, with gaskets.
b. Screw: Oval-head stainless steel.

2.5.3 Sheet Steel

a. Finish: Zinc electroplate.
b. Screws: Oval-head stainless steel.

2.5.4 Weatherproof

a. For Receptacles:
   1. Gasketed, cast-aluminum, with individual cap over each receptacle opening.
   2. Mounting Screw and Cap Spring: Stainless steel.

b. For Switches:
   1. Gasketed, cast-metal or -aluminum, incorporating external operator for internal switch.
   2. Mounting Screw: Stainless steel.

2.5.5 Raised Sheet Metal

1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

2.5.6 Sheet Steel

Formed sheet steel or Feraloy designed for installation on cast metal boxes.

2.6 LIGHTING AND POWER DISTRIBUTION PANELBOARD

a. NEMA PB 1, NFPA 70, and UL 67.

b. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

c. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

d. Rating: Applicable to a system with available short-circuit current of the indicated amperes rms symmetrical at volts as shown.

e. Cabinet:

   1. NEMA 250, Type 12 or 3R, as shown.
   2. Material: Code-gauge, hot-dip galvanized sheet steel, with reinforced steel frame.
   3. Wiring Gutter: Minimum 4-inch square; both sides, top and bottom.
   4. Front: Fastened with adjustable clamps.
      (a) Trim Size:
         1) Surface Mounted: Same as box.
         2) Flush Mounted: 3/4-inch larger than box on all sides.
      (b) Finish: Rust inhibitor prime, with manufacturer's standard baked enamel or lacquer.
   5. Interior:
      (a) Factory assembled; complete with circuit breakers.
      (b) Capable of circuit breaker replacement without disturbing adjacent circuit breakers or without removing main bus.
      (c) Spaces: Cover openings with easily removable metal cover.
   6. Door Hinges: Concealed.
   7. Locking Device:

(a) Flush type.
(b) Doors Over 30 Inches in Height: Multipoint.
(c) Identical keylocks, with two milled keys each lock.

8. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.

f. Bus Bar

1. Material: Copper full sized throughout length.
2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.
3. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
5. Lugs and Connection Points:
   (a) Suitable for either copper or aluminum conductors.
   (b) Solderless main lugs for main, neutral, and ground bus bars.
   (c) Subfeed or through-feed lugs as shown.
6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

g. Circuit Breakers:

1. NEMA AB 1 and UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Noninterchangeable, in accordance with NFPA 70.
4. Locking: Provisions for handle padlocking, unless otherwise shown.
5. Type: Bolt-on circuit breakers in all panelboards.
6. Multi-pole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
7. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
8. Do not use tandem or dual circuit breakers in normal single-pole spaces.
9. Ground Fault Interrupter:
   (a) Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 30 mA ground fault (UL 943, Class B sensitivity).
   (b) Sensor with same rating as circuit breaker and a push-to-test button.

2.7 MINI-POWER CENTER (MPC)

2.7.1 General

Transformer, primary and secondary main circuit breakers, and secondary panelboard section enclosed in NEMA 250, Type 3R enclosure.

2.7.2 Transformer

a. Type: Dry, self-cooled, encapsulated.
b. Insulation: Manufacturer's standard, with UL 1561 temperature rise.
c. Full capacity, 2-1/2 percent voltage taps, two above and two below normal voltage.
d. Primary Voltage: 480, single three-phase, as shown.

e. Secondary Voltage: 208/120 volts, single or three-phase, four-wire, as shown.

2.7.3 Panelboard

Full, UL 489, short-circuit current rated.

Type: Thermal-magnetic, quick-make, quick-break, indicating, with noninterchangeable molded case circuit breakers.

2.8 NUMBER AND BREAKER AMPERE RATINGS

Refer to Panel Schedule

2.9 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

a. NEMA AB 1, UL 489 listed for use at location of installation.
b. Minimum Interrupt Rating: As indicated.
c. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of operating handle.
d. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
e. Locking: Provisions for padlocking handle.
f. Multi-pole breakers to automatically open all poles when an overload occurs on one pole.
g. Enclosure: NEMA 250, Type as indicated in Part 3 of this Specification unless otherwise shown.
h. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.
i. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

2.10 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

a. Contact Rating: NEMA ICS 2, Type A600.
b. Selector Switch Operating Lever: Standard.
c. Indicating Lights: Push-to-test, transformer-type.
d. Pushbutton Color:
   (1) ON or START: Black.
   (2) OFF or STOP: Red.
e. Pushbuttons and selector switches lockable in OFF position where indicated.
f. Legend Plate:
   (1) Material: Aluminum.
   (2) Engraving: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, indicating specific function.
   (3) Letter Height: 7/64-inch.

2.11 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

a. NEMA KS 1.
b. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
c. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
d. Enclosure: NEMA 250, Type as indicated in Part 3 of this Specification unless otherwise shown.

2.12 INTERLOCK

Enclosure and switch to prevent opening cover with switch in the ON position.

2.13 TERMINAL JUNCTION BOX

a. Cover: Hinged, unless otherwise shown.
b. Interior Finish: Paint with white enamel or lacquer.
c. Terminal Blocks:
   (1) Separate connection point for each conductor entering or leaving box.
   (2) Spare Terminal Points: 25 percent.

2.14 TERMINAL BLOCK (0 TO 600 VOLTS)

a. UL 486E and UL 1059.
b. Size components to allow insertion of necessary wire sizes.
c. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.
d. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.
e. Yoke, current bar, and clamping screw of high strength and high conductivity metal.
f. Yoke shall guide all strands of wire into terminal.
g. Current bar shall ensure vibration-proof connection.
h. Terminals:
   (1) Capable of wire connections without special preparation other than stripping.
   (2) Capable of jumper installation with no loss of terminal or rail space.
   (3) Individual, rail mounted.
i. Marking system, allowing use of preprinted or field-marked tags.

2.15 MAGNETIC CONTROL RELAY

a. NEMA ICS 2, Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control with field convertible contacts.
b. Time Delay Relay Attachment:
   (1) Pneumatic or electronic type, timer adjustable from 0.2 to 60 seconds (minimum).
   (2) Field convertible from ON delay to OFF delay and vice versa.
c. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

2.16 ELAPSED TIME METER

a. Drive: Synchronous motor.
b. Range: 0 to 99,999.9 hours, nonreset type.
c. Mounting: Semiflush, panel.

2.17 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

a. UL 1561, NEMA ST 20, unless otherwise indicated.
b. Self-cooled, two-winding.
c. Insulation Class and Temperature Rise: Manufacturer's standard.
d. Core and Coil:
   (1) Encapsulated for single-phase units 1/2 to 25 kVA and for three-phase units 3 to 15 kVA.
   (2) Thermosetting varnish impregnated for single-phase units 37.5 kVA

and above, and for three-phase units 30 kVA and above.

e. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

f. Enclosure:
   (1) Single-Phase, 3 to 25 kVA: NEMA 250, Type 3R, nonventilated.
   (2) Single-Phase, 37-1/2 kVA and Above: NEMA 250, Type 2, ventilated.
   (3) Three-Phase, 3 to 15 kVA: NEMA 250, Type 3R, nonventilated.
   (4) Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.
   (5) Outdoor Transformers: NEMA 250, Type 3R.

g. Wall Bracket: For single-phase units, 15 to 37-1/2 kVA, and for three-phase units, 15 to 30 kVA.

h. Voltage Taps:
   (1) Single-Phase, 3 to 10 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
   (2) Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
   (3) Three-Phase, 3 to 15 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
   (4) Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

i. Impedance: 4.5 percent minimum on units 75 kVA and larger.

j. Maximum Sound Level: NEMA ST 20:
   (1) 40 decibels for 0 to 9 kVA.
   (2) 45 decibels for 10 to 50 kVA.
   (3) 50 decibels for 51 to 150 kVA.
   (4) 55 decibels for 151 to 300 kVA.
   (5) 60 decibels for 301 to 500 kVA.

k. Vibration Isolators:
   (1) Rated for transformer's weight.
   (2) Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
   (3) Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
   (4) 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

2.18 LOW VOLTAGE, SECONDARY SURGE PROTECTIVE EQUIPMENT

a. NEMA LA 1, ANSI C62.11.

b. Surge Capacitor:
   (1) Impregnated with nonPCB, biodegradable dielectric fluid.
   (2) Integral discharge resistor which will drain residual voltage to 50-volts crest in less than 1 minute after disconnection from circuit.

c. Arrestor: High strength metal oxide valve elements enclosed in high strength, corrosion-resistant, molded resin housing.

d. Equip capacitor and arrestor with mounting nipple, flat washer, and nut suitable for knockout or bracket mounting.

2.19 SUPPORT AND FRAMING CHANNELS

a. Carbon Steel Framing Channel:
   (1) Material: Rolled, mild strip steel, 12-gauge, ASTM A 570/A 570M, Grade 33.
   (2) Finish: Hot-dip galvanized after fabrication.

b. Paint Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.

c. PVC Coated Framing Channel: Carbon steel framing channel with 40-mil polyvinyl chloride coating.

d. Stainless Steel Framing Channel: Rolled, ASTM A 167, Type 316 stainless steel, 12-gauge.
e. Extruded Aluminum Framing Channel:
   (1) Material: Extruded from Type 6063-T6 aluminum alloy.
   (2) Fittings fabricated from Alloy 5052-H32.
f. Nonmetallic Framing Channel:
   (1) Material: Fire retardent, fiber reinforced vinyl ester resin.
   (2) Channel fitting of same material as channel.
   (3) Nuts and bolts of long glass fiber reinforced polyurethane.

2.20 NAMEPLATES

a. Material: Laminated plastic.
b. Attachment Screws: Stainless steel.
c. Color: Black, engraved to a white core.
d. Engraving:
   (1) Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
   (2) Panelboards: Panelboard designation, service voltage, and phases.
e. Letter Height:
   (1) Pushbuttons/Selector Switches: 1/8 inch.
   (2) Panelboards: 1/4 inch.

PART 3 EXECUTION

3.1 GENERAL

Install equipment in accordance with NECA 5055, applicable parts of NFPA 70 and local codes.

3.2 OUTLET AND DEVICE BOXES

a. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
b. Size:
   (1) Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
      a) Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
   (2) Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
   (3) Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.
c. Locations:
   (1) Drawing locations are approximate.
   (2) To avoid interference with mechanical equipment or structural features, relocate outlets as directed by the Contracting Officer.
   (3) Light Switch: Install on lock side of doors.
   (4) Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.
d. Mounting Height:
   (1) General:
      a) Dimensions given to centerline of box.
      b) Where specified heights do not suit building construction or finish, mount as directed by Contracting Officer.
   (2) Light Switch: 48 inches above floor.
   (3) Wall mounted telephone outlet: 52 inches above floor.
   (4) Convenience Receptacle:
      a) General Interior Areas: 15 inches above floor.

b) Industrial Areas, Workshops: 48 inches above floor.
c) Outdoor, All Areas: 24 inches above finished grade.
(5) Switch, Motor Starting: 48 inches above floor, unless otherwise indicated.

e. Install plumb and level.
f. Flush Mounted:
(1) Install with concealed conduit.
(2) Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
(3) Holes in surrounding surface shall be no larger than required to receive box.
g. Support boxes independently of conduit by attachment to building structure or structural member.
h. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.
i. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
j. Boxes embedded in concrete or masonry need not be additionally supported.
k. Install galvanized mounting hardware in industrial areas.
l. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.
m. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.
n. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
o. Box Type (Steel Raceway System:
(1) Exterior Locations: Cast metal.
(2) Interior Dry Locations:
a) Exposed Rigid Conduit: Sheet steel.
b) Concealed Raceways: Sheet steel.
c) Concrete Encased Raceways: Cast metal.
d) Lighting Circuits, Ceiling: Sheet steel.
(3) Interior Wet Locations: Cast metal.
p. Box Type, Corrosive Locations (PVC-Coated Rigid Galvanized Steel Raceway System): PVC-coated cast metal.

3.3 JUNCTION AND PULL BOXES

a. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
b. Install pull boxes where necessary in raceway system to facilitate conductor installation.
c. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.
d. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
e. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.
f. Installed boxes shall be accessible.
g. Do not install on finished surfaces.
h. Install plumb and level.
i. Support boxes independently of conduit by attachment to building structure or structural member.
j. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or

welded threaded studs on steelwork.

k. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

l. Boxes embedded in concrete or masonry need not be additionally supported.

m. At or Below Grade:
   (1) Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
   (2) If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
   (3) Obtain Contracting Officer's Representative's written acceptance prior to installation in paved areas, roadways, or walkways.
   (4) Use boxes and covers suitable to support anticipated weights. Provide traffic rated covers in traffic areas.

n. Flush Mounted:
   (1) Install with concealed conduit.
   (2) Holes in surrounding surface shall be no larger than required to receive box.
   (3) Make edges of boxes flush with final surface.

o. Mounting Hardware:
   (1) Noncorrosive Dry Areas: Galvanized.
   (2) Noncorrosive Wet Areas: Stainless steel.
   (3) Corrosive Areas: Stainless steel.

p. Location/Type:
   (1) Wet: NEMA 250, Type 4X.
   (2) Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.
   (3) Underground Conduit: Concrete.
   (4) Corrosive Locations: NEMA 250 Type 4X, stainless steel.
   (5) Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.

3.4 WIRING DEVICES

3.4.1 Switches

a. Mounting Height: See Article OUTLET AND DEVICE BOXES.

b. Install with switch operation in vertical position.

c. Install single-pole, two-way switches such that toggle is in up position when switch is on.

3.4.2 Receptacles

a. Install with grounding slot up except where horizontal mounting is shown, in which case install with neutral slot up.

b. Weatherproof Receptacles:
   (1) Install in cast metal box.
   (2) Install such that hinge for protective cover is above receptacle opening.
   (3) Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for "downstream" conventional receptacles.
   (4) Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

3.4.3 Switch, Motor Rated

a. Install with switch operation in vertical position such that toggle is

in up position when ON.
b. Install within sight of motor when used as a disconnect switch.
c. Mounting Height: See Article OUTLET AND DEVICE BOXES.
d. Enclosure Type: See Article OUTLET AND DEVICE BOXES.

3.5 DEVICE PLATES

a. Securely fasten to wiring device; ensure a tight fit to box.
b. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.
c. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.
d. Install with alignment tolerance to box of 1/16 inch.
e. Types (Unless Otherwise Shown):
   (1) Exterior: Weatherproof.
   (2) Interior:
      a) Flush Mounted Boxes: Metal.
      b) Surface Mounted, Metal Boxes:
         1) General Purpose Areas: Sheet Steel.
         2) Other Areas: Cast.
      c) Surface Mounted, Nonmetallic Boxes: Manufacturer's standard.

3.6 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

3.6.1 Heavy-Duty, Oiltight Type

Locations (Unless Otherwise Shown): Nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

3.6.2 Heavy-Duty, Watertight, and Corrosion-Resistant Type

a. Locations (Unless Otherwise Shown): Nonhazardous, outdoor, or normally wet areas.
b. Mounting: NEMA 250, Type 4X enclosure.

3.7 TERMINAL JUNCTION BOX

a. Install in accordance with Article JUNCTION AND PULL BOXES.
b. Label each block and terminal with permanently attached, nondestructible tag.
c. Do not install on finished outdoor surfaces.
d. Location/Type:
   (1) Indoor, Dry: NEMA 250, Type 12.
   (2) Unfinished, Indoor and Outdoor, Wet: NEMA 250, Type 4.
   (3) Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.
   (4) Unfinished, indoor and outdoor, wet, dust, or oil: NEMA 250, Type 13.

3.8 LIGHTING AND POWER DISTRIBUTION PANELBOARD

a. Install securely, plumb, in-line and square with walls.
b. Install top of cabinet 6 feet above floor unless otherwise shown.
c. Provide typewritten circuit directory for each panelboard.
d. Cabinet Location/Type:
   (1) General Use in Finished Areas: NEMA 250, Type 1.

(2) Wet or Outdoor: NEMA 250, Type 3R, Outdoor.
(3) Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.

3.9 CIRCUIT BREAKER, FUSED SWITCH, AND NONFUSED SWITCH ENCLOSURES

a. Location/Type:
(1) Wet: NEMA 250, Type 4.
(2) Corrosive: NEMA 250, Type 4X.
(3) Wet/Corrosive: NEMA 250, Type 4X.
(4) Industrial Use: NEMA 250, Type 12.
(5) General Purpose: NEMA 250, Type 1.
(6) Where Denoted WP: NEMA 250, Type 3R.

3.10 SUPPORT AND FRAMING CHANNEL

a. Install where required for mounting and supporting electrical equipment and raceway systems.
b. Channel Type:
(1) Interior, Wet or Dry (Noncorrosive) Locations:
a) PVC-Coated Conduit: PVC coated.
b) Steel Raceway and Other Systems Not Covered: Carbon steel or paint coated.
(2) Interior, Corrosive (Wet or Dry) Locations:
a) PVC Conduit: Type 316 stainless steel or nonmetallic.
b) PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC-coated steel.
(3) Outdoor, Noncorrosive Locations:
a) Steel Raceway: Carbon steel or paint coated framing channel, except where mounted on aluminum handrail, then use aluminum framing channel.
(4) Outdoor Corrosive Locations:
a) PVC Conduit: Type 316 stainless steel or nonmetallic.
b) PVC-Coated Steel Conduit, and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC coated steel.
c. Paint cut ends prior to installation with the following:
(1) Carbon Steel Channel: Zinc-rich primer.
(2) Painted Channel: Rust-inhibiting epoxy or acrylic paint.
(3) Nonmetallic Channel: Epoxy resin sealer.
(4) PVC-Coated Channel: PVC patch.

3.11 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

a. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.
b. Provide moisture-proof, flexible conduit for electrical connections.
c. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.
d. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and three-phase units, 15 to 112 kVA.
e. Isolation Transformer: Ground isolation shields to unit enclosure with conductor of same material, and same size minimum, as shield ground lead provided with unit.

3.12 MOTOR SURGE PROTECTION

a. Ground in accordance with NFPA 70.
b. Low Voltage: Ground terminals to equipment bus.

-- End of Section --

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DIVISION 16 - ELECTRICAL

SECTION 16110

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SECTION 16110

RACEWAYS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.1	(1995) Rigid Steel Conduit - Zinc Coated

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 857	Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

NATIONAL ELECTRICAL CONTRACTOR'S ASSOCIATION, INC. (NECA)

NECA 5055	Standard of Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA RN 1	(1998) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(1998) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES, INC. (UL)

UL 6	(1997) Rigid Metal Conduit
UL 360	(1996; Rev thru Oct 1997) Liquid-Tight Flexible Steel Conduit
UL 514B	(1997; Rev Oct 1998) Fittings for Cable and Conduit
UL 651A	(1995; Rev thru Apr 1998) Type EB and A Rigid PVC Conduit and HDPE Conduit

1.2 SUBMITTALS

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

SD-02 Shop Drawings

PVC-Coated Rigid galvanized steel conduit; G, RE
PVC Schedule 40 conduit; G, RE
Flexible metal, liquid-tight conduit; G, RE
Conduit fittings; G, RE

Precast Manholes and Handholes;
G, RE

Equipment and machinery proposed for bending metal conduit; G, RE

Method for bending PVC conduit less than 30 degrees; G, RE

1.3 UL COMPLIANCE

Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.4 QUALIFICATIONS

PVC-Coated, Rigid Steel Conduit Installer: Must be certified by the conduit manufacturer as having received minimum 2 hours of training on correct installation procedures.

PART 2 PRODUCTS

2.1 CONDUIT AND TUBING

2.1.1 PVC-Coated Rigid Galvanized Steel Conduit

a. Meet requirements of NEMA RN 1.

b. Material:
   (1) Meet requirements of ANSI C80.1 and UL 6.
   (2) Exterior finish : PVC coating, 40 mils nominal thickness, bond to metal shall have tensile strength greater than PVC.
   (3) Interior finish: Urethane coating, 2 mils nominal thickness.

c. Threads: Hot-dipped galvanized and factory coated with urethane.

d. Bendable without damage to either interior or exterior coating.

2.1.2 PVC Schedule 40 Conduit

a. Meet requirements of NEMA TC 2 and UL 651A.

b. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

2.1.3 Flexible Metal, Liquid-Tight Conduit

a. UL 360 listed for 105 degrees C insulated conductors.

b. Material: Galvanized steel, with an extruded PVC jacket.

2.2 FITTINGS

2.2.1 PVC-Coated Rigid Galvanized Steel Conduit

a. Meet requirements of UL 514B.
b. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.
c. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.
d. Finish: 40-mil PVC exterior, 2-mil urethane interior.
e. Overlapping pressure sealing sleeves.
f. Conduit Hangers, Attachments, and Accessories: PVC-coated.

2.2.2 PVC Conduit and Tubing

a. Meet requirements of NEMA TC-3.
b. Type: PVC, slip-on.

2.2.3 Flexible Metal, Liquid-Tight Conduit

a. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
b. Insulated throat and sealing O-rings.

2.2.4 Watertight Entrance Seal Device

a. New Construction:
   (1) Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   (2) Cored-Hole Application:
      (a) Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.

2.3 PRECAST MANHOLES AND HANDHOLES

a. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

b. Loading: AASHTO, H-20 in accordance with ASTM C 857.

c. Access: Provide cast concrete 6- or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

d. Drainage:

   (1) Slope floors toward drain points, leaving no pockets or other nondraining areas.
   (2) Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

e. Raceway Entrances:

   (1) Provide on all four sides.

(2) For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.
(3) At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

f. Embedded Pulling Iron:

(1) Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
(2) Location:
a) Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
b) Floor: Centered below manhole or handhole cover.

g. Cable Racks:

(1) Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
(2) Wall Attachment:
a) Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
b) Insert Spacing: Maximum 3-foot on center entire inside perimeter of manhole.
c) Arrange so that spare raceway ends are clear for future cable installation.

h. Manhole Frames and Covers:

(1) Material: Machined cast iron.
(2) Diameter: 32 inch.
(3) Cover Type: Indented, solid top design, with two drop handles each.
(4) Cover Loading: AASHTO H-20.
(5) Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
a) Above 600 Volts: ELECTRIC HV.
b) 600 Volts and Below: ELECTRIC LV.
c) TELEPHONE.

i. Handhole Frames and Covers:

(1) Material: Steel, hot-dipped galvanized.
(2) Cover Type: Solid, bolt-on,hinged, of checkered design.
(3) Cover Loading: AASHTO H-20.
(4) Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
a) 600 Volts and Below: ELECTRIC LV.
b) TELEPHONE.

j. Hardware: Steel, hot-dip galvanized.

k. Furnish knockout for ground rod in each handhole and manhole.

2.4 ACCESSORIES

a. Duct Bank Spacers:

(1) Type: Nonmetallic, interlocking, for multiple conduit sizes.

(2) Suitable for all types of conduit.

b. Identification Devices:

(1) Raceway Tags:
a) Material: Permanent, nonferrous metal.
b) Shape: Round.
c) Raceway Designation: Pressure stamped, embossed, or engraved.
d) Tags relying on adhesives or taped-on markers not permitted.
(2) Warning Tape:
a) Material: Polyethylene, 4-mil gauge.
b) Color: Red.
c) Width: Minimum 3-inch.
d) Designation: Warning on tape that electric circuit is located below tape.
(3) Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
(4) Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES, in letters 1/4-inch high.
(5) Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

c. Wraparound Duct Band:

(1) Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.

PART 3 EXECUTION

3.1 GENERAL

a. Conduit and Tubing sizes shown are based on the use of copper conductors. Reference Section 16120 CONDUCTORS, concerning conduit sizing for aluminum conductors.

b. All installed Work shall comply with NECA 5055.

c. Crushed or deformed raceways not permitted.

d. Maintain raceway entirely free of obstructions and moisture.

e. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

f. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

g. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

h. Group raceways installed in same area.

i. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

j. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

k. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

l. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

m. Install watertight fittings in outdoor, underground, or wet locations.

n. Paint threads and cut ends, before assembly of fittings, galvanized conduit, or PVC-coated galvanized conduit, installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

o. Metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

p. Do not install raceways in concrete equipment pads, foundations, or beams.

q. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

r. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

3.2 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

a. Minimum cover 2 inches, including all fittings.

b. Conduit placement shall not require changes in reinforcing steel location or configuration.

c. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.

d. Conduit larger than 1-inch shall not be embedded in concrete slabs, walls, foundations, columns or beams unless approved by the Contracting Officer.

e. Slabs and Walls:

(1) Trade size of conduit not to exceed one-fourth of the slab or wall thickness.
(2) Install within middle two-fourths of slab or wall.
(3) Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
(4) Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
(5) Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
(6) Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.
(7) Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.

f. Columns and Beams:

(1) Trade size of conduit not to exceed one-fourth of beam thickness.
(2) Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

3.3 CONDUIT APPLICATION

a. Diameter: Minimum 3/4-inch.

b. Exterior, Exposed, Noncorrosive: PVC-Coated Rigid galvanized steel.

c. Interior, Exposed: PVC-Coated Rigid galvanized steel.

d. Interior, Concealed (Not Embedded in Concrete): PVC-Coated Rigid galvanized steel.

e. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: PVC-Coated Rigid galvanized steel.

f. Direct Earth Burial:

(1) PVC Schedule 40.

g. Concrete-Encased Raceways:

(1) PVC Schedule 40.

h. Under Slabs-On-Grade:

(1) PVC Schedule 40.

i. Conduits between AFDs and motors: PVC-Coated Rigid Galvanized Steel.

3.4 CONNECTIONS

a. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:

(1) Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
(2) Conduit Size Over 4 Inches: Nonflexible.
(3) Wet or Corrosive Areas: Flexible metal liquid-tight.
(4) Dry Areas: Flexible, metallic liquid-tight.
(5) Length: 18-inch minimum, 60-inch maximum, sufficient to allow movement or adjustment of equipment.

b. Lighting fixtures in dry areas: Flexible steel, nonliquid - tight conduit.

c. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

d. Transition From Underground or Concrete Embedded to Exposed: PVC-Coated Rigid galvanized steel conduit.

e. Under Equipment Mounting Pads: PVC-Coated Rigid galvanized steel conduit.

f. Exterior Light Pole Foundations: PVC-Coated Rigid galvanized steel conduit.

3.5 PENETRATIONS

a. Make at right angles, unless otherwise shown.

b. Notching or penetration of structural members, including footings and beams, not permitted.

c. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating.

d. Apply single layer of wraparound duct band to all metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

e. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

f. Entering Structures:

(1) General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
(2) Concrete Roof or Membrane Waterproofed Wall or Floor:
a) Provide a watertight seal.
b) Without Concrete Encasement: Install watertight entrance seal device on each side.
c) With Concrete Encasement: Install watertight entrance seal device on the accessible side.
d) Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
e) Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
(3) Heating, Ventilating, and Air Conditioning Equipment:
a) Penetrate equipment in area established by manufacturer.
b) Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
c) Seal penetration with silicone type sealant.
(4) Corrosive-Sensitive Areas:
a) Seal conduit entering equipment panel boards and field panels containing electronic equipment.
b) Seal penetration with silicone type sealant.
(5) Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.
(6) Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
a) Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
b) Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint, on each side.
(7) Manholes and Handholes:
a) Metallic Raceways: Provide insulated grounding bushings.
b) Nonmetallic Raceways: Provide bell ends flush with wall.
c) Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.6 SUPPORT

a. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.

b. Multiple Adjacent Raceways: Provide ceiling trapeze.

c. Application/Type of Conduit Strap:

(1) PVC-Coated Rigid galvanized steel conduit: PVC-Coated metal.
(2) Nonmetallic Conduit: Nonmetallic or PVC coated metal.

d. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

(1) Wood: Wood screws.
(2) Hollow Masonry Units: Toggle bolts.
(3) Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
(4) Steelwork: Machine screws.
(5) Location/Type of Hardware:
a) Dry, Noncorrosive Areas: Galvanized.
b) Wet, Noncorrosive Areas: Stainless steel.
c) Corrosive Areas: Stainless steel.

e. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.7 BENDS

a. Install concealed raceways with a minimum of bends in the shortest practical distance.

b. Make bends and offsets of longest practical radius.

c. Install with symmetrical bends or cast metal fittings.

d. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

e. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

f. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

g. PVC Conduit:

(1) Bends 30-Degree and Larger: Provide factory-made elbows.
(2) 90-Degree Bends: Provide PVC coated rigid galvanized steel elbows.
(3) Use manufacturer's recommended method for forming smaller bends.

h. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

i. Contractor shall limit total bends between pull points to 270 degrees.

3.8 EXPANSION/DEFLECTION FITTINGS

a. Provide on all raceways at all structural expansion joints, and in long

tangential runs.
b. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.
c. Install in accordance with manufacturer's instructions.

3.9 PVC CONDUIT

3.9.1 Solvent Welding

a. Provide manufacturer recommended solvent; apply to all joints.
b. Install such that joint is watertight.

3.9.2 Adapters

a. PVC to Metallic Fittings: PVC terminal type.
b. PVC to Rigid Metal Conduit: PVC female adapter.

3.9.3 Belled-End Conduit

Bevel the unbelled end of the joint prior to joining.

3.10 PVC-COATED RIGID STEEL CONDUIT

a. Install in accordance with manufacturer's instructions.
b. All tools and equipment used in the cutting, bending, threading and installation of PVC-coated rigid steel conduit shall be designed to limit damage to the PVC coating.
c. Provide PVC boot to cover all exposed threading.

3.11 WIREWAYS

a. Install in accordance with manufacturer's instructions.
b. Locate with cover on accessible vertical face of wireway, unless otherwise shown.
c. Applications:
   (1) Metal wireway in indoor dry locations.
   (2) Nonmetallic wireway in indoor wet, outdoor, and corrosive locations.

3.12 TERMINATION AT ENCLOSURES

3.12.1 Cast Metal Enclosure

Provide manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.

3.12.2 NEMA 4 and 4X Boxes, Cabinets, and Enclosures

Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.

3.12.3 Sheet Metal Boxes, Cabinets, and Enclosures

a. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
b. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
c. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.

3.12.4 Switchboard and Free-Standing Enclosures

Terminate conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.13 UNDERGROUND RACEWAYS

a. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
b. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.
c. Make routing changes as necessary to avoid obstructions or conflicts.
d. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.
e. Union type fittings not permitted.
f. Spacers:
   (1) Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
   (2) Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.
g. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.
h. Installation with Other Piping Systems:
   (1) Crossings: Maintain minimum 12-inch vertical separation.
   (2) Parallel Runs: Maintain minimum 12-inch separation.
   (3) Installation over valves or couplings not permitted.
i. Metallic Raceway Coating: Apply wraparound duct band with one-half tape width overlap to obtain two complete layers.
j. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.
k. Provide deflectional/expansion fittings in conduit runs that exit building or structure below grade. Conduit from building wall to fitting shall be PVC-coated rigid steel.
l. Concrete Encasement:
   (1) As specified in Section 03307 CONCRETE FOR MINOR STRUCTURES.
   (2) Concrete Color: Red.
m. Backfill:
   (1) As specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITY SYSTEMS.
   (2) Do not backfill until inspected by Contracting Officer.

3.14 MANHOLES AND HANDHOLES

a. Excavate, shore, brace, backfill, and final grade in accordance with Section 02316 EXCAVATION, FILLING AND BACKFILLING FOR UTILITIES SYSTEMS.
b. Do not install until final raceway grading has been determined.
c. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.
d. Grounding: As specified in Section 16450 GROUNDING.

3.15 IDENTIFICATION

Field stamp covers with MANHOLE or HANDHOLE NUMBER as indicated. Stamped numbers to be 1-inch minimum height.

3.16 EMPTY RACEWAYS

a. Provide permanent, removable cap over each end.
b. Provide PVC plug with pull tab for underground raceways with end bells.
c. Provide nylon pull cord.
d. Identify, as specified in Article IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.17 IDENTIFICATION DEVICES

3.17.1 Raceway Tags

a. Identify origin and destination.
b. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed raceway, whether in ceiling space or surface mounted.
c. Provide noncorrosive wire for attachment.

3.17.2 Warning Tape

Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

3.18 PROTECTION OF INSTALLED WORK

a. Protect products from effects of moisture, corrosion, and physical damage during construction.
b. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.
c. Touch up painted conduit threads after assembly to cover nicks or scars.
d. Touch up coating damage to PVC-coated conduit with patching compound approved by manufacturer; compound shall be kept refrigerated according to manufacturers' instructions until time of use.

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SECTION 16120

CONDUCTORS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 8	(1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION, INC. (NECA)

NECA 5055	Standard of Installation

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION (NEMA)

NEMA CC 1	Electric Power Connectors for Substations
NEMA WC 3	(1992; Rev 1 1994) Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 5	(1992; Rev 2 1996) Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 7	(1998; Rev 3 1996) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1988: Rev 3 1996) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Engergy
NEMA WC 55	Instrumentation Cables and Thermocouple Wire

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES, INC. (UL)

UL 13	Standard for Safety Power-Limited Circuit Cables
UL 44	(1999) Thermoset-Insulated Wires and Cables

UL 62	Standard for Safety Flexible Cord and Fixture Wire
UL 486A	(1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 510	(1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 854	(1996; Rev Oct 1999) Service-Entrance Cables
UL 1277	Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
UL 1581	(1997; R Nov 1998) Reference Standard for Electrical Wires, Cables, and Flexible Cords

1.2 SUBMITTALS

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

SD-02 Shop Drawings

Wire and cable descriptive product information; G, RE

Wire and cable accessories descriptive product information; G, RE

1.3 UL COMPLIANCE

Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 CONDUCTORS 600 VOLTS AND BELOW

a. Conform to applicable requirements of NEMA WC 3, NEMA WC 5, and NEMA WC 7.
b. Conductor Type:
   (1) 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Stranded copper.
   (2) 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Stranded copper.
   (3) All Other Circuits: Stranded copper.
c. Insulation: Type XHHW, except for sizes No. 1 and larger, with XHHW-2 insulation.
d. Flexible Cords and Cables:
   (1) Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
   (2) Conform to physical and minimum thickness requirements of NEMA WC 8.

2.2 600-VOLT RATED CABLE

2.2.1 General

a. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.
b. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
c. Suitable for installation in open air, in cable trays, or conduit.
d. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
e. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

2.2.2 Type 1, Multiconductor Control Cable

a. Conductors:
   (1) No. 14 AWG, seven-strand copper.
   (2) Insulation: 15-mil PVC with 4-mil nylon.
   (3) UL 1581 listed as Type XHHW rated VW-1.
   (4) Conductor group bound with spiral wrap of barrier tape.
   (5) Color Code: In accordance with NEMA WC 5, Method 1, Sequence K-2.
b. Cable: Passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.
c. Cable Sizes:

No. of Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

2.2.3 Type 3-No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable

Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

a. Outer Jacket: 45-mil nominal thickness.
b. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
c. Dimension: 0.31-inch nominal OD.
d. Conductors:
   (1) Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   (2) 20 AWG, seven-strand tinned copper drain wire.
   (3) Insulation: 15-mil nominal PVC.
   (4) Jacket: 4-mil nominal nylon.
   (5) Color Code: Pair conductors black and red.

2.2.4 Type 5-No. 18 AWG, Multi-Twisted, Shielded Pairs with a Common, Overall Shield Instrumentation Cable

Designed for use as instrumentation, process control, and computer cable,

meeting NEMA WC 55 requirements.

a. Conductors:
   (1) Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B 8.
   (2) Tinned copper drain wires.
   (3) Pair drain wire size AWG 20, group drain wire size AWG 18.
   (4) Insulation: 15-mil PVC.
   (5) Jacket: 4-mil nylon.
   (6) Color Code: Pair conductors black and red with red conductor numerically printed for group identification.
   (7) Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.
b. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
c. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.50	45
8	0.68	60
12	0.82	60

2.3 GROUNDING CONDUCTORS

a. Equipment: Stranded copper with green, Type XHHW except for size No. 1 and larger with XHHW-2 insulation.
b. Direct Buried: Bare stranded copper.

2.4 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

a. Tape:
   (1) General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
   (2) Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
   (3) Arc and Fireproofing: 30-mil, elastomer.
b. Identification Devices:
   (1) Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
   (2) Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
   (3) Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.
c. Connectors and Terminations:
   (1) Nylon, Self-Insulated Crimp Connectors:
   (2) Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   (3) Self-Insulated, Freespring Wire Connector (Wire Nuts):
      a) Plated steel, square wire springs.
      b) UL 486C.
   (4) Self-Insulated, Set Screw Wire Connector:
      a) Two piece compression type with set screw in brass barrel.
      b) Insulated by insulator cap screwed over brass barrel.
d. Cable Lugs:
   (1) In accordance with NEMA CC 1.
   (2) Rated 600 volts of same material as conductor metal.
   (3) Insulated, Locking-Fork, Compression Lugs:

a) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
b) Seamless.

(4) Uninsulated Crimp Connectors and Terminators:
a) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

(5) Uninsulated, Bolted, Two-Way Connectors and Terminators.

e. Cable Ties:
(1) Nylon, adjustable, self-locking, and reusable.

f. Heat Shrinkable Insulation:
(1) Thermally stabilized, crosslinked polyolefin.

2.5 PULLING COMPOUND

a. Nontoxic, noncorrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.
b. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.
c. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

2.6 WARNING TAPE

As specified in Section 16110 RACEWAYS.

2.7 SOURCE QUALITY CONTROL

Conductors 600-Volts and Below: Test in accordance with UL 44 and UL 854 Standards.

PART 3 EXECUTION

3.1 GENERAL

a. Conductor installation to be in accordance with NECA 5055.
b. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.
c. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
d. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.
e. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.
f. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.
g. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.
h. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

3.2 POWER CONDUCTOR COLOR CODING

a. Conductors 600 Volts and Below:

(1) No. 6 AWG and Larger: Apply general purpose, flame retardant tape

at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2-inches wide.
(2) No. 8 AWG and Smaller: Provide colored conductors.
(3) Colors: System Conductor Color All Systems Equipment Grounding Green 240/120 Volts Single-Phase, Three-Wire Grounded Neutral One Hot Leg Other Hot Leg White Black Red 208Y/120 Volts Three-Phase, Four-Wire Grounded Neutral Phase A Phase B Phase C White Black Red Blue 480Y/277 Volts Three-Phase, Four-Wire Grounded Neutral Phase A Phase B Phase C White Brown Orange Yellow NOTE: Phase A, B, C implies direction of positive phase rotation.
(4) Tracer: Outer covering of white with an identifiable colored strip other than green in accordance with NFPA 70.

3.3 CIRCUIT IDENTIFICATION

3.3.1 Method

a. Conductors No. 3 AWG and Smaller: Identify with sleeves.
b. Cables, and Conductors No. 2 AWG and Larger:
(1) Identify with marker plates.
(2) Attach marker plates with nylon tie cord.
c. Taped-on markers or tags relying on adhesives not permitted.

3.3.2 Conductors Above 600 Volts

Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.

a. Colors:
(1) Grounded Neutral: White.
(2) Phase A: Red.
(3) Phase B: Yellow.
(4) Phase C: Blue.

3.4 CONDUCTORS 600 VOLTS AND BELOW

a. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.
b. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by the Contracting Officer.
c. Connections and Terminations:
(1) Install wire nuts only on solid conductors.
(2) Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
(3) Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors No. 12 AWG and smaller.
(4) Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
(5) Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors No. 3/0 AWG and larger.
(6) Install uninsulated terminators bolted together on motor circuit conductors No. 10 AWG and larger.
(7) Tape insulate all uninsulated connections.
(8) Place no more than one conductor in any single-barrel pressure connection.
(9) Install crimp connectors with tools approved by connector

manufacturer.
(10) Install terminals and connectors acceptable for type of material used.
(11) Compression Lugs:
a) Attach with a tool specifically designed for purpose.
b) Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
c) Do not use plier type crimpers.

d. Do not use soldered mechanical joints.
e. Splices and Terminations:
(1) Indoors: Use general purpose, flame retardant tape.
(2) Outdoors: Use flame retardant, cold- and weather-resistant tape.
f. Cap spare conductors and conduits with UL listed end caps.
g. Cabinets and Panels:
(1) Remove surplus wire, bridle and secure.
(2) Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.
h. Control and Instrumentation Wiring:
(1) Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
(2) Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
(3) Locate splices in readily accessible cabinets or junction boxes using terminal strips.
(4) Where connections of cables installed under this section are to be made under other sections leave pigtails of adequate length for bundled connections.
(5) Cable Protection:
a) Under Infinite Access Floors: May be installed without bundling.
b) All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2-inch in diameter.
c) Maintain integrity of shielding of instrumentation cables.
d) Ensure grounds do not occur because of damage to jacket over the shield.
i. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.5 UNDERGROUND DIRECT BURIAL CABLE

a. Install in trench as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.
b. Warning Tape: Install approximately 6 inches above cable, aligned parallel to, and within 12 inches of centerline of the run.

3.6 FIELD QUALITY CONTROL

In accordance with Section 16950 ELECTRICAL TESTING.

-- End of Section --

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SECTION 16405

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SECTION 16405

AC INDUCTION MOTORS

PART 1 GENERAL

1.1 REFERENCES

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE Std 85	(1973; R 1986) Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery
IEEE Std 112	(1996) Polyphase Induction Motors and Generators
IEEE Std 114	(1982) Single-Phase Induction Motors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(1998) Motors and Generators
NEMA MG 13	Frame Assignments for Alternating Current Integral Horsepower Induction Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

1.2 RELATED SECTIONS

This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.3 DEFINITIONS

a. CISD-TEFC: Chemical industry, severe-duty enclosure.
b. DIP: Dust-ignition-proof enclosure.
c. EXP: Explosion-proof enclosure.
d. ODP: Open drip-proof enclosure.
e. TEFC: Totally enclosed, fan cooled enclosure.
f. TENV: Totally enclosed, nonventilated enclosure.
g. WPI: Open weather protected enclosure, Type I.
h. WPII: Open weather protected enclosure, Type II.
i. Motor Nameplate Horsepower: That rating after any derating required to

allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

1.4 SUBMITTALS

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

SD-02 Shop Drawings

Descriptive information; G, RE.
Nameplate; G, RE.

Data in accordance with NEMA MG 1.

Enclosure type and mounting (e.g. horizontal, vertical); G, RE.
Dimensions and total weight; G, RE.
Conduit box; G, RE

Dimensions and usable volume as defined in NEMA MG 1 and NFPA 70

Bearing type; G, RE.
Bearing lubrication; G, RE.
Bearing life; G, RE.
Space heater; G, RE.

Voltage and watts

Motor Thermal Protection; G, RE.

Description and rating of motor thermal protection.

Motor sound power level; G, RE.

In accordance with NEMA MG 1.

Maximum brake horsepower; G, RE.

Required by the equipment driven by the motor.

Submersible motor moisture and temperature sensing system; G, RE.

Description and rating of submersible motor moisture and temperature sensing system.

SD-06 Test Reports

Factory test report; G, RE.

SD-10 Operation and Maintenance Data

Operation and maintenance manual; G, RE.

PART 2 PRODUCTS

2.1 GENERAL

a. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.
b. In order to obtain single source responsibility, utilize a single supplier to provide a drive motor, its driven equipment, and specified motor accessories.
c. Meet requirements of NEMA MG 1.
d. Frame assignments in accordance with NEMA MG 13.
e. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.
f. Lifting lugs on all motors weighing 100 pounds or more.
g. Operating Conditions:
   (1) Maximum ambient temperature not greater than 40 degrees C.
   (2) Elevation: 4,700 feet.
   (3) Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.
   (4) Overspeed in either direction in accordance with NEMA MG 1.

2.2 HORSEPOWER RATING

a. As designated in motor-driven equipment specifications.
b. Design Requirement: Meet requirements of NEMA parts 30 and 31 for inverter duty rating.
c. Adjustable Frequency, Adjustable Speed Applications: Driven equipment brake horsepower at any operating condition not to exceed motor nameplate horsepower rating, excluding any service factor. Motors shall be inverter duty rated.

2.3 SERVICE FACTOR

1.15 minimum at rated ambient temperature for pure sine wave, 1-0 for Adjustable Frequency Drive (AFD) operation, unless otherwise indicated.

2.4 VOLTAGE AND FREQUENCY RATING

a. System Frequency: 60-Hz.
b. Voltage Rating: Unless otherwise indicated in motor-driven equipment specifications:

Size	Voltage	Phases
1/2 hp and smaller	115	1
3/4 hp through 300 hp	200	3

c. Suitable for full voltage starting.
d. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.5 EFFICIENCY AND POWER FACTOR

a. For all motors except single-phase, under 1 horsepower, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:
   (1) Efficiency:

a) Tested in accordance with NEMA MG 1, paragraph 12.58.1.
b) Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.

(2) Power Factor: Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.

2.6 LOCKED ROTOR RATINGS

a. Locked rotor kVA Code F or lower if motor horsepower not covered by NEMA MG 1 tables.
b. Safe stall time 12 seconds or greater.

2.7 INSULATION SYSTEMS

a. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.
b. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.
c. Three-Phase and Integral Horsepower Motors, Unless Otherwise Indicated in Motor-Driven Equipment Specifications: Class F with Class B rise at nameplate horsepower and designated operating conditions.

2.8 ENCLOSURES

a. All enclosures to conform to NEMA MG 1.
b. TEFC and TENV: Furnish with a drain hole with porous drain/weather plug.

2.9 TERMINAL (CONDUIT) BOXES

a. Oversize main terminal boxes for all motors.
b. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.
c. Except ODP, furnish gaskets between box halves and between box and motor frame.

Voltage	Horsepower	Percentage
Below 600	15 through 125	500
Below 600	150 through 300	275
Below 600	350 through 600	225
Above 600	All sizes	200

d. Minimum Usable Volume: Provide 500 percent of that specified in NEMA MG 1 -4.19 and NFPA 70, Article 430.
e. Terminal for connection of equipment grounding wire in each terminal box.

2.10 BEARINGS AND LUBRICATION

2.10.1 Vertical Motors

a. Thrust Bearings:
(1) Antifriction bearing.
(2) Minimum 50,000 hours L-10 bearing life.
b. Guide Bearings:
(1) Manufacturer's standard bearing type and lubrication.
(2) Minimum 100,000 hours L-10 bearing life.

2.10.2 Regreasable Antifriction Bearings

a. Readily accessible, grease injection fittings.
b. Readily accessible, removable grease relief plugs.

2.10.3 Oil Lubrication Systems

a. Oil reservoirs with sight level gauge.
b. Oil fill and drain openings with opening plugs.
c. Provisions for necessary oil circulation and cooling.
d. Bearing Isolation: Motors rated for inverter duty shall have electrically isolated bearing to prevent strong currents.

2.11 NOISE

a. Measured in accordance with IEEE Std 85 and NEMA MG 1.
b. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.12 BALANCE AND VIBRATION CONTROL

In accordance with NEMA MG 1 Part 7.

2.13 EQUIPMENT FINISH

2.13.1 Protect Motor for Service Conditions

a. ODP Enclosures: Indoor industrial atmospheres.
b. Other Enclosures: Outdoor industrial atmospheres, including moisture and direct sunlight exposure.

2.13.2 Internal Finish:

Bore and end turns coated with clear polyester or epoxy varnish.

2.14 SPECIAL FEATURES AND ACCESSORIES

2.14.1 Screen Over Air Openings

Corrosion-resistant on motors with ODP, WPI, and WPII enclosures meeting requirements for Guarded Machine in NEMA MG 1.

2.14.2 Winding Thermal Protection

a. Thermistors:
   (1) Motors for constant speed application 100 horsepower and Motors for adjustable speed application 40 horsepower and larger.
   (2) Thermistor embedded in each stator phase winding before winding dip and bake process.
   (3) In intimate contact with winding conductors.
   (4) Epoxy-potted, solid state thermistor control module mounted in NEMA 250, Type 4X box on motor by motor manufacturer.
   (5) Individual thermistor circuits factory-wired to control module.
   (6) Control module rated for 120V ac power supply.
   (7) Control module automatically reset contact for external use rated 120 volts ac, 5 amps minimum, opening on abnormally high winding temperature. Manual reset shall be provided at motor controller.

2.14.3 Space Heaters

Provide where specified in driven equipment specification.

2.14.4 Nameplates

a. Raised or stamped letters on stainless steel or aluminum.
b. Display all motor data required by NEMA MG 1-10.39 and NEMA MG 1-10.40 in addition to bearing numbers for both bearings.
c. Premium efficiency motor nameplates to also display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

2.15 FACTORY TESTING

2.15.1 Tests

a. In accordance with IEEE Std 112 for polyphase motors and IEEE Std 114 for single-phase motors.
b. Routine (production) tests on all motors in accordance with NEMA MG 1, plus no load power at rated voltage and polyphase, rated voltage measurement of locked rotor current. Test multispeed motors at all speeds.
c. For energy efficient motors, test efficiency at 50, 75, and 100 percent of rated horsepower:
   (1) In accordance with IEEE Std 112, Test Method B, and NEMA MG 1, paragraphs 12.59 and 12.60.
d. Power factor.
   (1) Speed.
   (2) Current at rated horsepower.
   (3) kW input at rated horsepower.
   (4) Furnish a certified copy of a motor efficiency test report on an identical motor.

2.15.2 Test Report Forms

a. Routine Tests: IEEE Std 112, Form A-1.
b. Efficiency and power factor by Test Method B, IEEE Std 112, Form A-2, and NEMA MG 1, tables 12-10, 12-11, or 12-12.
c. Temperature Test: IEEE Std 112, Form A-2.

PART 3 EXECUTION

3.1 INSTALLATION

a. In accordance with manufacturer's instructions and recommendations.
b. Align motor carefully and properly with driven equipment.
c. Secure equipment to mounting surface with anchor bolts. Provide anchor bolts meeting manufacturer's recommendations and of sufficient size and number for the specified seismic conditions.

3.2 FIELD QUALITY CONTROL

Refer to Section 16950 ELECTRICAL TESTING.

3.3 MANUFACTURER'S SERVICES

a. Furnish manufacturer's representative at site in accordance with Section 01200, GENERAL REQUIREMENTS, for installation assistance, inspection, equipment testing, and startup assistance for motors.

b. Manufacturer's Certificate of Proper Installation.
c. Furnish manufacturer's representative for the following services at jobsite or classroom as designated by Contracting Officer, for minimum person-days listed below, travel time excluded:
   (1) 1 person-day for installation assistance, and inspection of installation at each site.
   (2) 1 person-day for functional and performance testing, and for plant startup at each site.

3.4 MOTOR PERFORMANCE REQUIREMENTS

Attached at the end of this Section.

-- End of Section --

TABLE 1
MOTOR PERFORMANCE REQUIREMENTS

		% Guar. Min. Full Load Efficiency				% Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
100	3,600	93.0	93.6	91.7	91.7	87.0	88.2	87.0	88.5
	1,800	94.1	94.5	94.0	93.5	81.0	81.0	81.0	81.0
	1,200	94.1	94.1	92.8	92.8	82.1	81.7	85.5	85.5
	900	93.5	92.4	92.8	91.7	77.0	77.3	77.0	80.0
125	3,600	93.6	94.5	91.7	91.7	86.4	89.1	87.0	90.5
	1,800	94.5	94.5	93.5	92.8	85.4	85.5	87.5	86.0
	1,200	94.1	94.1	93.5	92.8	82.7	82.3	85.5	85.5
	900	93.5	93.0	92.8	92.4	78.5	78.5	78.5	78.5
150	3,600	93.6	94.5	92.4	91.7	86.5	90.0	86.5	90.5
	1,800	95.0	95.0	94.5	94.0	82.5	85.0	84.5	85.0
	1,200	94.5	95.0	93.5	94.0	81.5	81.5	81.5	81.5
	900	93.5	93.0	92.8	92.4	78.0	78.5	78.0	78.5
200	3,600	94.5	95.0	92.4	93.0	87.8	89.4	91.0	91.0
	1,800	95.0	95.0	94.0	94.0	85.2	86.5	87.0	87.0
	1,200	94.5	95.0	93.5	93.5	79.0	82.5	79.0	82.5

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SECTION 16425

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3.3 MANUFACTURER'S SERVICES

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SECTION 16425

SWITCHBOARDS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C62.11	Standard for Metal-Oxide Surge Arrestors for AC Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA PB 2	(1995) Deadfront Distribution Switchboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES, INC. (UL)

UL 891	(1994; Rev thru Jan 1995) Dead-front Switchboards
UL 1025	(1980; R 1990, Bul. 1991) Electric Air Heaters

1.2 SCOPE

a. This specification applies to Switchboards and Service Entrance Sections, as indicated.
b. Service entrance sections shall be provided in accordance with the requirements of local electrical utilities. Cost should include coordination with local electrical utilities and obtain their approvals.

1.3 SUBMITTALS

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

SD-02 Shop Drawings

Descriptive product information; G, RE.

Itemized Bill of Material; G, RE.
Dimensional drawings; G, RE.
Operational description; G, RE.
Anchoring instructions and details; G, RE.
One-line, three-line, and control schematic drawings; G, RE.
Connection and interconnection drawings; G, RE.
Circuit Breakers: Copies of time-current characteristics; G, RE.
Ground Fault Protection: Relay time-current characteristics; G, RE.
Bus data; G, RE.
Incoming line section equipment data; G, RE.
Transformer section equipment data; G, RE.
Conduit entrance locations; G, RE.

SD-08 Manufacturer's Instructions

Manufacturer's installation instructions; G, RE.

SD-06 Test Reports

Certified Factory Test Report; G, RE.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual; G, RE.

SD-07 Certificates

Manufacturer's Certification of Proper Installation; G, RE.

1.4 UL COMPLIANCE

Products manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL Listing Mark.

PART 2 PRODUCTS

2.1 GENERAL

a. Equipment suitable for 480 volt, three-phase, four-wire grounded-wye electrical system, unless otherwise shown, having an available short-circuit current at line terminals of amperes rms symmetrical as shown.
b. Comply with NEMA PB 2 and UL 891.
c. Switchboard and/or service entrance section and all its major components to be manufactured and assembled by a single manufacturer in order to achieve standardization for appearance, operation andmaintenance, spare parts replacement, and manufacturer's services.
d. Lifting lugs on all equipment and devices weighing over 100 pounds.
e. Operating Conditions:
   (1) Ambient Temperature: Maximum 45 degrees C.
   (2) Equipment shall be fully rated without derating for the above operating conditions.

2.2 STATIONARY STRUCTURE

a. Type: NEMA PB 2 construction, dead front, completely metal enclosed, self-supporting.
b. Sections bolted together to form one rigid assembly capable of being moved into position and bolted directly to the floor without use of

floor sills.

2.3 ENCLOSURE

a. Equipment Finish: Baked enamel applied over rust-inhibiting phosphated base coating.
   (1) Color:
      a) Exterior: Manufacturer's standard.
      b) Interior: White.
      c) Unpainted Parts: Plated for corrosion resistance.
b. Aisleless Outdoor Enclosure:
   (1) NEMA 250, Type 3R enclosing NEMA 250, Type 1, enclosed switchboard.
   (2) Front access, hinged, full-height doors with three-point latch operated by vault-type handle with multiple padlocking provisions for each front switchboard section.
   (3) Minimum 10-inch front access space between exterior door and front of interior switchboard doors.
   (4) Gasketed doors, end panels, and sloped roof having 4-inch minimum overhang on all sides.
   (5) Support assembly on 4-inch modular base.
   (6) Steel bottom enclosure and support assembly undercoated with a coal tar emulsion.
   (7) Ventilating louvers with filters in front door.
   (8) Space Heaters: Thermostatically controlled 250-watt, 120-volt, in each switchboard vertical section in accordance with UL 1025. Provide control power transformer, disconnecting means, and wiring internal to the switchboard, to provide power to space heater.
   (9) Adjustable thermostat for temperature range of 50 to 70 degrees F.
c. Overall Dimensions: The Complete switchboard assembly must fit in the space indicated. The front and plan views shall be as indicated.

2.4 BUSWORK

a. Material: Phase insulated copper throughout entire length of sufficient cross section to limit temperature rise at rated current to 55 degrees C.
b. Bus Arrangement: A-B-C, left-to-right, top-to-bottom, and front-to-rear, as viewed from front.
c. Brace for short-circuit currents as shown.
d. Main Horizontal Bus: Nontapered, continuous current rating as shown.
e. Ground Bus:
   (1) Tin-plated copper.
   (2) Rating: 800 amperes.
   (3) Bolted to each vertical section.
f. Extend each bus entire length of switchboard with provisions for extension to future units.

2.5 PROTECTIVE DEVICES

2.5.1 Molded-Case Circuit Breakers

a. Main, and Branch Feeder Protective Devices: Group mounted, suitable for use with 75 degree C wire at full 75 degree C ampacity when mounted in switchboard.
b. Arrangement: Fully rated main and branch feeder 400 amperes and above.
c. Frame sizes: As shown provide solid state trip units per 400 amperes and above.
d. Interupting Rating: Amperes rms symmetrical at rated voltage of 480V, as shown.

e. Mechanical interlock to prevent opening compartment door while breaker is in closed position.
f. Provide padlock provision where breaker is in OFF position.

2.6 SOLID-STATE TRIP UNIT

a. Flux-shift trip and current sensors.
b. Protective Programmers:
   (1) Self-powered, automatic rms sensing micro-electronic processor.
   (2) No external relays or accessories.
   (3) Printed circuit cards with gold-plated contacts.
   (4) Programmable Controls:
      a) Fixed-point, with repetitive accuracy and precise unit settings.
      b) Trip adjustments made by nonremovable, discrete step switching.
   (5) Field-Installable Rating Plugs:
      a) Long-time pickup LED indicator and test receptacle.
      b) Matching load and cable requirements.
      c) Interlocked with tripping mechanism.
      d) Breaker to remain trip-free with plug removed.
      e) Keyed rating plugs to prevent incorrect application.
   (6) Long-time pickup light.
   (7) Selective Coordination Time/Current Curve Shaping Adjustable Functions:
      a) Current setting.
      b) Long-time pickup.
      c) Long-time delay.
      d) Instantaneous pickup with short-time for main and feeders.
      e) Short-time pickup for main and feeders.
      f) Short-time delay for main and feeders with I2T function, and IN-OUT switch.
      g) Ground fault pickup.
      h) Ground fault delay with I2T function.
      i) High instantaneous pickup with short-time delay.
      (8) Fixed, instantaneous pickup for main feeders.
      (9) Fault Trip Indicators: Mechanical push-to-reset type for overload and short-circuit overload plus ground fault trip.
      (10) Rejection Pins: For each programmer frame size.
c. Phase Current Sensors:
   (1) Single-ratio type.
   (2) Fixed, mounted on breaker frame.
   (3) Molded epoxy construction.
   (4) One toroidal type for each phase.
d. Portable Test Set: Ac/dc static, full function unit for checking programmer's time-current characteristics of programmer.

2.7 CONTROL WIRING

a. Control, Instrumentation, and Power/Current Circuits: NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts.
b. Transducer Output/Analog Circuits: Shielded cable rated 600 volts, 90 degrees C minimum.
c. Conductor Lugs: Preinsulated, self-locking, spade-type, with reinforced sleeves.
d. Identification: Individually, with permanent wire markers at each end.
e. Enclose in top and vertical steel wiring troughs, and front-to-rear in nonmetallic wiring troughs.
f. Splices: Not permitted in switchboard wiring.

2.8 TERMINAL BLOCKS

a. Enclosed in steel wiring troughs.
b. Rated 600 volts, 30 amperes minimum, one-piece barrier type with strap screws.
c. Shorting type for current transformer leads.
d. Provide terminal blocks for:
   (1) Conductors connecting to circuits external to switchboard.
   (2) Internal circuits crossing shipping splits.
   (3) Equipment parts requiring replacement and maintenance.
e. Spare Terminals: Not less than 20 percent.
f. Group terminal blocks for external circuit wiring leads.
g. Maintain 6-inch minimum space between columns of terminal blocks.
h. Identification: Permanent, for each terminal and columns of terminal blocks.

2.9 POWER METER

a. Solid-state device with LED displays.
b. Direct voltage input up to 600 volts ac.
c. Current input via current transformer with 5-ampere secondary.
d. Programmable current and potential transformer ratios.
e. Programmable limits to activate up to four alarms.
f. Selectable voltage measurements; line-to-line or line-to-neutral, and wye or delta.
g. Simultaneous Display:
   (1) Volts, three-phase.
   (2) Amperes, three-phase.
   (3) Kilowatts.
   (4) Kilowatthours.
   (5) Power factor.
   (6) Peak demand.
h. Voltage Rating: 600 volts, ac.

2.10 LOW VOLTAGE, SECONDARY SURGE PROTECTIVE EQUIPMENT

a. NEMA, LA 1, ANSI C62.11.
b. Sure Capacitor:
   (1) Impregnated with non PCB, biodegradable dielectric fluid.
   (2) Integral discharge resistor which will drain residual voltage to crest in less than 1 minute after disconnection from circuit.
c. Arrestor: High strength metal oxide elements enclosed in high corrosion resistant, molded resin housing.
d. Equip capacitor and arrestor with mounting nipple, flat washer, and make suitable for knockout or bracket mounting.

2.11 IDENTIFICATION

2.11.1 Nameplates

a. Master:
   (1) Deep-etched aluminum, with manufacturer's name and model number.
   (2) Riveted to main vertical section.
b. Circuit Breaker Cubicle and Door-Mounted Device:
   (1) Engraved, phenolic.
   (2) Color: White with black.
   (3) Characters: Block-type, 1/4-inch high.
   (4) Size: As required for three lines, with 15 characters each line.
   (5) Inscription: As shown on one-line diagram.
   (6) Blank plates for future spaces.

(7) Attachment Screws: Stainless steel panhead.

2.11.2 Section Identification

a. Stamped metallic, riveted to each vertical section.
b. Serial number, bus rating, and section reference number.
c. Size: Manufacturer's standard.

2.11.3 Cubicle Labels

a. Nonmetallic, applied inside each cubicle compartment.
b. Device serial number, rating, and description.

2.11.4 Metering Instruments

Meter type identified on meter face below pointer or dial.

2.11.5 Control Switches

Deep etched, aluminum escutcheon plate.

2.11.6 Relays and Devices

a. Stamped metallic, riveted to instrument case.
b. Manufacturer's name, model number, relay type, and rating data.

2.11.7 Switchboard Sign

a. Sign on front.
b. Engraved, phenolic.
c. Size: Manufacturer's standard.
d. Color: Red with white.
e. Characters: Gothic-type, 1 inch(es) high.
f. Inscription: DANGER/HIGH VOLTAGE/KEEP OUT.
g. Attachment: Four rivets each sign.

2.12 FACTORY TESTIING

Perform performance tests in accordance with UL 891 and production tests in accordance with NEMA PB 2.

PART 3 EXECUTION

3.1 INSTALLATION

a. Install in accordance with manufacturer's instructions and recommendations.
b. Secure to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
c. Install plumb and in longitudinal alignment with pad or wall.
d. Coordinate terminal connections with installation of secondary feeders.

3.2 FIELD QUALITY CONTROL

In accordance with Section 16950 ELECTRICAL TESTING.

3.3 MANUFACTURER'S SERVICES

a. Furnish manufacturer's representative in accordance with Section 01640

MANUFACTURERS' SERVICES, for the following services at jobsite, for minimum person-days listed below, travel time excluded:
(1) 1 person-days for installation assistance, final adjustment, and initial energization of equipment.
(2) 1/2 person-days for functional and performance testing.
(3) 1/2 person-days for adjustment of relay settings.

b. Furnish startup services and training of the Contracting Officer at such times as requested by Contracting Officer.

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SECTION 16450

GROUNDING

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SECTION 16450

GROUNDING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2 (1997) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

1.2 SUBMITTALS

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

SD-03 Product Data

Exothermic weld connectors; G, RE.
Mechanical connectors; G, RE.
Ground rods; G, RE.
Compression connectors; G, RE

1.3 UL COMPLIANCE

Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 GROUND RODS

a. Material: Copper-clad. Steel.
b. Diameter: Minimum 5/8 inch.
c. Length: 10 feet.

2.2 GROUND CONDUCTORS

As specified in Section 16120 CONDUCTORS.

2.3 CONNECTORS

2.3.1 Exothermic Weld Connectors

a. Outdoor Weld: Suitable for exposure to elements or direct burial.
b. Indoor Weld: Utilize low-smoke, low-emission process.

2.3.2 Compression Connectors

a. Compress-deforming type; wrought copper extrusion material.
b. Single indentation for conductors 6 AWG and smaller.
c. Double indentation with extended barrel for conductors 4 AWG and larger.
d. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.

2.3.3 Mechanical Connectors

Split-bolt, saddle, or cone screw type; copper alloy material.

2.4 GROUNDING WELLS

Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

PART 3 EXECUTION

3.1 GENERAL

a. Grounding shall be in compliance with NFPA 70 and ANSI C2.
b. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.
c. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.
d. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.
e. Shielded Power Cables:
   (1) Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.
f. Shielded Control Cables:
   (1) Ground shield to ground bus at power supply for analog signal.
   (2) Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
   (3) Do not ground control cable shield at more than one point.
g. Instruments:
   (1) Provide instruments grounding with stranded copper wires to local ground rod near instrument for all outdoor instruments; ground instruments to nearest ground bus for all indoor instruments.

3.2 WIRE CONNECTIONS

a. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.
b. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.
c. Connect ground conductors to raceway grounding bushings.
d. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

e. Connect enclosure of equipment containing ground bus to that bus.
f. Bolt connections to equipment ground bus.
g. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.
h. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.3 MOTOR GROUNDING

a. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.
b. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.
c. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.
d. Motors 10 hp and Above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.
e. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.4 GROUND RODS

a. Install full length with conductor connection at upper end.
b. Install with connection point below finished grade, unless otherwise shown.

3.5 GROUNDING WELLS

a. Install inside buildings, asphalt, and paved areas.
b. Install riser ring and cover flush with surface.
c. Place 9 inches crushed rock in bottom of each well.

3.6 CONNECTIONS

3.6.1 General

a. Abovegrade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.
b. Belowgrade Connections: Install exothermic weld or compression type connectors.
c. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
d. Notify Contracting Officer prior to backfilling ground connections.

3.6.2 Exothermic Weld Type

a. Wire brush or file contact point to bare metal surface.
b. Use welding cartridges and molds in accordance with manufacturer's recommendations.
c. Avoid using badly worn molds.
d. Mold to be completely filled with metal when making welds.
e. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

3.6.3 Compression Type

a. Install in accordance with connector manufacturer's recommendations.
b. Install connectors of proper size for grounding conductors and ground rods specified.
c. Install using connector manufacturer's compression tool having proper sized dies.

3.6.4 Mechanical Type

a. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
b. Install in accordance with connector manufacturer's recommendations.
c. Do not conceal mechanical connections.

3.7 MANHOLE AND HANDHOLE GROUNDING

a. Install one ground rod inside each.
b. Ground Rod Floor Protrusion: 4 to 6 inches above floor.
c. Make connections of grounding conductors fully visible and accessible.
d. Connect all noncurrent-carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.8 TRANSFORMER GROUNDING

Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

3.9 METAL STRUCTURE GROUNDING

a. Ground metal sheathing and exposed metal vertical structural elements to grounding system.
b. Bond electrical equipment supported by metal platforms to the platforms.
c. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

Connect surge arrestor ground terminals to equipment ground bus.

3.11 FIELD QUALITY CONTROL

As specified in Section 16950 ELECTRICAL TESTING.

-- End of Section --

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SECTION 16485

ADJUSTABLE FREQUENCY DRIVE SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI 359-A-1	Special Colors

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 519	(1992) Harmonic Control in Electric Power Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA CP 1	Shunt Capacitors
NEMA MG 1	(1998) Motors and Generators
NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA WC-57	Control Cables

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 79	Electrical Standard for Industrial Machinery

1.2 DEFINITIONS

a. Terms that may be used in this section:

(1) AFD: Adjustable frequency drive.
(2) CMOS: Complementary metal oxide semiconductor.
(3) GTO: Gate Turn-Off Thyristor.
(4) MTBF: Mean time between failure.
(5) PWM: Pulse width modulation.
(6) ROM: Read only memory.
(7) RTD: Resistance temperature detector.
(8) Rated Load: Load specified for the equipment.
(9) Rated Speed: Nominal rated (100 percent) speed specified for the equipment.
(10) TDD: Total demand distortion.
(11) THD: Total harmonic distortion.

(12) TTL: Transistor-transistor-logic.

1.3 SCOPE

This Specification applies to adjustable frequency drives to be furnished for production well pump motors. Furnish, install, and wire adjustable frequency drives for the following motors:

1. 150 horsepower RSPW-1 motor as indicated.
2. 100 horsepower RSPW-2 motor as indicated.

1.4 SYSTEM DESCRIPTION

1.4.1 Adjustable Frequency Drives

Adjustable frequency drives and any harmonic conditioning equipment shall be furnished complete, as indicated and as specified, and ready for operation. All specified harmonic distortion limits shall be met.

1.4.2 Harmonic Distortion

Current and voltage harmonic distortion under operation from utility sources shall be controlled within the specified limits. Harmonic conditioning may be applied at the distribution equipment bus or AFD branch circuit level.

1.4.3 Performance Requirements

Rated Continuous Operation Capacity:

Not less than 1.15 times full load current rating of driven motor, as indicated on the motor nameplates, and suitable for continuous operation at any continuous overload which may be imposed on motor by driven equipment operating over specified speed range.

Application of High-Pulse-Equivalent-Rectifier Drives:

Where the proposed drive equipment's rectifier input operates on an eighteen- (18)-pulse basis or higher, effectively eliminating the effectsof high magnitude lower-order harmonics, harmonic computations are not required. Furnish test documentation that demonstrates minimal harmonic distortion levels of the proposed equipment under similar conditions of operation.

Basis for Harmonic Computations:

Using One-Line Diagram for current and voltage distortion computations, furnish harmonic filters, line reactors, isolation transformers, or higher pulse converter arrangements required to meet current/voltage distortion limits.

Normal Current Source Harmonic Distortion:

Compute normal source individual and total current harmonic distortion at the location identified as PCC1, in accordance with IEEE Std 519. For harmonic computations, assume all drives running except those shown as standby.

Normal Source Voltage Harmonic Distortion:

Compute normal source voltage harmonic distortion at location identified as PCC1. THD shall not exceed 5 percent, and individual voltage harmonic distortion shall not exceed 3 percent.

Other Devices:

Furnish isolating transformers or series reactors, harmonic filters, or other devices necessary for proper system operation. Furnish necessary devices and circuits to prevent operation of one drive from adversely affecting operation of other drives, supplied from same transformer or same bus.

Additional Features:

Additional features and components have been specified for the purposes of limiting input current/voltage distortion, isolating the drive inputs from incoming power transient conditions, preventing the output of a drive from adversely affecting its connected motor, and preventing the output of a drive from adversely affecting circuits or devices connected to drive signal or communication interfaces.

Isolation Transformers:

When isolation transformers are used, design shall meet K-factor requirements of drive(s) connected.

1.4.4 Design Requirements

a. Design and provide drive system consisting of adjustable frequency controller, auxiliary items, and components necessary for complete operating system. Drive motors are specified with pumps.
b. Other equipment is being powered from same bus as adjustable frequency drives. Ensure proper operation of drives and other loads under normal conditions.
c. Furnish AFDs rated on basis of actual motor full load nameplate current rating.
d. Drive System: Convert incoming three-phase, 60-Hz ac power to variable voltage, adjustable frequency output for adjustable speed operation of a standard ac induction squirrel-cage motor, using the pulse-width-modulation (PWM) technique to produce the adjustable frequency output.
e. System rated for continuous industrial duty and suitable for use with NEMA MG 1, Design B motors. Motors are specified as inverter duty.
f. Drive rating shall be based upon the specified carrier frequency. AFD variable torque load rating shall equal or exceed the driven motor's nameplate horsepower rating. Units shall be rated for continuous industrial duty and suitable for use with the motors being supplied.
g. Incoming Line Reactor: Design to minimize harmonic distortion on incoming power feeder.
h. Provide control and signal inputs, outputs, and interfaces, as specified and as indicated.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the

Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Dimension Drawings; G, RE.

Controller, reactor, harmonic filter, and isolating transformer (if applicable).

Outline Drawings; G, RE.

Outline and arrangement drawings for all enclosures, showing internal and external layout of devices, wiring, terminal blocks.

Layout; G, RE.

Layout of controller face showing keypads, displays, pushbuttons, switches, instruments, indicating lights.

System Operating Description; G, RE.

Complete system interconnection diagrams showing terminal blocks for interface with drive motor and all related components.

One-line diagram of system, including component ratings.

SD-03 Product Data

"dc link" capacitor

Data on the shelf life of "dc link" capacitor.

Adjustable Frequency Drive; G, RE.

Include all name plate data , continuous operation load capability throughout speed range of 0 to 120 percent of rated speed and coordinated with motor full load nameplate current rating; list any controller special features being supplied.

Ventilation; G, RE.

Maximum heat dissipation from enclosure(s) and details of any ventilation provisions.

Diagnostics; G, RE.

Description of diagnostic features being provided.

Control and Interface Devices; G, RE.

Descriptive literature for all control and interface devices.

Bill-of-Materials; G, RE.

Itemized bill-of-materials listing all system components.

Shipping and Handling Instructions

Special shipping, storage and protection, and handling instructions.

SD-05 Design Data

Drive System Operating Data; G, RE.

Including efficiencies, input currents, and power factors, at driven equipment actual load and rated system input voltage, at 0, 40, 60, 80, 100, and 110 percent of rated speed.

Individual and Total Harmonic Content; G, RE.

Voltage and current reflected in system normal source supply, at the PCC1 shown and under the following load conditions: actual drive-operated loads at 50 percent and 100 percent of rated speed, and all non-drive loads as shown. Normal source system short-circuit current available at drive shall be calculated from the data furnished in the Supplement to this section shown. Use TDD and THD factors as defined in IEEE 519 to designate total harmonic content.

Pulse; G

AFD output pulse maximum peak voltage, pulse rise time and pulse rate of rise, including any justification for proposed deviation from specified values. Include motor manufacturer's certification that motor insulation will withstand long-term overvoltages caused at motor terminals due to specified output pulse data or any proposed deviation from this data.

SD-07 Certificates

Statement of Supplier qualifications; G, RE.
Factory functional test reports; G, RE
Field test reports; G, RE.
Manufacturer's Certificate of Proper Installation

SD-10 Operation and Maintenance Data

System Schematic; G, RE.

Complete system schematic (elementary) wiring diagrams.

Spare Parts List; G, RE.

Suggested spare parts list service for a period of 1 year.

Special Tools;
G, RE.

Special tools required for checking, testing, parts replacement, and maintenance.

Operation and maintenance manual; G, RE.

1.6 QUALITY ASSURANCE

Supplier: Minimum 5 years' experience in furnishing similar size and type

adjustable frequency, drive systems.

1.7 EXTRA MATERIALS

a. Furnish for Each Drive Unit
   (1) Complete set of components likely to fail in normal service.
   (2) Printed circuit boards.
   (3) One complete power bridge and one spare printed circuit card for each modular, plug-in type card in controller.
b. One Each Type/Size: Input/output interface modules not integral to drive board (if applicable).
c. Six of each type and rating of fuse.

PART 2 PRODUCTS

2.1 SERVICE CONDITIONS

a. Ambient Operating Temperature: 32 to 104 degrees F.
b. Storage Temperature: Minus 40 to 158 degrees F.
c. Humidity: 0 to 95 percent relative (noncondensing).
d. Altitude: 0 to 4,700 feet.
e. Frequency Stability: Plus or minus 0.1 percent of maximum frequency.

2.2 COMPONENTS

2.2.1 Drive Units

a. Incorporate a switching power supply operating from a dc bus, to produce a PWM output waveform simulating a sine wave.

b. Current-limiting semiconductor fuses for protection of internal power semiconductors.

c. Employ a diode bridge rectifier providing a constant displacement power factor of 0.95 minimum at all operating speeds and loads.

d. Use transistors for output section, providing a minimum 97 percent drive efficiency at full speed, full load.

e. Employ dc power discharge circuit so that after removal of input power dc link capacitor voltage level will decay below 50 volts dc within 1 minute after de-energizing following NEMA CP 1 and NFPA 79. Design dc link capacitor for a MTBF of 5 years.

f. Operate with an open circuited output.

g. Input Voltage: 460V ac plus or minus 10 percent.

h. Output Voltage: 0 to 460 volts, three-phase, 0 to 66 -Hz, minimum.

i. Maximum peak voltage of PWM AFD output pulse of 1,000 volts, with pulse rise time of not less than 2 microseconds, and a maximum rate of rise of 500 volts per microsecond. Provide user-selectable output pulse (carrier) frequency. Minimum available frequency range shall be 2,000 to 6,000 Hz. AFD rating and performance in the specified application(s) shall be based upon a carrier frequency of 4,000 Hz, minimum.

j. Motor Audible Noise Level: When operating throughout speed range of PWM

AFD, no more than 3 dBA above that designated in NEMA MG 1 for same motor operated at constant speed with a 60-Hz supply voltage.

k. Short-Time Overload Capacity: 125 percent of rated load in rms current for 1 minute following full load, full speed operation.

l. Equipment Short-Circuit Rating: Suitable for connection to system with maximum source three-phase, bolted fault, short-circuit available of 65,000 amps rms symmetrical at 480 volts.

m. Furnish drives with output current-limiting reactors or filters-mounted within equipment enclosures.

n. Conditioning:
   (1) Line and load reactors or filters may be installed on the top of the drive enclosure. Submit details for approval. Otherwise, install all devices within the drive panel or enclosure.
   (2) Power Input: Provide series line reactors of 3 percent nominal reactance.
   (3) Signal/Communication Inputs: Provide common mode toroidal chokes on analog and remote I/O inputs.
   (4) Power Output: Provide series load reactors or filters of 3 percent nominal reactance.

o. Diagnostics: Comprehensive for drive adjustment and troubleshooting:
   (1) Memory battery backup; 100-hour minimum during a power loss.
   (2) Status messages will not stop drive from running but will prevent it from starting.
   (3) Fault Condition Messages and History: First fault protection function to be activated, ability to store six successive fault occurrences in order. Minimum faults shall include:
      a) Overcurrent (time and instantaneous).
      b) Overvoltage.
      c) Undervoltage (dc and ac).
      d) Drive overtemperature.
      e) Serial communication fault.
      f) Short-circuit/ground fault (motor and drive).
      g) Motor stalled.
      h) Semiconductor fault.
      i) Microprocessor fault.
      j) Single-phase voltage condition.

p. Drive Protection:
   (1) Fast-acting semiconductor fuses.
   (2) Overcurrent, instantaneous overcurrent trip.
   (3) Dc undervoltage protection, 70 percent dropout.
   (4) Dc overvoltage protection, 130 percent pickup.
   (5) Overtemperature, drive, inverter, converter, and dc link components.
   (6) Overtemperature, motor, and pump (Type: Thermistor).
   (7) Single-phase protection.
   (8) Reset overcurrent protection (manual or automatic reset).
   (9) Active current limit/torque limit protection.
   (10) Semiconductor fault protection.
   (11) Short-circuit/ground fault protection.
   (12) Serial communication fault protection.
   (13) Microprocessor fault.
   (14) Surge protection for transient overvoltage (6,000 volts, 80 joule surge, tested per IEEE C62.41).
   (15) Visual display of specific fault conditions.

q. Operational Features:
   (1) Use manufacturer's standard unless otherwise indicated.
   (2) Programmable response to power loss.
   (3) Power Loss Ride-through: Output (15 milliseconds minimum at full load), logic and control (0.5 second minimum).
   (4) Catch a spinning motor on the fly.
   (5) Process proportional-integral controller.
   (6) Selectable volts/Hz control.
   (7) Motor torque-current control for optimized starting and accelerating torque.
   (8) Selectable acceleration and deceleration profiles.
   (9) Electronic motor overload protection.
   (10) Stall protection.
   (11) Slip compensation.
   (12) Automatic restart after power return (ability to enable/disable function).
   (13) Critical frequency lockout (three selectable points minimum, by 1.5-Hz steps in 10-Hz bands, to prevent resonance of system).
   (14) Drive maintenance system software for complete programming and diagnostics.
   (15) Ground fault protection, drive, and motor.
   (16) Operate with no motor connected to output terminals.

r. Output Isolation Contactor.

2.2.2 Rectifier

Three-phase, 18-pulse minimum, full wave diode bridge rectifier to provide a constant dc voltage to the drive's dc bus.

2.2.3 Choke and Capacitors

Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power supply.

2.2.4 Controller

Microprocessor-controller PWM inverter to convert to dc voltage to variable voltage, adjustable frequency three-phase ac output. The output voltage shall vary proportionally with the frequency to maintain a constant ratio of volts to hertz up to 60-Hz. Above 60-Hz, the voltage shall remain constant, with the drive operating in a constant horsepower output mode. Provide filters in the inverter output circuit to minimize the impact of fast rise time switching pulses associated with PWM drives.

2.2.5 Enclosure and Electrical

a. NEMA 250, Type 3R, gasketed, freestanding or wall-mounted enclosure as shown, completely front accessible, with hinged doors. Enclosure shall not require rear excess. Properly sized to dissipate heat generated by controller within limits of specified operating conditions (including ambient temperature and ambient airflow). Enclosure shall not exceed dimensions shown on the drawings.
b. Furnish drive complete with incoming cable termination compartment, padlockable doors, emergency stop pushbutton, alphanumeric keypad/display-type operator interface unit, and operator's controls.
c. Wire drive from above for power and control wiring.

d. Size air conditioning system for periodic operation to cool unit with enclosure temperature not to exceed 95 degrees. Furnish filters on ventilation intakes.
e. Wiring: Bundle stranded copper wiring neatly with nylon tie wraps or with continuous plastic spiral binding. Terminate all incoming and outgoing circuits at numbered terminal blocks identified as indicated. Label each terminal for permanent identification of leads. Identify each wire at each end with imprinted mylar adhesive-back wire markers. For wiring across door hinges, use 19-strand, NEMA WC-57 Class C stranding looped for proper twist rather than bending at hinge. Provide connections internal to panels by crimp-on terminals.
f. Selector switches, indicating lights, potentiometers, instruments, protective devices, major system components, etc., shall be identified by means of engraved, laminated nameplates.
g. Provide 120-volt, single-phase, 60-Hz circuits for control power and operator controls from internal control power transformer.

2.2.6 Operator Interface and Controls

a. Controls: Mount drive local controls on front door of enclosure. Provide keypad/display-type operator interface unit and control switch for the following operator functions:
   (1) Start (when in local mode).
   (2) Stop (when in local mode).
   (3) Speed increase (when in local mode).
   (4) Speed decrease (when in local mode).
   (5) Parameter mode selection (recall programmed parameters).
   (6) LOCAL/REMOTE control selection. In the LOCAL mode, remote run control and speed control, via digital/analog input or serial interface, shall be locked out.
   (7) Manual fault reset, for all faults (except loss of ac input voltage, which is automatic reset upon restoration).
   (8) RUN at preset speed.
   (9) Parameter lock (password or key switch lockout of changes to parameters).
   (10) Start disable (key switch or programmed code).
b. Control circuit disconnect shall be de-energized circuits in units that are not de-energized by main power disconnect device.
c. Provide 120 volts, single-phase, 60-Hz circuits for control power and operator controls from internal control power transformer.
d. Arrange components and circuits such that failure of any single component cannot cause cascading failure(s) of any other component(s).
e. Alphanumeric Display: During normal operation and routine test, the following parameters shall be available:
   (1) Motor current (percent of drive rated current).
   (2) Output frequency (Hertz).
   (3) Output voltage.
   (4) Running time.
   (5) Local/remote indication.
   (6) Status of digital inputs and outputs.
   (7) Analog input and output values.
   (8) Output motor current per leg.
   (9) All test points and configuration parameters.
   (10) Adjustable Parameters: Set all drive operating parameters and indicate in a numeric form.
f. Provide start/stop interlocks, motor winding thermistor relay interface, and control of external devices as shown, including all interposing relays.
g. Power Circuits:

(1) Provide 120 V single-phase ac circuit for motor space heater. Switch this circuit on when the drive is not running.
(2) Provide 120 V single-phase ac circuit for thermistor control module for motor.

2.2.7 Signal Interface

a. Digital Inputs: When in the REMOTE mode, start drive upon receiving a remote RUN command. Remote run command will be an isolated maintained contact.
b. Digital Output: Furnish discrete output dry contact closures rated 5 amps at 120V ac.
(1) DRIVE RUNNING.
(2) DRIVE FAULT (with common contact closure for all fault conditions).
(3) DRIVE IN REMOTE MODE.
c. Analog Input: When in REMOTE mode, control drive speed from a remote 4 to 20 mA dc signal. Provide adjustment of minimum and maximum motor speed which shall result from this signal. Factory set this adjustment to comply with operating speed range designated in driven equipment specifications. Frequency resolution shall be 0.1 percent of base speed.
d. Analog Output: Furnish two 4 to 20 mA dc isolated signals and isolators. Signals shall be proportional to actual frequency and actual load. Each isolator shall be capable of driving a load impedance of at least 650 ohms in a nominal 24 volt dc circuit.

2.2.8 Accessories

a. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
b. Lifting Lugs: Equipment weighing over 100 pounds.

2.3 FACTORY FINISHING

a. Enclosure:
(1) Primer: One coat of rust-inhibiting coating.
(2) Finish:
a) Interior: One coat white enamel.
b) Exterior: One coat manufacturer's standard gray enamel or ANSI 359-A-1, No. 61.

2.4 SOURCE QUALITY CONTROL

a. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
b. Factory Tests and Adjustments: Test all equipment actually furnished.
c. Record test data for report.
d. Functional Test: Perform manufacturer's standard, confirming all functions and performance, specified or shown.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

3.1.1 Functional Test

a. Conduct on each controller.
b. Configure each drive in accordance with Contracting Officer

requirements. Provide typewritten tabulation of parameter settings.

c. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.
d. Demonstrate operation, configuration, and interfaces.
e. Record test data for report.

3.1.2 Performance Test

a. Conduct on each controller.
b. Perform under actual or approved simulated operating conditions. Coordinate with the testing, startup, and adjustment of any associated active harmonic conditioner equipment.
c. Operate for continuous 12-hour period without malfunction.
d. Demonstrate performance by operating the continuous period while varying the application load, as the input conditions allow, to verify system performance.
e. Record test data for report.
f. With station load connected to normal utility source and following startup and adjustment of any associated AHC equipment, measure the following to show parameters within specified limits:
   (1) Total and individual current harmonic distortion (up to and including 35th harmonic) at locations identified as PCC1 on each One-Line Diagram, under following load conditions:
      a) All AFDs on that bus running at full load.
      b) All AFDs on that bus running at half load.
      c) Half of the AFDs on that bus running at full load.
      d) Half of the AFDs on that bus running at half load.
   (2) Power factor at input side of each drive. Documented verification that power factor is maintained at 95 percent as speed of drive is adjusted from 100 percent to 33 percent.
   (3) Voltage THD at locations identified as PCC1 under the following conditions: All AFD's running at full load and half load (except standby drives).

3.1.3 Test Equipment

a. Use Dranetz, Model No. 626-PA, harmonic distortion monitor and Series 626 disturbance analyzer or equivalent instrument to document results. Provide any CT's and PT's required for connection to the instrument.
b. Provide diagnostic plug-in test card, complete with instructions, multiposition selector switch, and meters or built-in diagnostic control panel or ROM-based processor for monitoring ac, dc, and digital signals to assist in troubleshooting and startup of drive.

3.2 MANUFACTURER'S SERVICES

a. Manufacturer's Representative: Present at site or classroom designated by Contracting Officer, for minimum person-days listed below, travel time excluded:
   (1) 1 person-day for installation assistance.
   (2) 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
   (3) 1 person-day for facility startup and training of the Contracting Officer personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by the Contracting Officer.
b. Above services includes all drives shown on One-Line Diagram.
c. See Section 01200 GENERAL REQUIREMENTS.

3.3 OPERATION AND MAINTENANCE DATA

3.3.1 Manual Format

a. Size: 8-1/2 inches by 11 inches.
b. Paper: 20-pound minimum, white for typed pages.
c. Text: Manufacturer's printed data, or neatly typewritten.
d. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
e. Provide fly-leaf for each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment and provide with heavy section dividers with numbered plastic index tabs.
f. Provide each manual with title page, and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
g. Cover: Identify each volume with typed or printed title OPERATION AND MAINTENANCE MANUAL, VOLUME NO. ___ OF ___, if applicable, and list:
   (1) Project title.
   (2) Designate the system or equipment for which it is intended.
h. Binders:
   (1) Preliminary Manuals: Heavy paper covers.
   (2) Final Manuals: Commercial quality, substantial, permanent, three-ring binders with durable, cleanable, plastic binders.
i. Table of contents neatly typewritten, arranged in a systematic order:
   (1) CONTRACTOR, name of responsible principal, address, and telephone number.
   (2) List of each product required to be included, indexed to content of each volume.
   (3) List with Each Product: Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
      a) Identify area of responsibility of each.
      b) Provide local source of supply for parts and replacement.
   (4) Identify each product by product name and identifying numbers.
j. Product Data:
   (1) Include only those sheets that are pertinent to specific product.
   (2) Clearly annotate each sheet to:
      a) Identify specific product or part installed.
      b) Identify data applicable to installation.
      c) Delete references to inapplicable information.
k. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
   (1) Relations of component parts of equipment and systems.
   (2) Control and flow diagrams.
   (3) Provide reinforced punched binder tab, bind in with text.
   (4) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
   (5) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
   (6) Identify Specification section and product on Drawings and envelopes.
l. Instructions and Procedures: Within text, as required to supplement product data.
   (1) Handling, storage, maintenance during storage, assembly, erection, installation, adjusting, testing, operating, shutdown in emergency, troubleshooting, maintenance, interface, and as may otherwisebe required.
m. Warranties, Bonds, and Service Agreements.

n. Electronic Format: Microsoft Word, most current version.

3.3.2 Submittal Procedure

a. Preliminary Manuals: Submit three copies for Contractor's review.
b. Final Manuals: Submit 5 copies.

3.3.3 Content for Each Unit (or Common Units) and System

a. Description of unit and component parts, including controls, accessories, and appurtenances:
   (1) Function, normal operating characteristics, and limiting conditions.
   (2) Performance curves, engineering data, nameplate data, and tests.
   (3) Complete nomenclature and commercial number of replaceable parts.
b. Operating Procedures:
   (1) Startup, breakin, routine, and normal operating instructions.
   (2) Test procedures and results of factory tests where required.
   (3) Regulation, control, stopping, and emergency instructions.
   (4) Description of operation sequence by control manufacturer.
   (5) Shutdown instructions for both short and extended durations.
   (6) Summer and winter operating instructions, as applicable.
   (7) Safety precautions.
   (8) Special operating instructions.
   (9) Installation instructions.
c. Maintenance and Overhaul Procedures:
   (1) Routine operations.
   (2) Guide to troubleshooting.
   (3) Disassembly, removal, repair, reinstallation, and reassembly.
d. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
e. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
f. Spare parts ordering instructions.
g. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).
h. Manufacturer's printed operating and maintenance instructions.
i. As-installed, color-coded piping diagrams.
j. Charts of valve tag numbers, with the location and function of each valve.
k. Interconnection wiring diagrams, including all control and lighting systems.
l. Circuit Directories of Panelboards:
   (1) Electrical service.
   (2) Controls.
   (3) Communications.
m. List of electrical relay settings, and control and alarm contact settings.
n. Electrical interconnection wiring diagram, including control and lighting systems.
o. As-installed control diagrams by control manufacturer.

3.3.4 Maintenance Summary

a. Compile an individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or subunits.
b. Format:
   (1) Use Maintenance Summary Form bound with this section, or an

electronic facsimile of such.

(2) Complete using typewriter or electronic printing.

c. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.

-- End of Section --

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DIVISION 16 - ELECTRICAL

SECTION 16500

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SECTION 16500

LIGHTING

PART 1 GENERAL

1.1 REFERENCES

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

UNDERWRITERS LABORATORIES, INC.

UL 924	(1995; Rev thru Oct 1997) Emergency Lighting and Power Equipment

1.2 SUBMITTALS

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

SD-03 Product Data

Interior Luminaires; G, RE.

The submittal should include the following:

a. Catalog data sheets and pictures
b. Luminaire finish and metal gauge
c. Lens material, pattern, and thickness
d. Candle power distribution curves in two or more planes
e. Candle power chart 0 to 90 degrees
f. Lumen output chart
g. Average maximum brightness data in foot lamberts
h. Coefficients of utilization for zonal cavity calculations
i. Mounting or suspension details

Lamps; G, RE.

The submittal should include the following:

a. Voltages
b. Colors
c. Approximate life (in hours)
d. Approximate initial lumens
e. Lamp type and base
f. Copy of lamp order, including individual quantities, for Project

Ballasts; G, RE.

The submittal should include the following:

a. Type
b. Wiring diagram
c. Nominal watts and input watts
d. Input voltage and power factor
e. Starting current, line current, and restrike current values
f. Sound rating
g. Temperature rating
h. Efficiency ratings
i. Low temperature characteristics
j. Emergency ballasts rating and capacity data

Photocells; G, RE.

The submittal should include the following:

a. Voltage, and power consumption
b. Capacity
c. Contacts and time delay
d. Operating levels
e. Enclosure type and dimensions
f. Temperature range

1.3 UL COMPLIANCE

Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.4 SPARE PARTS

Furnish, tag, and box for shipment and storage the following spare parts.

(1) One spare ballast of each type.
(2) Two spare lamps of each type.

PART 2 PRODUCTS

2.1 LUMINAIRES

a. Specific requirements relative to execution of the work of this section are located in Luminaire Schedule on th drawings.
b. Feed-through type, or separate junction box.
c. Ballasts: Two-lamp when possible.
d. Tandem wired for three-lamp, fluorescent fixtures.
e. Wire Leads: Minimum 18 AWG.
f. Component Access: Accessible and replaceable without removing luminaire from ceiling.
g. Emergency Lighting:
   (1) Power Pack: Self-contained, 120/277-volt dual voltage transformer, inverter/charger, sealed nickel cadmium battery, and indicator switch in accordance with UL 924.
   (2) Lighted, push-to-test indicator.
   (3) Capable of providing full illumination for 1-1/2 hours in emergency mode.
   (4) Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
   (5) Capable of protecting against excess charging and discharging.

2.2 LAMPS

High Intensity Discharge:

(1) Type: High pressure sodium.
(2) Color: Color corrected.

2.3 BALLASTS

2.3.1 General

a. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
b. Certified by electrical testing laboratory to conform to CBM specifications.

2.3.2 High Pressure Sodium

a. High power factor, normal ambient, 180 degrees C insulation class, with capacitor and ignitor.
b. Type:
(1) Autotransformer for 50-watt lamps.
(2) Constant wattage autotransformer for lamps 70 watts and above.

2.4 LIGHTING CONTROL

a. Photocell:
(1) Automatic ON/OFF switching photo control.
(2) Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
(3) Setting: ON at dusk and OFF at dawn.
(4) Time delay feature to prevent false switching.
(5) Field adjustable to control operating levels.

2.5 EMERGENCY BALLAST

a. In accordance with UL 924.
b. Nickel cadmium battery, charger, and electronic circuitry in metal case.
c. Solid state charging indicator monitoring light and double-pole test switch.
d. Capable of operating two fluorescent lamps for a period of 90 minutes with output of 1,100 to 1,200 lumens.

PART 3 EXECUTION

3.1 LUMINAIRES

3.1.1 General

a. Install in accordance with manufacturer's recommendations.
b. Provide proper hangers, pendants, and canopies as necessary for complete installation and meeting specified seismic requirements.
c. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building required to safely mount.
d. Install plumb and level.
e. Mounting heights shown for pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
f. Install each luminaire outlet box with galvanized stud.

3.1.2 Finished Areas

a. Install symmetrically with tile pattern.
b. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
c. Junction Boxes:
   (1) Flush and Recessed Luminaires: Locate minimum 1-foot from luminaire.
   (2) In concealed locations, install junction boxes to be accessible by removing luminaire.
d. Wiring and Conduit:
   (1) Provide wiring of temperature rating required by luminaire.
   (2) Provide flexible steel conduit.

3.2 LAMPS

Provide in each fixture, number and type for which fixture is designed, unless otherwise noted.

3.3 BALLASTS

a. Install in accordance with manufacturer's recommendations.
b. Utilize all ballast mounting holes to fasten securely within luminaire.
c. Replace noisy or defective ballasts.

3.4 EMERGENCY BALLAST

a. Install battery, charger, and electronic circuitry metal case inside fluorescent fixture housing.
b. Install monitoring light and double-pole switch adjacent to light fixture.
c. Wire in accordance with manufacturer's wiring diagrams.

3.5 CLEANING FOLLOWING CONSTRUCTION

a. Remove labels and markings, except UL listing mark.
b. Wipe luminaires inside and out to remove construction dust.
c. Clean luminaire plastic lenses with antistatic cleaners only.
d. Touch up painted surfaces of luminaires and poles with matching paint ordered from manufacturer.
e. Replace defective lamps at time of Substantial Completion.

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SECTION 16520

EXTERIOR LIGHTING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LTS-3	(1994; R 1998) Structural Supports for Highway Signs, Luminaires and Traffic Signals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
ANSI C136.14	(1988) Roadway Lighting Equipment - Enclosed Side-Mounted Luminaires for Horizontal-Burning High-Intensity-Discharge Lamps
ANSI C136.21	(1987; R 1997) Roadway Lighting - Vertical Tenons Used with Post-Top-Mounted Luminaires

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2000) Zinc Coating (Hot-Dip) on Iron and Steel Hardware - AASHTO No.: M232

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IES LHBK	(1993) Lighting Handbook, Reference and Application

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code (ANSI/IEEE)
IEEE C136.3	(1995) Roadway Lighting Equipment - Luminaire Attachments
IEEE C136.13	(1992; R 1996) Roadway Lighting - Metal Brackets for Wood Poles

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C78.42	(1995) Electric Lamps - Guidelines for High-Pressure Sodium Lamps
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 773	(1995; R 2000) Plug-In, Locking Type Photocontrols for Use with Area Lighting
UL 773A	(1995; R 1999) Nonindustrial Photoelectric Switches for Lighting Control
UL 1029	(1994; R 1997, Bul. 2000) High-Intensity-Discharge Lamp Ballasts
UL 1572	(1995; R 1999, Bul. 2000) High Intensity Discharge Lighting Fixtures

1.2 DEFINITIONS

1.2.1 Average Life

Time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

1.2.2 Groundline Section

That portion between one foot above and 2 feet below the groundline.

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Luminaire drawings; G, RE
Poles; G, RE

SD-03 Product Data

Luminaires; G, RE
Lamps; G, RE
Ballasts; G, RE
Lighting contactor; G, RE

Photocell switch; G, RE
Steel poles; G, RE
Brackets

SD-04 Samples

Luminaires; G, RE

Submit one sample of each luminaire type, complete with lamp and ballast. Sample will be returned to the Contractor for installation in the project work.

SD-06 Test Reports

Test Data for luminaires; G, RE
Operating test

Submit operating test results as stated in paragraph entitled "Field Quality Control."

1.4 QUALITY ASSURANCE

1.4.1 Drawing Requirements

1.4.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data shall accompany shop drawings.

1.4.1.2 Poles

Include dimensions, wind load determined in accordance with AASHTO LTS-3, pole deflection, pole class, and other applicable information.

1.4.2 Test Data for Luminaires

a. Distribution data according to IES classification type as defined in IES LHBK.

b. Computerized horizontal illumination levels in footcandles at ground level, taken every 20 feet. Include average maintained footcandle level and maximum and minimum ratio.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Steel Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

PART 2 PRODUCTS

2.1 LUMINAIRES

ANSI C136.14 or UL 1572. Provide luminaires as indicated. Provide luminaires complete with lamps of number, type, and wattage indicated.

Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution and brightness characteristics, and of equal finish and quality will be acceptable as approved.

2.1.1 Lamps

2.1.1.1 High-Pressure Sodium (HPS) Lamps

NEMA C78.42 Wattage as indicated. HPS lamps shall have average rated life of 16,000 hours (minimum) for 35 watt lamps and 24,000 hours (minimum) for all higher wattage lamps. 150 watt lamps, if required, shall be 55 volt lamps.

2.1.2 Ballasts for High-Intensity-Discharge (HID) Luminaires

UL 1029 and ANSI C82.4, and shall be constant wattage autotransformer (CWA) or regulator, high power-factor type unless otherwise indicated. Provide single-lamp ballasts which shall have a minimum starting temperature of minus 30 degrees C. Ballasts shall be:

a. Designed to operate on voltage system to which they are connected.

b. Constructed so that open circuit operation will not reduce the average life.

HPS ballasts shall have a solid-state igniter/starter with an average life in the pulsing mode of 3500 hours at the intended ambient temperature. Igniter case temperature shall not exceed .

2.2 LIGHTING CONTACTOR

NEMA ICS 2, mechanically held contactor. Contacts shall be rated 480 volts, 30 amperes, and 6 poles. Coils shall be rated 120 volts. Provide in NEMA 4 enclosure conforming to NEMA ICS 6. Contactor shall have silver alloy double-break contacts and coil clearing contacts for mechanically held contactor and shall require no arcing contacts. Provide contactor with hand-off-automatic selector switch. Contactor shall be hermetically sealed.

2.3 PHOTOCELL SWITCH

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 600 volts ac, 60 Hz with single pole double-throw (spdt) contacts for mechanically held contactors rated 1000 watts. Switch shall turn on at or below 3 footcandles and off at 2 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition. Provide switch:

a. in a U.V. stabilized polycarbonate housing with swivel arm and adjustable window slide, rated 1800 VA, minimum.

2.4 POLES

Provide poles designed for wind loading of 70 miles per hour determined in accordance with AASHTO LTS-3 while supporting luminaires having effective projected areas indicated. Poles shall have oval-shaped handhole having a

minimum clear opening of 2.5 by 5 inches. Handhole cover shall be secured by stainless steel captive screws.

2.4.1 Steel Poles

AASHTO LTS-3. Provide steel poles having minimum 11-gage steel with minimum yield/strength of 48,000 psi and hot-dipped galvanized in accordance with ASTM A 123/A 123M iron-oxide primed factory finish. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 36,000 psi.

2.5 BRACKETS AND SUPPORTS

IEEE C136.3, IEEE C136.13, and ANSI C136.21, as applicable. Pole brackets shall be not less than 1-1/4 inch galvanized steel pipe secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 24 feet above street. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with luminaire head.

2.6 POLE FOUNDATIONS

Anchor bolts shall be steel rod having a minimum yield strength of 50,000 psi; the top 12 inches of the rod shall be galvanized in accordance with ASTM A 153/A 153M. Concrete shall be as specified in Section 03410 PRECAST STRUCTURAL CONCRETE.

PART 3 EXECUTION

3.1 INSTALLATION OF POLES

IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 Steel

Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end. Provide galvanized nuts, washers, and ornamental covers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit ells, and ground rods shall be as specified in Section 16450 GROUNDING. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location. After installation, paint exposed surfaces of steel poles with two finish coats of galvanizing patch.

3.1.2 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations. Set adjustable window slide for 1 footcandle photocell turn-on.

3.2 GROUNDING

Ground noncurrent-carrying parts of equipment including metal poles,

luminaires, mounting arms, brackets, and metallic enclosures. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.3 FIELD QUALITY CONTROL

Upon completion of installation, conduct an operating test to show that the equipment operates in accordance with the requirements of this section.

-- End of Section --

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SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

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

LIGHTNING PROTECTION INSTITUTE (LPI)

LPI 175	Installation Standard
LPI 176	Lightning Protection System Material and Component Standard
LPI 177	Inspection Guide for LPI Certified Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 78	Lightning Protection Code

UNDERWRITERS LABORATORIES, INC. (UL)

UL 96	(1994; Rev thru Jan 2000) Lightning Protection Components
UL 96A	(1994; Rev thru July 1998) Installation Requirements for Lightning Protection Systems

1.2 DESIGN REQUIREMENTS

a. Provide lightning protection system design for restroom building.
b. Lightning protection system design to comply with all applicable provisions of LPI 175 and LPI 176, UL 96 and UL 96A, and NFPA 78.

1.3 SUBMITTALS

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

SD-02 Shop Drawings

Lightning protection system layout,G, RE.
Component locations; G, RE.
Detailed plans; G, RE.
Down conductor; G, RE.
Connecting conductor; G, RE.

Bond strap; G, RE.
Air terminals; G, RE.
Fittings; G, RE.
Connectors; G, RE.
Ground rods; G, RE.

Reproducible Mylar Drawings.

SD-06 Test Reports

Field test report; G, RE.

SD-07 Certificates

Ground Witness Certification; G, RE.

Form LPI-175A

Post-Installation Certification; G, RE.

Form LPI-175B

UL 96 Master Label "C" Certification; G

1.4 QUALITY ASSURANCE

1.4.1 Design

Lightning protection system design shall be prepared by a certified master label designer or recognized lightning protection manufacturer.

1.4.2 Manufacturer

All system components shall be the product of a manufacturer regularly engaged in the manufacturing of lightning protection components in accordance with LPI 176 and UL 96.

1.4.3 Installer

Lightning protection system shall be installed under the direct supervision of an LPI 175 Certified Master Installer.

1.4.4 Inspector

Final installation and grounding connection inspection of the System shall be performed by an LPI-certified inspector in accordance with LPI 177.

1.4.5 UL Compliance

Materials manufactured within scope of Underwriters Laboratories, Inc. shall conform to UL Standards and have an applied UL listing mark.

PART 2 PRODUCTS

2.1 GENERAL

a. Complete system shall bear UL 96 Master Label C.
b. System Material: Copper or high copper content, heavy-duty bronze castings, unless otherwise specified.

c. All material shall comply in weight, size, and composition for the class of structure to be protected as established by the LPI 176.

2.2 AIR TERMINAL

a. Material: Solid copper rods, with tapered points.
b. Length: Sufficient to extend minimum 10 inches above object being protected.
c. UL 96 Label B applied to each terminal.

2.3 CONDUCTORS

All main down and connecting conductors shall bear the UL 96 Label A, applied every 10 feet.

2.3.1 Copper Cable

Bare medium hard-drawn stranded, having 97.5 percent minimum conductivity.

2.3.2 Main Down Conductor

Smooth twist stranding.

2.3.3 Connecting Conductor

Concentric stranding.

2.3.4 Bonding Conductor

Flexible strap.

2.4 CABLE FASTENER AND ACCESSORIES

Capable of withstanding minimum pull of 100 pounds.

2.5 FITTINGS

a. Heavy-duty.
b. Bolts, Screws, and Related Hardware: Stainless steel.

2.6 GROUND RODS

Material: Copper.

2.7 GROUNDING CONNECTIONS

a. Welds: Exothermic process.
b. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
c. Hardware: Silicone bronze.

2.8 CABLE CONNECTIONS AND SPLICERS

a. Welds: Exothermic process.
b. Fasteners: Bolted clamp type, corrosion-resistant copper alloy.
c. Through-Roof Connectors: Straight or right angle with bronze and lead seal flashing washer.

2.9 CONDUIT

Schedule 40 PVC, as specified in Section 16110 RACEWAYS.

PART 3 EXECUTION

3.1 GENERAL

a. Workmanship to comply with all applicable provisions of LPI 175 and LPI 176, UL 96 and UL 96A, and NFPA 78.
b. Installation of bare copper materials on aluminum surfaces will not be permitted.
c. Provide pitchpockets and waterproof all roof penetrations.
d. Install system in inconspicuous manner so that components blend with building aesthetics.

3.2 EXAMINATION

Verify conditions prior to installation. Actual conditions may require adjustments in air terminal and ground rod locations.

3.3 AIR TERMINALS

a. Supports: Brackets or braces.
b. Parapet Bracket Attachment: Lag or expansion bolts.
c. Secure base to roof surface with adhesive or pitch compatible with roofing bond.
d. Provide terminal flashing at roof penetrations.
e. Perimeter Terminals:
   (1) Maximum Spacing: 20 feet.
   (2) Maximum Distance From Outside Edge of Building: 2 feet.
f. Roof Ridge Terminals: Maximum spacing 20 feet.
g. Mid-Roof Terminals: Maximum spacing 50 feet.

3.4 CONDUCTORS

a. Conceal whenever practical.
b. Provide 1-inch PVC conduit in building walls or columns for main downleads and roof risers.
c. Support: Maximum spacing for exposed conductors.
   (1) Vertical: 3 feet.
   (2) Horizontal: 4 feet.
d. Maintain horizontal and vertical conductor courses free from dips or pockets.
e. Bends: Maximum 90 degrees, with minimum 8-inch radius.
f. Install air terminal conductors on the structural roof surface before roofing composition is applied.

3.5 BONDING

a. Bond to Main Conductor System:
   (1) All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
   (2) Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.
b. Bond each steel column or major framing members to grounding system.
c. Bond each main down conductor to grounding system.

3.6 GROUNDING SYSTEM

a. Grounding Conductor:
   (1) Completely encircle building structure.
   (2) Bury minimum 1 foot below finished grade.
   (3) Minimum 2 feet distance from foundation walls.
b. Interconnect ground rods by direct-buried copper cables.
c. Maximum Resistance: 3 ohms when connected to ground rods.
d. Connections:
   (1) Install ground cables continuous between connections.
   (2) Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
   (3) Provide bolted clamp type mechanical connectors for all exposed secondary connections.
   (4) Use bolded offset parapet bases or through-roof concealed base assemblies for air terminal connections.
   (5) Provide interconnections with electrical systems and all underground metal pipes.

3.7 FIELD QUALITY CONTROL

a. Isolate lightning protection system from other ground conditions while performing tests.
b. Resistance: Test ground resistance of grounding system by the fall-of-potential method.
   (1) Test Resistance to Ground: Maximum 3 ohms.
   (2) Install additional ground rods as required to obtain maximum allowable resistance.
c. Test Report:
   (1) Description of equipment tested.
   (2) Description of test.
   (3) Test results.
   (4) Conclusions and recommendations.
   (5) Appendix, including appropriate test forms.
   (6) Identification of test equipment used.
   (7) Signature of responsible test organization authority.

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SECTION 16950

ELECTRICAL TESTING

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SECTION 16950

ELECTRICAL TESTING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2	(1997) National Electrical Safety Code
ANSI C37.20.1	Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear
ANSI C62.33	Standard Test Specifications for Varistor Surge-Protective Devices

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 118	Standard Test Code for Resistance Measurement

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 4	Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code
NFPA 70E	Standard for Electrical Safety Requirements for Employee Workplaces

1.2 SUBMITTALS

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

SD-01 Preconstruction Submittals

Schedule for performing inspection and tests
List of references to be used for each test
Sample copy of equipment and materials inspection form(s)
Sample copy of individual device test form
Sample copy of individual system test form

Submit 30 days prior to performing inspections or tests.

SD-06 Test Reports

Test or inspection reports for each electrical item tested

Submit within 30 days after completion of test.

SD-07 Certificates

Certificates for each electrical item tested

Submit within 30 days after completion of testing and acceptance.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual

After test or inspection reports and certificates have been reviewed by Contracting Officer and returned, insert a copy of each in operation and maintenance manual.

1.3 TESTING

1.3.1 Test Firm Qualifications

a. Corporately and financially independent organization functioning as an unbiased testing authority.

b. Professionally independent of manufacturers, suppliers, and installers, of electrical equipment and systems being tested.

c. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.

d. Supervising Engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years testing experience on similar projects.

e. Technicians certified by NICET or NETA.

f. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.

g. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.

h. In compliance with OSHA Title 29, Part 1907 criteria for accreditation

of testing laboratories or a full Member Company of International Electrical Testing Association.

1.3.2 Accuracy

Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

1.3.3 Calibration

Test instrument calibration shall be in accordance with NETA ATS.

1.4 SEQUENCING AND SCHEDULING

a. Perform inspection and electrical tests after equipment has been installed.
b. Perform tests with apparatus de-energized whenever feasible.
c. Inspection and electrical tests on energized equipment are to be:
   (1) Scheduled with the Contracting Officer prior to de-energization.
   (2) Minimized to avoid extended period of interruption to the operating plant equipment.
d. Notify Contracting Officer at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 GENERAL

a. Tests specified in this section are to be performed and verified by the on-site CQC Manager or representative.
b. Tests and inspection shall establish that:
   (1) Electrical equipment is operational within industry and manufacturer's tolerances.
   (2) Installation operates properly.
   (3) Equipment is suitable for energization.
   (4) Installation conforms to requirements of these specifications and NFPA 70, NFPA 70E, and ANSI C2.
c. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
d. Set, test and calibrate circuit breakers, fuses and other applicable devices in accordance with values established by the short circuit and coordination study as specified in Section 16015 ELECTRICAL SYSTEMS ANALYSIS.
e. Adjust mechanisms and moving parts for free mechanical movement.
f. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
g. Verify nameplate data for conformance to Contract Documents.
h. Realign equipment not properly aligned and correct unlevelness.
i. Properly anchor electrical equipment found to be inadequately anchored.
j. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.
k. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
l. Provide proper lubrication of applicable moving parts.
m. Inform Contracting Officer of working clearances not in accordance with NFPA 70.

n. Investigate and repair or replace:
   (1) Electrical items that fail tests.
   (2) Active components not operating in accordance with manufacturer's instructions.
   (3) Damaged electrical equipment.
o. Electrical enclosures:
   (1) Remove foreign material and moisture from enclosure interior.
   (2) Vacuum and wipe clean enclosure interior.
   (3) Remove corrosion found on metal surfaces.
   (4) Repair or replace, as determined by Contracting Officer, door and panel sections having dented surfaces.
   (5) Repair or replace, as determined by Contracting Officer, poor fitting doors and panel sections.
   (6) Repair or replace improperly operating latching, locking, or interlocking devices.
   (7) Replace missing or damaged hardware.
   (8) Finish:
      a) Provide matching paint and touch up scratches and mars.
      b) If required due to extensive damage, as determined by Contracting Officer, refinish the entire assembly.
p. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

3.2 SWITCHBOARD ASSEMBLIES

3.2.1 Visual and Mechanical Inspection

a. Insulator damage and contaminated surfaces.
b. Proper barrier and shutter installation and operation.
c. Proper operation of indicating devices.
d. Improper blockage of air cooling passages.
e. Proper operation of drawout elements.
f. Integrity and contamination of bus insulation system.
g. Check Door and Device Interlocking System By:
   (1) Closure attempt of device when door is in OFF or OPEN position.
   (2) Opening attempt of door when device is in ON or CLOSED position.
h. Check Nameplates for Proper Identification of:
   (1) Equipment title and tag number with latest one-line diagram.
   (2) Pushbutton.
   (3) Control switch.
   (4) Pilot light.
   (5) Control relay.
   (6) Circuit breaker.
   (7) Indicating meter.
i. Verify that fuse and circuit breaker ratings, sizes, and types conform to those specified.
j. Check bus and cable connections for high resistance by low resistance ohmmeter applied to bolted joints.

   Ohmic value to be zero.

k. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems By:
   (1) Closure attempt for locked open devices.
   (2) Opening attempt for locked closed devices.
   (3) Key exchange to operate devices in OFF-NORMAL positions.
l. Verify performance of each control device and feature.
m. Control Wiring:
   (1) Compare wiring to local and remote control and protective devices

with elementary diagrams.
(2) Proper conductor lacing and bundling.
(3) Proper conductor identification.
(4) Proper conductor logs and connections.

n. Exercise active components.
o. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

3.2.2 Electrical Tests

a. Insulation resistance tests:
(1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.1.1.
(2) Each phase of each bus section.
(3) Phase-to-phase and phase-to-ground for 1 minute.
(4) With switches and breakers open.
(5) With switches and breakers closed.
(6) Control wiring except that connected to solid state components.
(7) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

b. Overpotential tests:
(1) Applied ac or dc voltage and test procedure in accordance with ANSI C37.20.1.
(2) Each phase of each bus section.
(3) Phase-to-phase and phase-to-ground for 1 minute.
(4) Test results evaluated on a pass/fail basis.

c. Current injection tests:
(1) For entire current circuit in each section.
(2) Secondary injection for current flow of 1 ampere.
(3) Test current at each device.

d. Control wiring:
(1) Apply secondary voltage to control power and potential circuits.
(2) Check voltage levels at each point on terminal boards and each device terminal.

e. Operational test:
(1) Initiate control devices.
(2) Check proper operation of control system in each section.

3.3 DRY TYPE TRANSFORMERS

3.3.1 Visual and Mechanical Inspection

a. Physical and insulator damage.
b. Proper winding connections.
c. Bolt torque level in accordance with NETA ATS, Table 10.12, unless otherwise specified by manufacturer.
d. Defective wiring.
e. Proper operation of fans, indicators, and auxiliary devices.
f. Removal of shipping brackets, fixtures, or bracing.
g. Free and properly installed resilient mounts.
h. Cleanliness and improper blockage of ventilation passages.
i. Verify that tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
j. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

3.3.2 Electrical Tests

a. Insulation resistance tests:

(1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.5 for each:
a) Winding-to-winding.
b) Winding-to-ground.
(2) 10-minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
(3) Results temperature corrected in accordance with NETA ATS, Table 10.14.
(4) Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
(5) Insulation resistance test results to compare within 1 percent of adjacent windings.

b. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.4 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

3.4.1 Visual and Mechanical Inspection

a. Inspect each individual exposed power cable no. 6 and larger for:
(1) Physical damage.
(2) Proper connections in accordance with single-line diagram.
(3) Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
(4) Color coding conformance with specifications.
(5) Proper circuit identification.

b. Mechanical connections for:
(1) Proper lug type for conductor material.
(2) Proper lug installation.
(3) Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

c. Shielded instrumentation cables for:
(1) Proper shield grounding.
(2) Proper terminations.
(3) Proper circuit identification.

d. Control cables for:
(1) Proper termination.
(2) Proper circuit identification.

e. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

3.4.2 Electrical Tests for Conductors No. 6 and Larger

a. Insulation resistance tests:
(1) Utilize 1,000-volt dc megohmmeter for 600 volt insulated conductors.
(2) Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
(3) Evaluate ohmic values by comparison with conductors of same length and type.
(4) Investigate values less than 50 megohms.

b. Continuity test by ohmmeter method to ensure proper cable connections.

3.5 SAFETY SWITCHES, 600 VOLTS MAXIMUM

3.5.1 Visual and Mechanical Inspection

a. Proper blade pressure and alignment.
b. Proper operation of switch operating handle.
c. Adequate mechanical support for each fuse.

d. Proper contact-to-contact tightness between fuse clip and fuse.
e. Cable connection bolt torque level in accordance with NETA ATS, Table 10.12.
f. Proper phase barrier material and installation.
g. Verify that fuse sizes and types correspond to one-line diagram.
h. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

3.5.2 Electrical Tests

a. Insulation resistance tests:
   (1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.1.
   (2) Phase-to-phase and phase-to-ground for 1 minute on each pole.
   (3) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
b. Contact resistance tests:
   (1) Contact resistance in microhms across each switch blade and fuse holder.
   (2) Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.6 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

3.6.1 General

Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 100 amperes and larger.

3.6.2 Visual and Mechanical Inspection

a. Proper mounting.
b. Proper conductor size.
c. Feeder designation according to nameplate and one-line diagram.
d. Cracked casings.
e. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
f. Operate breaker to verify smooth operation.
g. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
h. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

3.6.3 Electrical Tests

a. Insulation resistance tests:
   (1) Utilize 1,000-volt dc megohmmeter for 480 and 600 volt circuit breakers and 500 volt dc megohmmeter for 240 volt circuit breakers.
   (2) Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   (3) Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   (4) Test values to comply with NETA ATS, Table 10.7.
b. Contact resistance tests:
   (1) Contact resistance in microhms across each pole.
   (2) Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
c. Primary current injection test to verify:
   (1) Long-time minimum pickup and delay.
   (2) Short-time pickup and delay.

(3) Ground fault pickup and delay.
(4) Instantaneous pickup by run-up or pulse method.
(5) Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
(6) Trip times shall be within limits established by NEMA AB 4, Table 5-3.
(7) Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4.

3.7 LOW VOLTAGE POWER CIRCUIT BREAKERS

3.7.1 Visual and Mechanical Inspection

a. Proper mounting, cell fit, and element alignment.
b. Proper operation of racking interlocks.
c. Check for damaged arc chutes.
d. Proper contact condition.
e. Bolt torque level in accordance with NETA ATS, Table 10.12.
f. Perform mechanical operational and contact alignment tests in accordance with manufacturer's instructions.
g. Check operation of closing and tripping functions of trip devices by activating ground fault relays, undervoltage shunt relays, and other auxiliary protective devices.
h. Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operation are correct.
i. Check charging motor, motor brushes, associated mechanism, and limit switches for proper operation and condition.
j. Check operation of electrically operated breakers in accordance with manufacturer's instructions.
k. Check for adequate lubrication on contact, moving, and sliding surfaces.

3.7.2 Electrical Tests

a. Insulation resistance tests:
(1) Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers.
(2) Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
(3) Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
(4) Test values to comply with NETA ATS, Table 10.7 and 10.8.
b. Contact resistance tests:
(1) Contact resistance in microhms across each pole.
(2) Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
c. Primary current injection test to verify:
(1) Long-time minimum pickup and delay.
(2) Short-time pickup and delay.
(3) Ground fault pickup and delay.
(4) Instantaneous pickup by run-up or pulse method.
(5) Trip characteristic when adjusted to setting sheet parameters shall be within manufacturer's published time-current tolerance band.

3.8 PROTECTIVE RELAYS

3.8.1 Visual and Mechanical Inspection

a. Visually check each relay for:

(1) Tight cover gasket and proper seal.
(2) Unbroken cover glass.
(3) Condition of spiral spring and contacts.
(4) Disc clearance.
(5) Condition of case shorting contacts if present.

b. Mechanically check each relay for:
(1) Freedom of movement.
(2) Proper travel and alignment.

c. Verify that each relay:
(1) Complies with Contract Documents and application.
(2) Is set in accordance with recommended settings.

3.8.2 Electrical Tests

a. Insulation resistance test on each circuit to frame except for solid state devices.

b. Tests on Nominal Recommended Setting For:
(1) Pickup parameters on each operating element.
(2) Timing at three points on time-current curve.
(3) Pickup target and seal-in units.
(4) Special tests as required to check operation of restraint, directional, and other elements in accordance with manufacturer's instruction manual.

c. Phase angle and magnitude contribution tests on differential and directional relays after energization to vectorially verify proper polarity and connections.

d. Current injection tests:
(1) For entire current circuit in each section.
(2) Secondary injection for current flow of 1 ampere.
(3) Test current at each device.

3.9 INSTRUMENT TRANSFORMERS

3.9.1 Visual and Mechanical Inspection

a. Visually check current, potential, and control transformers for:
(1) Cracked insulation.
(2) Broken leads or defective wiring.
(3) Proper connections.
(4) Adequate clearances between primary and secondary circuit wiring.

b. Verify mechanically that:
(1) Grounding and shorting connections have good contact.
(2) Withdrawal mechanism and grounding operation, when applicable, operate properly.

c. Verify proper primary and secondary fuse sizes for potential transformers.

3.9.2 Electrical Tests

a. Current transformer tests:
(1) Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
(2) Polarity test.

b. Potential transformer tests:
(1) Insulation resistance test at test voltages in accordance with NETA ATS, Table 10.9 for 1 minute on:
a) Winding-to-winding.
b) Winding-to-ground.
(2) Polarity test to verify polarity marks or H1-X1 relationship as

applicable.

c. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 10.9.

3.10 METERING

Visual and mechanical inspection:

(1) Verify meter connections in accordance with appropriate diagrams.
(2) Verify meter multipliers.
(3) Verify that meter types and scales conform to Contract Documents.
(4) Check calibration of meters at cardinal points.
(5) Check calibration of electrical transducers.

3.11 GROUNDING SYSTEMS

3.11.1 Visual and Mechanical Inspection

a. Equipment and circuit grounds in motor control center, panelboard, and switchboard, assemblies for proper connection and tightness.
b. Ground bus connections in motor control center, panelboard, and switchboard, assemblies for proper termination and tightness.
c. Effective transformer core and equipment grounding.
d. Accessible connections to grounding electrodes for proper fit and tightness.
e. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

3.11.2 Electrical Tests

a. Fall-of-potential test:
   (1) In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
   (2) Main ground electrode system resistance to ground to be no greater than 5 ohms.
b. Two-point direct method test:
   (1) In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   (2) Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3.12 GROUND FAULT SYSTEMS

3.12.1 Inspection and Testing

Inspection and testing limited to:

(1) Zero sequence grounding systems.
(2) Residual ground fault systems.

3.12.2 Visual and Manual Inspection

a. Neutral main bonding connection to assure:
   (1) Zero sequence sensing system is grounded ahead of neutral disconnect link.
   (2) Ground strap sensing system is grounded through sensing device.
   (3) Neutral ground conductor is solidly grounded.
b. Verify that control power has adequate capacity for system.
c. Manually Operate Monitor Panels For:
   (1) Trip test.

(2) No trip test.
(3) Nonautomatic rest.

d. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.
e. Relay check for pickup and time under simulated ground fault conditions.
f. Verify nameplate identification by device operation.

3.12.3 Electrical Tests

a. Test system neutral insulation resistance with neutral ground link removed. System neutral insulation resistance minimum 1 megohm.
b. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.
c. Test relay timing by injecting 300 percent of pickup current, or as specified by manufacturer. Relay operating time in accordance with manufacturer's time-current characteristic curves.
d. Test system operation at 55 percent rated control voltage, if applicable.
e. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.13 AC INDUCTION MOTORS

3.13.1 General

Inspection and testing limited to motors rated 5 hp and larger.

3.13.2 Visual and Mechanical Inspection

a. Proper electrical and grounding connections.
b. Shaft alignment.
c. Blockage of ventilating air passageways.
d. Operate Motor and Check For:
(1) Excessive mechanical and electrical noise.
(2) Overheating.
(3) Correct rotation.
(4) Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
5. Excessive vibration.

e. Check operation of space heaters.

3.13.3 Electrical Tests

a. Insulation resistance tests:
(1) In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.1 for:
a) Motors above 200 hp for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
b) Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
(2) Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.

b. Calculate polarization index ratios for motors above 200 hp. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
c. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
d. Measure running current and voltage, and evaluate relative to load

conditions and nameplate full-load amperes.

3.14 LOW VOLTAGE MOTOR CONTROL

3.14.1 Visual and Mechanical Inspection

a. Proper barrier and shutter installation and operation.
b. Proper operation of indicating and monitoring devices.
c. Proper overload protection for each motor.
d. Improper blockage of air cooling passages.
e. Proper operation of drawout elements.
f. Integrity and contamination of bus insulation system.
g. Check Door and Device Interlocking System By:
   (1) Closure attempt of device when door is in OFF or OPEN position.
   (2) Opening attempt of door when device is in ON or CLOSED position.
h. Check nameplates for proper identification of:
   (1) Equipment title and tag number with latest one-line diagram.
   (2) Pushbuttons.
   (3) Control switches.
   (4) Pilot lights.
   (5) Control relays.
   (6) Circuit breakers.
   (7) Indicating meters.
i. Verify that fuse and circuit breaker sizes and types conform to Contract Documents.
j. Verify that current and potential transformer ratios conform to Contract Documents.
k. Check Bus Connections for High Resistance by Low Resistance Ohmmeter.

   Ohmic value to be zero.

l. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems By:
   (1) Closure attempt for locked open devices.
   (2) Opening attempt for locked closed devices.
m. Verify performance of each control device and feature furnished as part of the motor control center.
n. Control Wiring:
   (1) Compare wiring to local and remote control, and protective devices with elementary diagrams.
   (2) Check for proper conductor lacing and bundling.
   (3) Check for proper conductor identification.
   (4) Check for proper conductor lugs and connections.
o. Exercise active components.
p. Inspect Contactors For:
   (1) Correct mechanical operations.
   (2) Correct contact gap, wipe, alignment, and pressure.
   (3) Correct torque of all connections.
q. Compare overload heater rating with full-load current for proper size.
r. Compare fuse motor protector and circuit breaker with motor characteristics and power factor correction capacitors for proper size.
s. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

3.14.2 Electrical Tests

a. Insulation resistance tests:
   (1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.1.

(2) Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
(3) Contactor phase-to-ground and across open contacts for 1 minute on each phase.
(4) Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
(5) Test values to comply with NETA ATS, Table 10.1.

b. Overpotential tests:
(1) Maximum applied ac or dc voltage in accordance with NETA ATS, Table 10.1.
(2) Phase-to-phase and phase-to-ground for 1 minute for each phase of each bus section.
(3) Test results evaluated on pass/fail basis.

c. Current injection through overload unit at 300 percent of motor full-load current and monitor trip time:
(1) Trip time in accordance with manufacturer's published data.
(2) Investigate values in excess of 120 seconds.

d. Control wiring tests:
(1) Apply secondary voltage to control power and potential circuits.
(2) Check voltage levels at each point on terminal boards and each device terminal.
(3) Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.

Insulation resistance to be 1 megohm minimum.

e. Operational test by initiating control devices to affect proper operation.

3.15 LOW VOLTAGE SURGE ARRESTORS

3.15.1 Visual and Mechanical Inspection

a. Adequate clearances between arrestors and enclosures.
b. Ground connections to ground electrode.

3.15.2 Electrical Tests

Varistor type arrestors:
(1) Clamping voltage test.
(2) Rated RMS voltage test.
(3) Rated dc voltage test.
(4) Varistor arrestor test values in accordance with ANSI C62.33, Sections 4.4 and 4.7.

-- End of Section --