

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT				1. CONTRACT ID CODE	PAGE OF PAGES	
2. AMENDMENT/MODIFICATION NO. 0003		3. EFFECTIVE DATE 04-May-2004	4. REQUISITION/PURCHASE REQ. NO.		5. PROJECT NO.(If applicable)	
6. ISSUED BY USA ENGINEER DISTRICT, SEATTLE ATTN: CENWS-CT 4735 EAST MARGINAL WAY SOUTH SEATTLE WA 98134-2329		CODE W912DW	7. ADMINISTERED BY (If other than item 6) <b>See Item 6</b>		CODE	
8. NAME AND ADDRESS OF CONTRACTOR (No., Street, County, State and Zip Code)				X	9A. AMENDMENT OF SOLICITATION NO. W912DW-04-R-0017	
				X	9B. DATED (SEE ITEM 11) 06-Apr-2004	
					10A. MOD. OF CONTRACT/ORDER NO.	
					10B. DATED (SEE ITEM 13)	
CODE		FACILITY CODE		11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS		
<input checked="" type="checkbox"/> The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offer <input checked="" type="checkbox"/> is extended, <input type="checkbox"/> is not extended.						
Offer 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 <u>0</u> 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 <input type="checkbox"/> is not, <input type="checkbox"/> 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.) Central Heat Plant Low Emissions Tech., Malmstrom AFB MN -- see continuation.						
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)		
				TEL: _____ EMAIL: _____		
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 04-May-2004	

## SECTION SF 30 BLOCK 14 CONTINUATION PAGE

**The following items are applicable to this modification:**CONTINUATION

## A. The purposes of this amendment are as follows:

1. To extend the due date for receipt of proposals  
**FROM:** 2:00 PM Pacific Time on 6 May 2004  
**TO:** 2:00 PM Pacific Time on 7 May 2004;
2. To revise the cover page for the Davis-Bacon General Wage Decision;
3. To provide a revised Section 00800;
4. To provide a revised Section 01110, revising paragraph 1.1.1-6;
5. To provide a revised Section 15555A, revising paragraphs 2.1-a, 2.1.1, 2.2.1.2, 2.2.1.3, 2.2.2.1, 2.2.2.2, 2.3.5, 2.8.1, 3.3.1, 3.3.1.2, 3.3.2, and 3.4.1;
6. To provide a revised Section 16120A, deleting paragraph 2.3.1;
7. To provide a revised Section 16403A, deleting Part 3-B;
8. To provide a revised Section 16415A, deleting paragraph 3.14.2;
9. To provide a revised G1.1 Flow Diagram that was inadvertently left off Amendment 0002 to this solicitation;
10. To add Reference Drawing "Main Induced Draft Fan."

B. The attached revised pages supersede and replace the corresponding pages. The attached revised specification sections supersede and replace the corresponding specification sections. Specification changes are generally identified, for convenience, by strikeout for deletions, and underlining of text for additions. All portions of the revised or new pages shall apply whether or not changes have been indicated.

C. **NOTICE TO OFFERORS:** Offerors must acknowledge receipt of this amendment by number and date on Standard Form 1442, BACK, Block 19, or by telegram.

D. All amendments are available for download this date on the Army Corps of Engineers website at <http://www.nws.usace.army.mil/ct/>.

## Enclosure:

Revised Cover Page for Davis-Bacon Wage Decision  
Revised Section 00800  
Revised Section 01110  
Revised Section 15555A

Revised Section 16120A  
Revised Section 16403A  
Section 16415A  
Revised Drawing G1.1 Flow Diagram  
New Drawing "Main Induced Draft Fan"

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**DAVIS-BACON GENERAL WAGE DECISIONS:**

**1. MT20030005 (Building)**

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## SPECIAL CLAUSES

## SC-1 COMMENCEMENT, PROSECUTION AND COMPLETION OF WORK

The Contractor shall be required to

- (a) commence work under this contract within five [5] 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 dates specified on the Heat Plant Schedule below (see Table 1). The time stated for completion shall include final cleanup of the premises.

Table 1: HEAT PLANT SCHEDULE

	ITEM	REMARK	DATE
1	1 <sup>st</sup> coal generator available for work (Generator #3)	Gas operation on remaining 2 generators and Bailey System operational	04/15/04
2	2 <sup>nd</sup> coal generator available for work (Generator #1)	1 generator, operation on gas only Bailey System operational	05/01/04
3	Ash system available		04/15/04
4	Plant summer shutdown	All systems available for work	Actual system operation verification during the heat plant season (1 Nov to 30 Dec)
5	Plant restart gas generator (Generator #2)	1 gas generator Bailey System operational	09/15/04 (Note 1 & 2)
6	1 <sup>st</sup> coal/gas generator available for heating	Gas and/or coal operation All systems operational	11/01/04 (Note 1 & 2)
7	2 <sup>nd</sup> coal/gas generator available for heating	All systems operational	11/01/04 (Note 1 & 2)
8	Load Simulator		Start anytime except for water tie-ins

Notes: (1) All work shall be completed within two construction seasons prior to 11/15/05. The contractor shall ensure the heat plant is operational by 11/01/04. Contractor shall resume construction impacting heat plant operations on 05/31/05. Continued construction during winter heating season is authorized provided plant heating is not impacted. If note (1) is not complied with, note (2) applies.

(2) See Section 01110 – 1.3.

The completion date is based on the assumption that the successful offeror will receive the notice to proceed no later than 31 May 2004.

## SC-1.1 OPTION FOR INCREASED QUANTITY

a. The Government may increase the quantity of work awarded by exercising one or more of the Optional Bid Items 0008 and 0009 at any time, or not at all, but no later than sixty [60] calendar days after receipt by Contractor of notice to proceed. Notice to proceed on work Item(s) added by exercise of the option(s) will be given upon execution of consent of surety.

b. The parties hereto further agree that any option herein shall be considered to have been exercised at the time the Government deposits written notification to the Contractor in the mails.

c. The time allowed for completion of any optional items awarded under this contract will be the same as that for the base item(s), and will be measured from the date of receipt of the notice to proceed for the base item(s).

#### SC-1.2 EXCEPTION TO COMPLETION PERIOD

In case the Contracting Officer determines that completion of the project is not feasible within the completion period(s) stated above, the Contractor shall be responsible for providing means to temporarily heat all the buildings served by the Central Heat Plant CHP (see Section 01110 – 1.3 Table 1) and accomplish such work in the first plant shut down period following the contract completion period and shall complete such work as specified, unless other plant shut down periods are directed or approved by the Contracting Officer.

#### SC-2. LIQUIDATED DAMAGES - CONSTRUCTION (SEP 2000) (FAR 52.211-12)

(a) If the Contractor fails to complete the work within the time specified in SC – 1.c, or any extension, the Contractor shall pay to the Government as liquidated damages, the sum of \$983 for each day of delay until the work is completed or accepted.

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

SC-3. TIME EXTENSIONS (Sept 2000) (FAR 52.211-13): Time extensions for contract changes will depend upon the extent, if any, by which the changes cause delay in the completion of the various elements of construction. The change order granting the time extension may provide that the Contract completion date will be extended only for those specific elements related to the changed work and that the remaining contract completion dates for all other portions of the work will not be altered. The change order also may provide an equitable readjustment of liquidated damages under the new completion schedule.

#### SC-5. INSURANCE - WORK ON A GOVERNMENT INSTALLATION (JAN 1997) (FAR 52.228-5)

(a) The Contractor shall, at its own expense, provide and maintain during the entire performance period of this Contract at least the kinds and minimum amounts of insurance required in the Insurance Liability Schedule or elsewhere in the Contract.

(b) Before commencing work under this Contract, the Contractor shall certify to the Contracting Officer in writing that the required insurance has been obtained. The policies evidencing required

insurance shall contain an endorsement to the effect that any cancellation or any material change adversely affecting the Government's interest shall not be effective:

(1) for such period as the laws of the State in which this Contract is to be performed prescribe;  
or

(2) until 30 days after the insurer or the Contractor gives written notice to the Contracting Officer, whichever period is longer.

(c) The Contractor shall insert the substance of this clause, including this paragraph (c), in subcontracts under this Contract that require work on a Government installation and shall require subcontractors to provide and maintain the insurance required in the Schedule or elsewhere in the Contract. The Contractor shall maintain a copy of all subcontractors' proofs of required insurance, and shall make copies available to the Contracting Officer upon request.

#### SC-5.1 REQUIRED INSURANCE IN ACCORDANCE WITH FAR 28.307-2:

(1) Workers' compensation and employer's liability. Contractors are required to comply with applicable Federal and State workers' compensation and occupational disease statutes. If occupational diseases are not compensable under those statutes, they shall be covered under the employer's liability section of the insurance policy, except when Contract operations are so commingled with a Contractor's commercial operation that it would not be practical to require this coverage. Employer's liability coverage of at least \$100,000 shall be required, except in states with exclusive or monopolistic funds that do not permit workers' compensation to be written by private carriers.

(2) General Liability.

(a) The Contracting Officer shall require bodily injury liability insurance coverage written on the comprehensive form of policy of at least \$500,000 per occurrence.

(b) Property damage liability insurance shall be required only in special circumstances as determined by the agency.

(3) Automobile liability. The Contracting Officer shall require automobile liability insurance written on the comprehensive form of policy. The policy shall provide for bodily injury and property damage liability covering the operation of all automobiles used in connection with performing the Contract. Policies covering automobiles operated in the United States shall provide coverage of at least \$200,000 per person and \$500,000 per occurrence for bodily injury and \$20,000 per occurrence for property damage. The amount of liability coverage on other policies shall be commensurate with any legal requirements of the locality and sufficient to meet normal and customary claims.

(4) Aircraft public and passenger liability. When aircraft are used in connection with performing the Contract, the Contracting Officer shall require aircraft public and passenger liability insurance. Coverage shall be at least \$200,000 per person and \$500,000 per occurrence for bodily injury, other than passenger liability, and \$200,000 per occurrence for property damage. Coverage for passenger liability bodily injury shall be at least \$200,000 multiplied by the number of seats or passengers, whichever is greater.

(5) Vessel liability. When Contract performance involves use of vessels, the Contracting Officer shall require, as determined by the agency, vessel collision liability and protection and indemnity liability insurance.

(6) Environmental Liability If this contract includes the transport, treatment, storage, or disposal of hazardous material waste the following coverage is required.

The Contractor shall ensure the transporter and disposal facility have liability insurance in effect for claims arising out of the death or bodily injury and property damage from hazardous material/waste transport, treatment, storage and disposal, including vehicle liability and legal defense costs in the amount of \$1,000,000.00 as evidenced by a certificate of insurance for General, Automobile, and Environmental Liability Coverage. Proof of this insurance shall be provided to the Contracting Officer.

SC-7. PERFORMANCE OF WORK BY THE CONTRACTOR (APR 1984) (FAR 52.236-1): The Contractor shall perform on the site, and with its own organization, work equivalent to at least twenty five percent (25%) of the total amount of work to be performed under the Contract. The percentage may be reduced by a supplemental agreement to this Contract if, during performing the work, the Contractor requests a reduction and the Contracting Officer determines that the reduction would be to the advantage of the Government.

SC-8. PHYSICAL DATA (APR 1984) (FAR 52.236-4): Data and information furnished or referred to below is for the Contractor's information. The Government will not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.

(a) Physical Conditions: The indications of physical conditions on the drawings and in the specifications are the result of site investigations by test holes shown on the drawings.

(b) Weather Conditions: Each bidder shall be satisfied before submitting his bid as to the hazards likely to arise from weather conditions. Complete weather records and reports may be obtained from any National Weather Service Office.

(c) Transportation Facilities: Each bidder, before submitting his bid, shall make an investigation of the conditions of existing public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress at the jobsite. The unavailability of transportation facilities or limitations thereon shall not become a basis for claims for damages or extension of time for completion of the work.

(d) Right-of-Way: The right-of-way for the work covered by these specifications will be furnished by the Government, except that the Contractor shall provide right-of-way for ingress and egress across private property where necessary to gain access to the jobsite. The Contractor may use such portions of the land within the right-of-way not otherwise occupied as may be designated by the Contracting Officer. The Contractor shall, without expense to the Government, and at any time during the progress of the work when space is needed within the right-of-way for any other purposes, promptly vacate and clean up any part of the grounds that have been allotted to, or have been in use by, him when directed to do so by the Contracting Officer. The Contractor shall keep the buildings and grounds in use by him at the site of the work in an orderly and sanitary condition. Should the Contractor require additional working space or lands for material yards, job offices, or other purposes, he shall obtain such additional lands or easements at his expense.

SC-10. LAYOUT OF WORK (APR 1984) (FAR 52.236-17): The Contractor shall lay out its work from Government-established base lines and bench marks indicated on the drawings, and shall be responsible for all measurements in connection with the layout. The Contractor shall furnish, at its own expense, all stakes, templates, platforms, equipment, tools, materials, and labor required to lay out any

part of the work. The Contractor shall be responsible for executing the work to the lines and grades that may be established or indicated by the Contracting Officer. The Contractor shall also be responsible for maintaining and preserving all stakes and other marks established by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through its negligence before their removal is authorized, the Contracting Officer may replace them and deduct the expense of the replacement from any amounts due, or to become due, to the Contractor.

SC-11. RESERVED

SC-12. AIRFIELD SAFETY PRECAUTIONS

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

(1) "Landing Areas" means:

(i) the primary surfaces which are comprised of the surface of the runways, the runway shoulders, and the lateral safety zones (the length of each primary surface is the same as the runway length; the width of each primary surface is 610 meters (2,000 feet), 305 meters (1,000 feet) on each side of the runway centerline; (see footnote at end of clause)).

(ii) the "clear zone" beyond the ends of each runway, i.e., the extension of the "primary surface" for a distance of 305 meters (1,000 feet) beyond each end of each runway;

(iii) all taxiways plus the lateral clearance zones along each side for the length of the taxiways (the outer edge of each lateral clearance zone is laterally 76 meters (250 feet) from the far or opposite edge of the taxiway, i.e., a 23 meters (75-foot)-wide taxiway would have a combined width of taxiway and lateral clearance zones of 130 meters (425 feet); and

(iv) all aircraft parking aprons plus the area 38 meters (125 feet) in width extending beyond each edge all around the aprons.

(2) "Safety precaution areas" means those portions of approach-departure clearance zones and transitional zones where placement of objects incident to Contract performance might result in vertical projections at or above the approach-departure clearance surface or the transitional surface.

(i) The "approach-departure clearance surface" is an extension of the primary surface and the clear zone at each end of each runway, for a distance of 15,240 meters (50,000 feet), first along an inclined (glide angle) and then along a horizontal plane, both flaring symmetrically about the runway centerline extended.

(a) The inclined plane (glide angle) begins in the clear zone 61 meters (200 feet) past the end of the runway (and primary surface) at the same elevation as the end of the runway, and continues upward at a slope of 50:1 (.3048 meter (one foot) vertically for each 15.24 meters (50 feet) horizontally) to an elevation of 152 meters (500 feet) above the established airfield elevation; at that point the plane becomes horizontal, continuing at that same uniform elevation to a point 15,240 meters (50,000 feet) longitudinally from the beginning of the inclined plane (glide angle) and ending there.

(b) The width of the surface at the beginning of the inclined plane (glide angle) is the same as the width of the clear zone; thence it flares uniformly, reaching the maximum width of 4,877 meters (16,000 feet) at the end.

(ii) The "approach-departure clearance zone" is the ground area under the approach-departure clearance surface.

(iii) The "transitional surface" is a sideways extension of all primary surfaces, clear zones, and approach-departure clearance surfaces along inclined planes.

(a) The inclined plane in each case begins at the edge of the surface.

(b) The slope of the inclined plane is 7:1 (.3048 meter (one foot) vertically for each 2.13 meters (7 feet) horizontally), and it continues to the point of intersection with

(1) Inner horizontal surface (which is the horizontal plane 46 meters (150 feet) above the established airfield elevation) or

(2) Outer horizontal surface (which is the horizontal plane 152 meters (500 feet) above the established airfield elevation), whichever is applicable.

(iv) The "transitional zone" is the ground area under the transitional surface. (It adjoins the primary surface, clear zone and approach-departure clearance zone.)

(b) General

(1) The Contractor shall comply with the requirements of this clause while

(i) Operating all ground equipment (mobile or station art);

(ii) Placing all materials; and

(iii) Performing all work, upon and around all airfields.

(a) The requirements of this clause are in addition to any other safety requirements of this contract.

(c) The Contractor shall--

(1) Report to the Contracting Officer before initiating any work;

(2) Notify the Contracting Officer of proposed changes to locations and operations;

(3) Not permit either its equipment or personnel to use any runway for purposes other than aircraft operation without permission of the Contracting Officer, unless the runway is--

(i) Closed by order of the Contracting Officer, and

(ii) Marked as provided in paragraph (d)(2) of this clause;

(4) Keep all paved surfaces such as runways, taxiways, and hardstands, clean at all times and, specifically, free from small stones which might damage aircraft propellers or jet aircraft;

(5) Operate mobile equipment according to the safety provisions of this clause, while actually performing work on the airfield. At all other times, the Contractor shall remove all mobile equipment to locations--

(i) Approved by the Contracting Officer,

(ii) At a distance of at least 229 meters (750 feet) from the runway centerline, plus any additional distance; and

(iii) Necessary to ensure compliance with the other provisions of this clause; and

(6) Not open a trench unless material is on hand and ready for placing in the trench. As soon as practicable after material has been placed and work approved, the Contractor shall backfill and compact trenches as required by the contract. Meanwhile, all hazardous conditions shall be marked and lighted in accordance with the other provisions of this clause.

(e) Landing Areas

The Contractor shall--

(1) Place nothing upon the landing areas without the authorization of the Contracting Officer.

(2) Outline those landing areas hazardous to aircraft, using (unless otherwise authorized by the Contracting Officer) red flags by day, and electric, battery-operated low-intensity red flasher lights by night;

(3) Obtain, at an airfield where flying is controlled, additional permission from the control tower operator every time before entering any landing area, unless the landing area is marked as hazardous in accordance with paragraph (d)(2) of this clause;

(4) Identify all vehicles it operates in landing areas by means of a flag on a staff attached to, and flying above, the vehicle. The flag shall be .9144 meters (3 feet) square, and consist of a checkered pattern of international orange and white squares of .3048 meter (1 foot) on each side (except that the flag may vary up to 10 percent from each of these dimensions);

(5) Mark all other equipment and materials in the landing areas, using the same marking devices as in paragraph (d)(2) of this clause; and

(6) Perform work so as to leave that portion of the landing area which is available to aircraft free from hazards, holes, piles of material, and projecting shoulders that might damage an airplane tire.

(e) Safety Precaution Areas

The Contractor shall--

(1) Place nothing upon the safety precaution areas without authorization of the Contracting Officer;

(2) Mark all equipment and materials in safety precaution areas, using (unless otherwise authorized by the Contracting Officer) red flags by day, and electric, battery-operated, low-intensity red flasher lights by night; and

(3) Provide all objects placed in safety precaution areas with a red light or red lantern at night, if the objects project above the approach-departure clearance surface or above the transitional surface.

SC-13. IDENTIFICATION OF GOVERNMENT-FURNISHED PROPERTY (APR 1984) (FAR 52.245-3): The Government will furnish to the Contractor the property identified in the schedule to be incorporated or installed into the work or used in performing the contract. The listed property will be furnished to the Contractor at the place designated by the Contracting Officer. The Contractor is required to accept delivery, pay any demurrage or detention charges, and unload and transport the property to the jobsite at its own expense. When the property is delivered, the Contractor shall verify its quantity and condition and acknowledge receipt in writing to the Contracting Officer. The Contractor shall also report in writing to the Contracting Officer within 24 hours of delivery any damage to or shortage of the property as received. All such property shall be installed or incorporated into the work at the expense of the Contractor, unless otherwise indicated in this contract. Delivery site location for Government Furnished Property is

SC-14. EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE (MAR 1995)-(EFARS 52.231-5000)

(a) This clause does not apply to terminations. See 52.249-5000, Basis for Settlement of Proposals and FAR Part 49.

(b) Allowable cost for construction and marine plant and equipment in sound workable condition owned or controlled and furnished by a contractor or subcontractor at any tier shall be based on actual cost data 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 IV. Working conditions shall be considered to be average for determining equipment rates using the schedule unless specified otherwise by the contracting officer. For equipment not included in the schedule, rates for comparable pieces of equipment may be used or a rate may be developed using the formula provided in the schedule. For forward pricing, the schedule in effect at the time of negotiations shall apply. For retroactive pricing, the schedule in effect at the time the work was performed shall apply.

(c) Equipment rental costs are allowable, subject to the provisions of FAR 31.105(d)(ii) and FAR 31.205-36. Rates for equipment rented from an organization under common control, lease-purchase arrangements, and sale-leaseback arrangements, will be determined using the schedule, except that actual rates will be used for equipment leased from an organization under common control that has an established practice of leasing the same or similar equipment to unaffiliated lessees.

(d) When actual equipment costs are proposed and the total amount of the pricing action exceeds the small purchase threshold, the contracting officer shall request the contractor to submit either certified cost or pricing data, or partial/limited data, as appropriate. The data shall be submitted on Standard Form 1411, Contract Pricing Proposal Cover Sheet.

(e) Copies of EP1110-1-8 "Construction Equipment Ownership and Operating Expense Schedule" Volumes 1 through 12 are available in Portable Document Format (PDF) and can be viewed or downloaded at <http://www.usace.army.mil/inet/usace-docs/eng-pamphlets/cecw.htm>. A CD-ROM containing (Volumes 1-12) is available through either the Superintendent of Documents or Government bookstores. For additional information telephone 202-512-2250, or access on the Internet at [http://www.access.gpo.gov/su\\_docs](http://www.access.gpo.gov/su_docs).

SC-15. PAYMENT FOR MATERIALS DELIVERED OFF-SITE (MAR 1995)-(EFARS 52.232-5000)

(a) Pursuant to FAR clause 52.232-5, Payments Under Fixed Priced Construction Contracts, materials delivered to the contractor at locations other than the site of the work may be taken into consideration in making payments if included in payment estimates and if all the conditions of the General Provisions are fulfilled. Payment for items delivered to locations other than the work site will be limited to:

(1) materials required by the technical provisions; or (2) materials that have been fabricated to the point where they are identifiable to an item of work required under this contract.

(b) Such payment will be made only after receipt of paid or receipted invoices or invoices with canceled check showing title to the items in the prime contractor and including the value of material and labor incorporated into the item. In addition to petroleum products, payment for materials delivered off-site is limited to the following items: Any other construction material stored offsite may be considered in determining the amount of a progress payment.

SC-18. CONTRACT DRAWINGS AND SPECIFICATIONS (AUG 2000)(DOD FAR SUPP 252.236-7001)

(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 media.

(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 which 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 which 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 in the index of drawings attached at the end of the Special Clauses.

SC-22. EPA ENERGY STAR: The Government requires that certain equipment be Energy Star compliant. Initially, the sole Energy Star requirement shall be the self certification by the bidder that the specified equipment is Energy Star compliant. Within 3 months of the availability of an EPA sanctioned test for Energy Star compliance, the Contractor shall submit all equipment upgrades and additions for testing and provide proof of compliance to the Government upon completion of testing. Testing shall be at the Contractor's expense.

SC-23. RECOVERED MATERIALS: The Corps of Engineers encourages all bidders to utilize recovered materials to the maximum extent practicable. The attached APPENDIX R contains procurement guidelines for products containing recovered materials.

## APPENDIX R

## PART 247 - COMPREHENSIVE PROCUREMENT GUIDELINE FOR PRODUCTS CONTAINING RECOVERED MATERIALS

40 CFR Ch. 1 (9-1-99 Edition)

Subpart B-Item Designations

§ 247.10 Paper and paper products.

Paper and paper products, excluding building and construction paper grades.

§ 247.11 Vehicular products.

(a) Lubricating oils containing re-refined oil, including engine lubricating oils, hydraulic fluids, and gear oils, excluding marine and aviation oils.

(b) Tires, excluding airplane tire

(e) Reclaimed engine coolants, excluding coolants used in non-vehicular applications.

247.12 Construction products.

(a) Building insulation product including the following items:

(1) Loose-fill insulation, including but not limited to cellulose fiber, mineral fibers (fiberglass and rock vermiculite, and perlite);

(2) Blanket and batt insulation, including but not limited to mineral fibers (fiberglass and rock wool).

(3) Board (sheathing, roof decking wall panel) insulation, including but not limited to structural fiberboard and laminated paperboard products perlite composite board, polyurethane, polyisocyanurate, polystyrene, phenolics, and composites; and

(4) Spray-in-place insulation, including but not limited to foam-in-place polyurethane and polyisocyanurate and spray-on cellulose.

(b) Structural fiberboard and laminated paperboard products for applications other than building insulation, including building board, sheathing shingle backer, sound deadening board, roof insulating board, insulating wallboard, acoustical and non-acoustical ceiling tile, acoustical and non-acoustical lay-in panels, floor underlayments, and roof overlay (cover board).

(c) Cement and concrete, including concrete products such as pipe and block, containing coal fly as ground granulated blast furnace (GGBF) slag.

(d) Carpet made of polyester fiber use in low- and medium-wear applications.

(e) Floor tiles and patio block containing recovered rubber or plastic.

(f) Shower and restroom dividers/partitions containing recovered plastic or steel.

(g) (1) Consolidated latex paint used for covering graffiti; and

(2) Reprocessed latex paint used for interior and exterior architectural applications such as wallboard, ceilings, and trim; gutter boards; and concrete, stucco, masonry, wood and metal surfaces.

§247.13 Transportation products.

(a) Traffic barricades and traffic cones used in controlling or restricting vehicular traffic.

(b) Parking stops made from concrete or containing recovered plastic or rubber.

(c) Channelizers containing recovered plastic or rubber.

(d) Delineators containing recovered plastic, rubber, or steel.

- (e) Flexible delineators containing recovered plastic.

§ 247.14 Park and recreation products

- (a) Playground surfaces and running tracks containing recovered rubber or plastic.
- (b) Plastic fencing containing recovered plastic for use in controlling snow or sand drifting and as a warning/safety barrier in construction or other applications.

247.15 Landscaping products.

- (a) Hydraulic mulch products containing recovered paper or recovered wood used for hydroseeding and as an over-spray for straw mulch in landscaping, erosion control, and soil reclamation.
- (b) Compost made from yard trimmings, leaves, and/or grass clippings for use in landscaping, seeding of grass or other plants on roadsides and embankments, as a nutritious mulch under trees and shrubs, and in erosion control and soil reclamation.
- (c) Garden and soaker hoses containing recovered plastic or rubber.
- (d) Lawn and garden edging containing recovered plastic or rubber.

§ 247.16 Non-paper office product.

- (a) Office recycling containers and office waste receptacles.
- (b) Plastic desktop accessories.
- (c) Toner cartridges.
- (d) Binders.
- (e) Plastic trash bags.
- (f) Printer ribbons.
- (g) Plastic envelopes.

§ 247.17 Miscellaneous products.

Pallets containing recovered wood, plastic, or paperboard.

## INDEX OF DRAWINGS

Central Heating Plant Application of Low Emissions Tech., Malmstrom AFB

Drawing file number: N/A

<b>SHEET NUMBER</b>	<b>PLATE NUMBER</b>	<b>TITLE</b>	<b>REVISION NUMBER</b>	<b>DATE</b>
1	T1.1	Cover Sheet/Vicinity Map		05 Mar 2004
2	G1.1	Flow Diagram (1 of 2)		05 Mar 2004
3	G1.2	Flow Diagram (2 of 2)		05 Mar 2004
4	M1.1	Plan @ El. 3410'-6"+/- (Operating Floor)		05 Mar 2004
5	M1.2	Plan @ El. 3438'-6 +/- (Coal Scale Floor)		05 Mar 2004
6	M1.3	Partial Plans @ El. 3461'-0"+/- & 3503'-0" +/- (Roof & Stack Platform)		05 Mar 2004
7	M1.4	Partial Plans @ El. 3392'-6"+/-, El. 3410'- 6"+/-, & El. 3432'-6"+/-		05 Mar 2004
8	M2.1	Sections (1 of 3)		05 Mar 2004
9	M2.2	Sections (2 of 3)		05 Mar 2004
10	M2.3	Sections (3 of 3)		05 Mar 2004
11	M3.1	Details (1 of 2)		05 Mar 2004
12	M3.2	Details (2 of 2)		05 Mar 2004
13	S1.1	Platform Framing Plans		05 Mar 2004
14	S1.2	Platform Framing Plans		05 Mar 2004
15	S1.3	Load Simulator Foundation Plan & Misc. Plans		05 Mar 2004
16	S2.1	Framing Elevations		05 Mar 2004
17	S3.1	Sections & Details		05 Mar 2004
18	S3.2	Sections & Details		05 Mar 2004
19	E1.1	Electrical Single Line Diagram		05 Mar 2004

SHEET NUMBER	PLATE NUMBER	TITLE	REVISION NUMBER	DATE
20	E2.1	Electrical Plan Operating Level		05 Mar 2004
21	E2.2	Electrical Plan Mezzanine Level		05 Mar 2004
22	E2.3	Electrical Plan Coal Scale Level		05 Mar 2004
23	E2.4	Electrical Plan Roof Level		05 Mar 2004
24	E3.1	Motor Control Center Elevations		05 Mar 2004
25	E3.2	Control Architecture Diagrams		05 Mar 2004
26	E3.3	Electrical Schedules		05 Mar 2004
<u>27</u>	<u>R1</u>	<u>Main Induced Draft Fan</u>		<u>03 May 2004</u>

Revisions by Notation

Drawing M3.1, Sheet 11 of 26.

Add the following new note to Section 1:

Raise the elevation of the new coal grate flame scanner from that shown in order to avoid welding below the exiting tube bends and to avoid modification of the existing armor block. In addition, the flame scanners may need to be directed at an angle below the horizontal in order to proper detect the presence of flame across the width of the furnace. The burner manufacturer shall be responsible for setting the elevation of the flame scanner above the grate as well as its angle of installation in order to provide a fully functional system.

STANDARD DETAILS BOUND IN THE SPECIFICATIONS

DRAWING NUMBER	SHEET NUMBER	TITLE	DATE
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SECTION 01501 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

1 & 2	U.S. Air Force Project Construction Sign	84JUN20
1	Hard Hat Sign	10SEP90

END OF SECTION

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## SECTION 01110

## SUMMARY OF WORK

## PART 1 GENERAL

## 1.1 WORK COVERED BY CONTRACT DOCUMENTS

## 1.1.1 Project Description

The work includes:

- 1) Furnishing and Installing natural gas burners on High Temperature Hot Water (HTHW) Generators 1 & 3.
- 2) Removal of existing burner and controls as indicated.
- 3) Modification and repair of existing HTHW Generators.
- 4) Furnishing and replacing air heater baskets and seals on air heaters for HTHW Generators 1 & 3.
- 5) Furnishing and installing new VFD's on ID Fans on HTHW Generators 1 & 3.
- 6) Furnishing and installing new ID Fan drive motors on HTHW Generators 1 & 3. Available information on the existing ID fans is included in reference drawing Plate 189 of Drawing File 225-25-51 which is included within the solicitation. If the new proposed motors have different shaft sizes than the existing motors, the Contractor shall provide replacement couplings as necessary.
- 7) Furnishing and installing SDA inlet temperature control bypass ductwork.
- 8) Furnishing and installing opacity monitor purge air fans on HTHW Generators 1 & 3.
- 9) Furnishing and installing an ash unloader system including a pug mill, rotary feeder, and knife gate valve.
- 10) Furnishing and installing a load simulator, and interconnecting piping.
- 11) Furnishing and installing a plant air receiver and instrument air receiver, desiccant air dryer, air compressor and interconnecting piping.
- 12) Furnishing and installing instrument air supply for modifications requiring instrument air.
- 13) Demolitions and relocations required for the above modifications.
- 14) Furnishing and placing concrete, steel and electrical work required for the above modifications.
- 15) Furnishing and installing all controls associated with the above, and all related incidental work.

## 1.1.2 Location

The work shall be located at the Central Heating Plant, approximately as indicated. The exact location will be shown by the Contracting Officer.

## 1.2 EXISTING WORK

In addition to "FAR 52.236-9, Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements":

- a. Remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain.
- b. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Contracting Officer. At the completion of operations, existing work shall be in a condition equal to or better than that which existed before new work started.

### 1.3 FAILURE TO COMPLETE

If the Contractor fails to complete the work within the time specified in SC - 1.c, or any extension, the Contractor shall:

- a. Provide temporary heat by "sidewalk" HTHW generators, or steam boilers operating in conjunction with steam to HTHW converters. HTHW shall be provided at a minimum temperature of 350 degrees F, and the number of generators/boilers shall be as required to provide a minimum total output capacity of 55 MBTU/HR (55,000,000 BTU/HR). The fuel source for the temporary generating units shall be natural gas. Natural gas shall be provided by the government, however the contractor shall be responsible for all gas piping connections, as well as all temporary HTHW and steam generator connections to provide HTHW to the district heating system. Electrical power for operating the generators/boilers, and all necessary pumps shall be provided by the government, however all temporary and or permanent electrical connections shall be provided by the contractor.
- b. Accomplish remaining work in the first plant shut down period following the contract completion period.

BLDG NO.	DESCRIPTION	SQ FT	HT SOURCE	HT (MBTU/HR)	YR BUILT	# STORIES
145	HQ GROUP	34,413	CHP	0.9774	76	1
160	HQ	18,458	CHP	1.3710	57	1
165	MISSILE OPS	28,442	CHP	1.5000	67	1
205	HTG FACILITY	1,305	CHP	10.3100		
218	HTG FACILITY	768	CHP	4.6320	69	1
220	CE SELF HELP & SHOPS	15,000	CHP	1.2600	90	2
250	ALERT CREW	21,785	CHP	3.0160	59	1+BSMNT
295	SP OPERATIONS	8,562	CHP	0.5040	69	1
300	HQ GROUP	13,162	CHP	1.1000	58	1
320	VEHICLE OPS HEAT	4,929	CHP	0.6469	88	1
330	LAB, PME	16,440	CHP	1.8000	59	1
349	FIRE STATION	20,616	CHP	3.2000	57	1
410	SUPPLY WAREHOUSE	86,412	CHP	1.1052	53	2
450	FUELS SHOP	3,644	CHP	0.8000	68	1
471	CE SHOPS	14,740	CHP	4.0200	59	1
500	HQ	192,841	CHP	10.0000	59	3+BSMNT
546	HEATING FACILITY	1,014	CHP	4.9600	51	1
610	FLIGHT SIMILTR	6,262	CHP	0.5272	91	1

630	DORMITORY	25,474	CHP	1.0080	68	3
635	DORMITORY	25,474	CHP	1.0080	67	3
640	DORMITORY	54,230	CHP	2.1460	0	3
655	DORMITORY	38,650	CHP	1.5290	97	3
1062	DORMITORY	39,500	CHP	1.5630	99	3
735	DORMITORY	25,474	CHP	1.5880	70	3
737	DORMITORY	23,873	CHP	1.5120	75	3
766	HQ	15,516	CHP	9.1086	54	1
	HQ GROUP 769	18,060	CHP	2.2180	58	1
770	LAW CENTER	16266	CHP	1.0080	57	1
772	PUBLICATIONS	7,728	CHP	0.4500	92	1
800	TRAFFIC MGT FACILITY	14,479	CHP	2.0090	77	1
850	VEHICLE MAINT SHOP	7973	CHP	1.2000	87	1
870	VEHICLE MAINT SHOP	27186	CHP	5.5000	60	1
882	VEHICLE MAINT SHOP	16964	CHP	1.9200	75	2
910	HEATED PARKING	20340	CHP	1.2800	68	1
1010	GYM	54877	CHP	4.7840	57	1
1020	SWIMMING POOL	13380	CHP	1.7000	75	1
1075	DINNING HAL	15006	CHP	6.6940	60	1
1082	COMM FACILITY 1082	6403	CHP	0.6320	56	1
1145	YOUTH CENTER	26561	CHP	2.8000	56	1
1150	BX	45899	CHP	2.0170	81	1
1152	LIBRARY	7891	CHP	0.4200	57	1
1154	BOWLING CENTER	16454	CHP	1.0000	66	1
1156	THEATER	9513	CHP	1.9536	57	1
1191	BASE PERSONNEL	35000	CHP	0.6800	73	2+BSMNT
1192	FAMILY SUPPORT CTR	5785	CHP	0.1490	69	1
1199	CHAPEL CENTER	18599	CHP	1.5720	57	2
1248	CONSOLIDATED SKILLS	19000	CHP	1.6000		1
1320	COMMISSARY	68200	CHP	2.0000	88	
1439	AIRCRAFT SHOPS	82404	CHP	8.1600	84	2
1440	3 BAY HANGER	80775	CHP	20.0000	93	1
1447	AGE SHOPS	23173	CHP	1.8880	59	1
1448	VEHICLE MAINT SHOP	13149	CHP	0.9325	70	1
1450	CORROSION HANGER	36565	CHP	14.2700	89	1
1460	MAINT DOCKS	28215	CHP	5.0000	59	1
1464	MAINT DOCKS	26482	CHP	6.3980	59	1
1467	VEHICLE SHOP	2750	CHP	2.5000	93	1
1482	CONTROL PUMP STN	812	CHP	0.2500	88	1
1600	OFFICIER CLUP	15130	CHP	2.8720	66	1
1620	QUARTERS	18153	CHP	1.0900	70	2
1680	VOQ	23560	CHP	1.3830	64	2
1700	HELO HANGER	21736	CHP	4.1072	56	1
1705	TRML AIR F/P	13048	CHP	1.1000	57	1
1708	MISSOLE OPS	17127	CHP	1.3360	57	2
2040	COMPOSITE MED	91950	CHP	4.3690	90	1
3080	MSL SVS SHOPS	49996	CHP	2.6776	76	1

3081	HEATED PARKING	17460	CHP	2.7290	76	1
82110	HEAT PLANT	35316	CHP	0.1475	87	
TOTAL		1,806,349		195.9887		

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

-- End of Section --

## SECTION 15555A

MODIFICATIONS TO CENTRAL HIGH TEMPERATURE WATER (HTW) GENERATING PLANT AND  
AUXILIARIES

## 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.

## ASME INTERNATIONAL (ASME)

ASME B31.1	(2001) Power Piping
ASME BPVC SEC I	(2001) Boiler and Pressure Vessel Code; Section I, Power Boilers
ASME BPVC SEC IX	(2001) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2001) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME PTC 4.1	(1964; Addenda: 1968, 1969; R 1991) Steam Generating Units ++
ASME PTC 4.1	(1964; Addenda: 1968, 1969; R 1991) Steam Generating Units ++

## ASTM INTERNATIONAL (ASTM)

ASTM A 36/A 36M	(2001) Carbon Structural Steel
ASTM A 366/A 366M	(1997e1) Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality **
ASTM A 568/A 568M	(2001) Steel, Sheet, Carbon, and High- Strength, Low-Alloy, Hot-Rolled and Cold- Rolled
ASTM A 653/A 653M	(2001a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C 155	(1997) Standard Classification of Insulating Firebrick
ASTM C 27	(1998) Fireclay and High-Alumina Refractory Brick

ASTM C 34	(1996) Structural Clay Load-Bearing Wall Tile
ASTM C 401	(1991; R 2000) Alumina and Alumina-Silicate Castable Refractories
ASTM C 62	(2001) Building Brick (Solid Masonry Units Made from Clay or Shale)

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 85	(2001) Boiler and Combustion Systems Hazard Code
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## UNDERWRITERS LABORATORIES (UL)

UL 795	(1999) Commercial-Industrial Gas Heating Equipment
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## 1.2 GENERAL REQUIREMENTS

## 1.2.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

## 1.2.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

## 1.2.3 Prevention of Rust

Unless otherwise specified, surfaces of ferrous metal subject to corrosion shall be factory prime painted with a rust inhibiting coating and subsequently factory finish painted in accordance with the manufacturer's standard practice. Equipment exposed to high temperature when in service shall be prime and finish painted with the manufacturer's standard heat resistant paint to a minimum thickness of 1 mil.

## 1.2.4 Equipment Guards and Access

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded. High temperature equipment and piping exposed to contact by personnel or where it creates a fire hazard shall be properly guarded or covered with insulation of a type specified.

## 1.2.5 Use of Asbestos Products

Products which contain asbestos are prohibited. This prohibition includes items such as packings or gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 01330, "SUBMITTAL PROCEDURES":

#### SD-02 Shop Drawings

##### Gas Burners; G.

Detail drawings consisting of schedules, performance charts, brochures, diagrams, drawings, and instructions necessary for installation of equipment, and for piping, wiring, and devices. Complete setting plans certified by the equipment manufacturers. Drawings shall indicate clearances required for maintenance and operation and shall contain complete wiring and schematic diagrams, equipment layout and anchorage, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

##### Combustion Air Ductwork; G.

##### Flue Gas Breeching; G.

##### Replacement Tubes; G.

Detail drawings describing materials of construction, dimensions, weights, support, and layout in both plan and elevation.

#### SD-03 Product Data

##### Spare Parts;

Spare parts data for each item of equipment provided, after approval of the drawings and not later than 3 months before the date of beneficial occupancy. The data shall include a complete list of spare parts and supplies, with current unit prices and source of supply, and a list of the parts recommended by the manufacturer to be replaced after 1 and 3 years of service.

##### Manufacturer's Instructions;

Proposed diagrams, instructions, and other sheets, before posting. Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

## Welding Qualifications;

A copy of qualified welding procedures and a list of names and identification symbols of qualified welders and welding operators.

## Field Training;

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

## SD-06 Test Reports

## Test Schedule; G.

A written schedule, 7 days before tests are performed. Schedule will be approved by the Contracting Officer.

## Proposed Test Procedure;

A proposed performance test procedure, 30 days prior to the proposed test date. The submittal shall contain a complete description of the proposed test with calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in the tests. The test shall not commence until the procedure has been approved.

## Boiler Emissions Report; G.

Boiler emissions report of air pollutants showing compliance with the limits established in the environmental permit and as specified herein.

## Adjusting, Balancing, Testing and Inspecting; .

Test reports in booklet form showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completing and testing the installed system. Each test report shall indicate the final position of controls. A written statement from the manufacturer's representative certifying that combustion control equipment has been properly installed and is in proper operating condition, upon completion of the installation. The action settings for automatic controls in the form of a typed, tabulated list indicating the type of control, location, setting, and function shall be included.

## Startup Test Hardcopy Printout;.

Printed report of control system startup test.

## SD-07 Certificates

Environmental Permit Compliance;  
Experience; G.

Evidence of the Contractor's prior experience in installing similar equipment, including a list of 5 co-firing (simultaneous

natural gas & coal) and stoker applications combustion control installations (Bailey/ABB INFI-90) on boilers of equal or larger size that have been in satisfactory operation for 2 years prior to bid opening. Provide the location of the combustion control installations.

#### Certificates of Inspection, Test, and Calibration

Certificate of inspection, test, and calibration of instrumentation to be used during acceptance testing. Certificate of compliance with applicable codes after installation.

#### SD-10 Operation and Maintenance Data

##### Gas Burners;

Operating instructions, prior to the field training course. Six copies of operating instructions outlining the step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance instructions, prior to the field training course. Six complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions shall include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. The manuals shall also include equipment lubrication requirements and schedules, recommended spare parts list, index, instruction book binders with hard back covers and printing to identify the name of the facility, Government entity operating the facility, Contractor, shop order, equipment, and volume number if required. Operation and maintenance manuals shall be approved prior to the training course.

#### 1.4 WELDING QUALIFICATIONS

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

#### 1.5 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

#### 1.6 VERIFICATION OF DIMENSIONS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

## PART 2 PRODUCTS

### 2.1 MODIFICATIONS TO HIGH TEMPERATURE WATER GENERATORS

Existing HTW generator (boiler) No. 1 is capable of operation on coal or natural gas. Existing Boiler No. 2 is capable of operation on natural gas only. Existing Boiler No. 3 is capable of operation on coal only. Boiler No. 1 and No. 3 each have an input capacity of 106 MMBtu/hr and an output capacity of 85 MMBtu/hr when operating on coal, when operating with 305 degrees F entering water temperature and 414 degrees F leaving water temperature with a water flow of 736,249 pounds per hour. Boiler No. 1 and No. 2 each have a capacity of approximately 30 MMBtu/hr when operating on natural gas only. Each boiler has a design pressure of 500 psig.

Modifications shall include all controls, piping, insulation, miscellaneous plant equipment, and other accessories indicated or necessary for the following major work elements:

- a. Removal of gas burner from HTW generator No. 1 and associated ~~new tubes straightening and~~ boiler wall repair.
- b. Addition of two 25 MMBtu/hr input to each gas burner on each HTW generator. No. 1 and No. 3, one on each side of boiler and associated tube bending and boiler wall work.
- c. Addition of combustion air bypass and flue gas bypass around existing air heater on HTW generator No. 1 and No. 3.
- d. Replacement of baskets and seals in Ljungstrom air heaters for Generators No. 1 and No. 3.

The equipment design and accessory locations shall permit accessibility for maintenance and service. Design conditions shall be as follows:

- a. Site elevation, 3,527 feet.
- b. Combustion air temperature, 80 degrees F.

The HTW generators shall be capable of operating continuously at maximum specified capacity without damage or deterioration to the generator, its setting, or firing equipment or auxiliaries. The generator shall be operable automatically while burning the fuel specified.

#### 2.1.1 Electrical Equipment

Electric motor-driven equipment shall be provided complete with motors and necessary motor control devices. Motors and motor control devices shall be as specified in Division 16 specifications. Enclosures for electrical equipment shall be NEMA 4~~ef~~ or NEMA 12. Motors shall have electrical characteristics and enclosure type as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type.

#### 2.1.1.1 Motor Ratings

Motors shall be suitable for the voltage and frequency provided. Motors 1/2 horsepower and larger shall be three phase, unless otherwise indicated. Ratings shall be adequate for the duty imposed, but shall not be less than indicated.

#### 2.1.1.2 Motor Starters

Where a motor starter is not indicated in a motor control center on the electrical drawings, a motor starter shall be provided under this section of the specifications. Motor starters shall be provided complete with properly sized thermal overload protection and other equipment at the specified capacity including an allowable service factor, and other appurtenances necessary. Manual or automatic control and protective or signal devices required for the operation specified, and any wiring required to such devices, shall be provided whether indicated or not. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers may be provided to accomplish the same function.

#### 2.1.2 HTW Generator Design Requirements

##### 2.1.2.1 Furnace Dimensions

Existing furnace dimensions are as follows:

- a. Width (new burner firing direction), 12.46 feet.
- b. Depth, 13.13 feet.
- c. Height, 22 feet.

##### 2.1.2.2 Burners

Burners shall conform to requirements of NFPA 85, except as otherwise specified. Flame safeguard controls shall be equipped with repetitive self-checking circuits.

#### 2.2 HIGH TEMPERATURE WATER GENERATOR MODIFICATION DETAILS

##### 2.2.1 HTW Generators and Components

Watertube, waterwall type HTW generating units shall be modified for the installation of gas burners, with the associated modifications to the existing over fire air system. Walls of the HTW generating units shall be modified to accommodate the installation, removal and rearrangement of gas burner using similar materials of construction and as shown on the contractors drawings.

##### 2.2.1.1 Headers

Existing HTHW generator nameplate data is as follows:

HTHW Generator No. 1:  
International Boiler Works Co.  
Model TJW-VC-85

Serial No. 14891  
 IBW Job No. 2068-69-70  
 Heating Surface:  
 Boiler: 5,975 square feet  
 Waterwall: 1,284 square feet

HTHW Generator No. 3:  
 International Boiler Works Co.  
 Model TJW-VC-85  
 Serial No. 14892  
 IBW Job No. 2068-69-70  
 Heating Surface:  
 Boiler: 5,975 square feet  
 Waterwall: 1,284 square feet

Note: The International Boiler Works Co. is defunct. For information concerning existing HTW Generators and Components contact:

International Boiler, Inc.  
 Attn: Jeffrey Beals  
 3000 NE 30 Place, Suite 109  
 Ft. Lauderdale, FL 33306  
 phone: (954) 537-7787  
 fax: (954) 537-7785

#### 2.2.1.2 Tubes

Replacement services and tubes for tube sections shown on the contract drawings shall be provided by International Boiler, Inc. at the Contractor's expense. Tubes shall be electric welded or seamless steel. Boilers shall have water-cooled furnace walls of a design suitable for the application. Tubes located in the primary furnace shall be designed for inclined or upflow of water. The water shall be distributed to the heating surface in proportion to the heat absorbing capacities of these surfaces. Tube heat absorbing surfaces shall be located so that radiant and convection sections provide for series flow of water, from generator inlet to outlet, to ensure uniform water distribution and uniform temperature rise from inlet to outlet.

#### 2.2.1.3 Furnace

Existing furnace side walls and rear wall ~~shall be~~ water-cooled by vertical tubes with center-to-center spacing not to exceed twice the tube diameter, and ~~shall be~~ furnished with cast-iron, water-cooled armor block at the grate line to a height of not less than 18 inches above the grate line. The armor block ~~shall be~~ keyed and held in place without the use of bolts, pins, or mastic. The existing armor block shall be readily replaceable without the use of special tools protected from damage during this work. See note added to Section 1 on Drawing M3.1 for revisions to the height of the new coal grate flame scanner to avoid having to modify the existing armor block.

#### 2.2.2 HTW Generator Setting Materials

Materials shall conform to the following:

- a. Firebrick: ASTM C 27, class shall conform to industry standards and ASME.
- b. Insulating Brick: ASTM C 155, Class A.
- c. Castable Refractory: ASTM C 401. The minimum modulus of rupture for transverse strength shall not be less than 600 psi after being heat-soaked for 5 hours or more at a temperature in excess of 3000 degrees F.
- d. Mortar, Air-Setting, Refractory: Shall conform to industry standards and ASME.
- e. Brick, Common: ASTM C 62.
- f. Tile, Load-Bearing, Hollow: ASTM C 34, Grade LBX.
- g. Iron and Steel Sheets: Galvanized, ASTM A 653/A 653M; gauge numbers specified refer to United States Standard gauge. Uncoated, black: ASTM A 568/A 568M, ASTM A 366/A 366M, or ASTM A 36/A 36M.

#### 2.2.2.1 HTW Generator Casing

HTW generator walls shall be steel-encased wall construction with fabrication details as recommended by the HTW generator manufacturer. HTW generator wall lining shall consist of a continuous screen of closely spaced water tubes. Casing for HTW generators shall be double wall construction. Reinforced, welded, gas-tight inner casing shall be constructed of not lighter than 10 gauge black steel sheets. Outer casing shall be constructed of not less than 10 gauge steel sheets. Outer casing may be either bolted or welded. Inner casing shall be reinforced with structural steel to provide rigidity and prevent buckling. Inner casing in furnace section shall abut furnace tubes with no foreign sealer between the tube steel and the casing steel. Casing shall not be attached to tubes. The inner casing shall be applied so as to form expansion joints at the point of tube support. Welded joints and openings shall be checked by a pressure test. Any casing leakage shall be repaired and made pressure-tight. The maximum deflection of the reinforced panels shall not exceed 1/360 of the length of the maximum span. Block insulation shall be applied between the inner and outer casings and held securely with insulating pins. The casing tested shall be capable of holding a pressure of 1-1/2 times the predicted maximum furnace operating pressure of .15 inH2O (.28 mmHg).

#### 2.2.2.2 Walls

~~Refractory behind the waterwall tubes shall be high-duty refractory not less than 2-1/2 inches thick conforming to manufacturer's requirements. High temperature block and mineral wool blanket shall be provided between the refractory backup and steel casing or between an inner and outer casing. Thickness of insulation shall be such that an average casing temperature in the furnace area will not exceed 130 degrees F with a surface air velocity of 100 fpm, and an ambient air temperature of 80 degrees F when operating at full capacity match adjacent construction.~~

#### 2.2.2.3 Firebrick

Firebrick shall be laid up in air-setting mortar. Each brick shall be dipped in mortar, rubbed, shoved into its final place, and then tapped with a wooden mallet until it touches the adjacent bricks. Mortar thick enough to lay with a trowel shall not be permitted. Maximum mortar joint thickness shall not exceed 1/8 inch and average joint thickness shall not exceed 1/16 inch.

#### 2.2.2.4 Plastic Refractory

Plastic refractory shall be installed in accordance with the manufacturer's recommendation and by workmen skilled in its application.

#### 2.2.3 Boiler Fittings and Appurtenances

HTW generator fittings and appurtenances suitable for a HTW design pressure of 500 psig and 470 degrees F shall be installed with each HTW generator in accordance with ASME BPVC SEC I.

### 2.3 NATURAL GAS FUEL BURNING EQUIPMENT

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MW Output	(Size) Type of Grate and Stoker
735 - 5860	Single retort, stationary grate, underfeed stokers
5860 - 8800	Single retort, moving grate, underfeed stoker
1465 - 22000 stoker	Reciprocating grate, front continuous ash discharge
1465 - 29500 discharge stoker	Vibrating conveyor grate, front continuous ash
5860 - 36500 grate stoker	Water-cooled, incline grate, hopper fed vibrating
8800 - 120,000	Spreader stoker, continuous front ash discharge

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(MBtuh Output	(Size) Type of Grate and Stoker
2,500 - 20,000	Single retort, stationary grate, underfeed stokers
20,000 - 30,000	Single retort, moving grate, underfeed stoker
5,000 - 75,000 stoker	Reciprocating grate, front continuous ash discharge
5,000 - 100,000 discharge stoker	Vibrating conveyor grate, front continuous ash

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20,000 - 125,000	Water-cooled, incline grate, hopper fed vibrating grate stoker
30,000 - 400,000	Spreader stoker, continuous front ash discharge)

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Natural gas fuel burning equipment shall be provided complete with flame safeguard system, forced draft low NO<sub>x</sub> burner, combustion air windbox, piping, fuel train and instrumentation. Fuel burning equipment shall be designed for a maximum allowable working pressure of 40 psig. Each burner shall be capable of firing at a continuous rating of 25 MMBtu/hr input when the boiler is firing natural gas only, using natural gas at 9 psi. When co-firing with coal, each burner shall not run higher than 15 MMBtu/hr input. Provisions shall be incorporated for withdrawing and shielding the gas burner from over heating while firing coal only. Emissions guarantees shall apply through specified turndown range. Flue gas recirculation shall not be utilized. Burner shall have a stable flame over the turndown range. Primary air spinner zone, zone divider and main burner shall be removable without removing the entire register or windbox. Register front plate shall have a swivel scanner and observation port. Natural gas fuel burning equipment shall limit emissions to 0.15 pounds of NO<sub>x</sub>/MMBtu of heat input.

#### 2.3.1 Pilot

- a. Pilot burner shall be natural gas-electric type with the capacity required to reliably light off the boiler. A high voltage secondary side ignition transformer shall be supplied and mounted backside of the windbox.
- b. Provision shall be made in the burner housing for inspection of the pilot flame.
- c. Pilot shall be provided with individual manual shut-off valve, pressure gauge, strainer, pressure regulation separate from the main burner, self closing solenoid valve and vent valve in accordance with FM P7825a, FM P7825b and UL 795. Pilot and valving shall be in accordance with NFPA 85.

#### 2.3.2 Burner Refractory Throat

Burner refractory throat shall be made of high quality castable refractory suitable for 3000 degrees F. The precast refractory in a steel retaining ring with stainless steel anchors shall be shipped separately for field mounting on the boiler. Burner refractory throat shall be concentric with the burner, contoured to ensure complete mixing of air and natural gas, and designed to assist in complete combustion by radiating heat to the fuel. Burner shall be so positioned that the flame parallels the contour of the burner refractory throat but avoids striking the refractory.

#### 2.3.3 Windbox

Windbox shall provide even airflow. Windbox shall not interfere with boiler smoke box door operation and shall have a flange bottom for easy firm mounting on a support structure.

#### 2.3.4 Combustion Air Fan

Combustion air fan shall be centrifugal type with backwardly inclined air foil bladed wheel. Combustion air-fan wheel shall be directly driven by a TEFC NEMA frame motor and shall be complete with inlet cone and screen and flange outlet. Combustion air fan shall be bottom flanged to be mounted on same structural member as windbox. Combustion air-fan shall be minimum sized to provide sufficient static pressure to overcome system losses when providing 15 percent excess air at maximum firing rate.

#### 2.3.5 Combustion Air Damper and Jack Shaft Control

Combustion air damper shall be flanged and located ~~between combustion air fan and windbox~~ at combustion air fan inlet. Combustion air damper shall be mechanically linked with an adjustable jack shaft that automatically adjusts the amount of combustion air supply required for the specified burner capacity turndown.

#### 2.3.6 Natural Gas Burner

Natural gas burner shall be a multi-spud burner with gas feed pipe in center of air register for easy removal. Natural gas burner shall be forced draft type and shall be suitable for efficiently burning natural gas having a calorific value of 1,000 Btu per cubic foot when supplied at a pressure of approximately 9 psig. Natural gas shall be discharged in burner throat area. Natural gas-air premix or natural gas discharged outside of burner throat are not acceptable. Main natural gas burner shall be capable of firing the boiler to maximum capacity with a turndown of five (5) to one (1) with a 4-20 mA signal.

#### 2.3.7 Natural Gas Burner Retract Equipment

Each natural gas burner shall be provided with a pneumatic actuator for retracting the gas burner nozzle from the refractory burner throat and a guillotine refractory damper with a pneumatic actuator that seals the refractory burner throat opening after the natural gas burner nozzle is retracted. The damper shall be provided with a seal air fan that limits the amount of air inleakage to the furnace to a maximum of 55 scfm when the damper is in the closed position. Refractory for the guillotine damper shall be as specified herein. Pneumatic actuators shall be piston and cylinder type, sealed and double acting. Cylinders and pistons shall be sized for operating 125 percent of the required load with an instrument air pressure range of 70-120 psig. Piping for each pneumatic actuator shall be complete including tubing, fittings, filter regulator set, four-way 120 VAC solenoid valve, speed control valves, isolation and bypass valves and a single point connected with the instrument air system. The assembly shall include mechanically operated position switches, DPDT, to indicate inserted and retracted positions for the gas burner nozzle retract actuator and open and closed positions for the guillotine damper actuator. The natural gas burner retract equipment shall be manually controlled from the burner management system control panels next to the new burner platforms. Controls shall be provided with appropriate interlocks for safe operation of the burner retract equipment. As a minimum, the burner shall not be capable of being retracted with natural gas flow. The burner management system control panel shall be provided with position indicating lights for burner nozzle inserted and retracted and guillotine damper closed and open.

## 2.3.8 Flame Safeguard System

- a. The flame safeguard system per burner shall be manufactured by burner manufacturer and mounted near the boiler as a panel. Flame safeguard system components shall be UL listed. Complete and automatic flame safeguard system shall be provided in accordance with NFPA requirements for safe start-up, on-line operation and shut-down of package burner.
- b. Flame safeguard system shall be micro-processor per boiler based system including, but not limited to, automatic burner sequencing, flame supervision, status indication, fire-out annunciation and self diagnostics.
- c. Flame safeguard system cabinet shall house overcurrent protective devices and motor starters for the combustion air fan motor and burner damper motor. Control transformers and an RS-232C serial communication port shall also be included.
- d. Flame scanner shall not require a separate purge air supply. Flame scanner output signal shall be connected to flame amplifier module in microprocessor based unit. Within four seconds after loss of flame, flame safeguard controller shall shut the automatic safety shut-off fuel valves and open the gas automatic vent valve. Flame failure signal shall be displayed on flame safeguard display or burner control panel.
- e. A separate adjustable coal grate flange scanner shall be provided for each boiler above the grate as shown on the contract drawings.
- f. Logic provided with flame safeguard system shall:
  1. Prevent introduction of ignitor flame (pilot) or main fuel flame to furnace until furnace, boiler passes, breeching and stack have been purged of combustible gases.
  2. Prevent opening of automatic fuel shut-off valves in main fuel line until ignitor flame is proven.
  3. Limit trial for main fuel ignition to ten (10) seconds from time ignitor flame is proven.
  4. In event of burner failure, operator intervention shall be required to manually reset flame safeguard controller prior to restart.
  5. Allow gas burner startup without a pre-purge cycle, when coal is being combusted as detected by the coal grate flame scanner.
- g. First-out annunciation per burner shall be provided by an expansion module. Alarms and flame-outs shall be individually annunciated at panel front and transmitted along with other process points monitored by the panel to existing Bailey DCS for graphic display. The following points, at a minimum, shall be individually annunciated by flame safeguard system:
  1. High outlet water temperature (from DCS).

2. High and low natural gas pressure.
  3. Low oxygen concentration (from DCS).
  4. Low water flow (from DCS).
  5. Combustion airflow.
  6. Ignitor failure.
  7. Main flame failure.
  8. Furnace pressure (from DCS).
- h. Flame safeguard system cabinet shall be provided for natural gas fuel.
- i. Indicating lights shall also be provided for following:
1. Limits satisfied.
  2. Purging.
  3. Pilot ON.
  4. Main flame ON.
  5. Flame failure.
  6. Natural gas ON.
- j. Indicating pilot lights shall be industrial, oil-tight construction with push-to-test feature or "All-Pilot Lights" test button.

#### 2.3.9 Boiler Piping Trains

Piping train shall be completely prepiped, wired and mounted on boiler. Natural gas train shall be in accordance with NFPA and FM standards and requirements and shall include but not be limited to following items:

##### 2.3.9.1 Natural Gas Trains

- a. NFPA 54 and ANSI Z83.3.
- b. Natural gas flow control valve with characterizing adjustments to match airflow.
- c. Y-type strainer supplied in ignitor natural gas line.
- d. Two (NC) solenoid safety shut-off valves, in series, in ignitor line with one (NO) solenoid vent valve located between safety shut-off valves, piped independently to atmosphere through the roof.
- e. Two motorized shut-off valves with proof of closure, piped in series in main gas line with one (NO) solenoid vent valve located

between safety shut-off valves, piped independently to atmosphere through the roof.

- f. One pressure regulating valve in ignitor natural gas line to regulate natural gas pressure to ignitor.
- g. Pressure gauge, with shut-off valve for main natural gas at burner.
- h. Pressure gauge, with shut-off valve for natural gas ignitor.
- i. Low natural gas pressure switch.
- j. High natural gas pressure switch.

#### 2.4 WASTE HEAT RECOVERY EQUIPMENT

Each existing boiler is equipped with an air preheater, separate from the boiler, which preheats combustion air that is delivered beneath the grate when firing coal. Bypasses, complete with opposed or parallel blade dampers as shown on the contract drawings, shall be added on both the combustion air and flue gas sides of the existing air heaters serving Boiler No. 1 and No. 3.

#### 2.5 OVERFIRE AIR DUCT MODIFICATIONS

Overfire air ducts shall be relocated to accommodate burner installation on the right side of HTHW Generators No. 1 & 3. In addition, cast iron fly ash reinjection nozzles (three per generator) shall be removed and a new 2 inch diameter overfire air duct shall be installed from the existing overfire air header to the new Detroit Stoker overfire air nozzles in the rear wall of HTHW Generators No. 1 & 3. Size of overfire air nozzles shall match existing.

#### 2.6 UNDER GRATE AIR DUCT MODIFICATIONS

Under grate air duct bypasses around air heaters shall be constructed of 3/16 inch thick steel plate conforming to ASTM A 36/A 36M. Ductwork shall be adequately reinforced and braced with structural steel angles not smaller than 2 x 2 x 3/16 inches on no more than 10 foot spacing, and all joints and seams in the sheets and angles shall be welded. Expansion joints shall be installed as indicated and as required to suit the installation and shall be flexible type requiring no packing. Ductwork shall have angle flanges and gaskets for connection to equipment. Ductwork connections shall be gas-tight and caulked-tight all around and sealed with cement to form an air-tight joint. Clean-out openings of suitable size and at approved locations shall be provided for access to all sections of the breeching and shall have tight-fitting, hinged, cast-iron doors with cast-iron frames.

#### 2.7 BREECHING MODIFICATIONS

Breeching bypasses around air heaters shall be constructed of 3/16 inch thick steel plate conforming to ASTM A 36/A 36M. Breeching shall be adequately reinforced and braced with structural steel angles not smaller than 2 x 2 x 5/16 inches on no more than 2 foot spacing, and all joints and seams in the sheets and angles shall be welded. Expansion joints shall be installed as indicated and as required to suit the installation and shall be flexible type requiring no packing. Breeching shall have angle flanges and

gaskets for connection to equipment. Breeching connections shall be gas-tight and caulked-tight all around and sealed with cement to form an air-tight joint. Clean-out openings of suitable size and at approved locations shall be provided for access to all sections of the breeching and shall have tight-fitting, hinged, cast-iron doors with cast-iron frames.

## 2.8 FABRIC EXPANSION JOINTS

### 2.8.1 General

Fabric expansion joints shall be integral flanged, U-belt design consisting of flexible element, backing bars, flow baffle, nuts, bolts and washers and have an operating temperature suitable for 300 degrees F on combustion air ductwork and 500 degrees F on flue gas breeching.

Acceptable manufacturers or approved equal of these joints are the following:

- a. Frenzelit North America Inc. - Purcellville, VA 540-338-2076.
- b. Advanced Flexible Systems, Inc. - Charleston, SC 800-724-4175.
- c. Hutch Engineering, Inc. - Canton, GA 770-751-9123.
- d. Senior Flexonics Pathway - New Braunsfels, TX 800-292-2152.
- e. Papco Industries, Inc. - Northvale, NJ 201-767-9051.

Flexible element, backing bars, and flow baffle shall be drilled to match adjacent breeching or equipment flanges. In open sections of breeching, the maximum spacing between hole centers shall be 6 inches. Design shall allow fit between adjacent breeching or equipment without disassembly of the adjoining breeching or equipment. Flow direction shall be marked on the expansion joint.

### 2.8.2 Flexible Element

The flexible element shall be designed to uncouple the forces and moments between adjoining sections due to thermal expansion while maintaining structural integrity. Design shall simultaneously allow .5 inches of compression, 1 inch of lateral relative motion and 1 degree of rotation in any plane. The flexible element material shall be suitable for the design temperature and contact with flue gas from coal combustion with a 2.50 to 3.81 percent sulfur coal.

### 2.8.3 Backing Bars

Backing bars shall be provided for the full width and circumference of the seal. Backing bars shall be ASTM A 36, a minimum of 2 inches wide by 3/8 thick, free of burrs and sharp edges, and coated with a rust-resistant primer.

### 2.8.4 Flow Baffle

The flow baffle shall be ASTM A 36 carbon steel, 1/8 inch thick, bolt-in design, fastened between flexible element and adjacent breeching or equipment flange, designed to protect flexible element from particulate abrasion throughout the range of thermal movements.

### 2.8.5 Fasteners

Fasteners shall be 5/8 inch bolts with flat washer between the bolt head and the backing bar, and a lock washer between the nut and adjacent breeching or equipment flange. Bolts shall be of adequate length to expose a minimum of two (2) threads beyond the nut after tightening. Bolts dimensions shall be in accordance with ASME B18.2.1 and be threaded in accordance with ASME B1.1, Class 2A. Bolts shall be ASTM A 307, Grade B, zinc-coated for operating temperatures up to 550 degrees F and ASTM A 193, Grade B7, heavy hex for operating temperatures above 550 degrees F. Nut dimensions shall be in accordance with ASME B18.2.2 and threaded in accordance with ASME B1.1, Class 2B. Nuts shall be ASTM A 563, Grade A, zinc-coated, heavy hex for operating temperatures up to 550 degrees F and ASTM A 194 Grade 7, heavy hex for operating temperatures above 550 degrees F.

## 2.9 LOUVER DAMPERS

### 2.9.1 General

Louver dampers shall be balanced weight, multiple blade type. Blades shall be opposed blade (combustion air) or parallel blade (flue gas and minimum leak,) as indicated on the Contract Drawings. Opposed blade dampers shall be designed for throttling service. Blade dampers shall be designed for shut-off service and shall be provided with sealed blade ends. Dampers shall be designed for a maximum shut-off pressure of 5 inches of water and a maximum temperature of 550 degrees F. Design shall allow fit between adjacent breeching or equipment without disassembly of the adjoining breeching or equipment.

### 2.9.2 Detailed Requirements

The frame shall be 12 inch, 20.7 pound channel with 5/8 inch diameter holes on a maximum of 6 inch center spacing. Blades shall be 10 gauge carbon (minimum) steel, bolted, double skin, air foil design. Blade seals shall be overlap and stepped. Shafts shall extend the total length of the blades and be Type 304 stainless steel. Brackets, linkages, bearings and packing shall be located and be serviceable from outside the gas stream. Bearings shall be graphite, self-lubricated, rated for 1000 degrees F service. The brackets and linkages shall be carbon steel. Non-machined, metal surfaces shall be power tool cleaned, solvent washed, and coated with a primer suitable for 500 degrees F.

### 2.9.3 Operator

The dampers shall be provided with a pneumatic actuator integrally mounted on the frame. The design shall be sized to operate satisfactorily with a 60 to 80 psig instrument air supply. Dampers designed for modulating service shall be provided with positioners suitable for 4 to 20 mA signal, with direct or reverse feedback. The selection and arrangement of the spring, solenoid, positioner, if required for modulating service, and the wiring and pneumatic connections shall meet the air and electrical failure positions specified on the Contract Drawings. Speed control on damper to open to closed in 1.0 minutes and closed to open in 1.0 minutes.

## 2.10 INSULATION

Shop and field applied insulation shall be as specified in Section 15080A "THERMAL INSULATION FOR MECHANICAL SYSTEMS".

## 2.11 TOOLS

Special tools only shall be furnished and shall include all uncommon tools necessary for the operation and maintenance of controls, meters and other equipment. Small hand tools shall be furnished with a suitable cabinet, mounted where directed.

## 2.12 ASH HANDLING SYSTEM

### 2.12.1 Boiler Room Ash Handling System

The existing ash handling system is of the dry pneumatic type. This system gathers ash from the boiler under grate and bottom ash hoppers, mechanical dust collector, and the baghouse hoppers, and discharges to the ash storage silo located outside of the building. An existing ash dust control conditioner is used to reduce fugitive dust emissions during discharge of ash from the storage silo. This ash dust conditioner (dustless unloader) shall be replaced with a new ash unloader system in accordance with Section 14710, "Ash Unloader System."

## 2.13 MODIFICATIONS TO EXISTING LJUNGSTROM AIR HEATERS (GENERATORS NO. 1 & 3)

Existing air heaters are the regenerative type constructed of materials adequate to withstand the corrosion effects of the flue gases. Modifications shall preclude cold-end corrosion of the air heater under any load condition. Temperatures of all metals in contact with flue gas shall be above the flue gas maximum dewpoint temperature for the fuel being fired under all load conditions. Control shall be by automatic bypass and shall be integrated with the combustion control system.

The existing air heaters were manufactured by:

Air Preheater Company  
Alstom Power Inc.  
3020 Traux Road, P.O. Box 372  
Wellsville, NY 14895  
Contract No. LAP-4128  
Size 3-13 FIK  
Serial Nos. 6992, 6993 or 6994

### 2.13.1 Modifications to Reduce the Heat Transfer Rate and Meet the Following Operating Conditions

Contractor shall replace existing hot end and cold end gasketed heating elements with new having reduced heat transfer capabilities. Seals and mounting hardware installation shall also be replaced to reduce leakage from air side to flue gas side.

Combustion air and flue gas bypasses shall be installed around the air heater to provide further reduction of heat transfer. With HTHW generator loads above approximately 80 percent, spray dryer absorber (SDA) inlet temperature shall be controlled using modulating dampers on the combustion air side of the air heater (D-1 & D-2). This normal mode of operation shall maintain a flue gas temperature of 350 degrees F to the SDA, allowing the SDA to operate at its optimum efficiency. A special condition will exist when HTHW generator outlet flue gas temperature drops below 414 degrees F.

At this time the combustion air side shall track in full bypass, and the flue gas side shall go into bypass. As the load increases and the HTHW generator outlet flue gas temperature increases above 430 degrees F, the flue gas bypass dampers (D-3 & D-4) shall go out of bypass mode. The combustion air side shall be released from track and allowed to modulate, controlling the SDA inlet temperature at 350 degrees F.

Load	100%	90%	80%
Flow Rates Lbs/Hr			
Air Entering	80,066	56,100	25,500
Air Leaving	65,266	42,000	13,000
Gas Entering	92,693	88,270	80,872
Gas Leaving	107,493	102,370	93,372
Cold Air Bypassed	7,495	26,583	50,889
Leakage	14,800	14,100	12,500
	15.97%	15.97%	15.46%
Temperatures Deg. F			
Air Entering	68	68	68
Air Leaving	152	157	226
Mixed Air to Grate	143	121	100
Gas Entering	448	431	414
Gas Leaving w/o Leakage	393	392	391
Gas Leaving w/ Leakage	351	350	350
Average Cold End	231	230	230
Pressure Diff. In. W.G.			
Pressure Drop Air	0.15	0.10	0.05
Pressure Drop Gas	0.35	0.30	0.30
Hot End Diff.	8.90	8.20	7.10
Cold End Diff.	9.40	8.60	7.45

### 2.13.2 Material List of Changes

Material list of changes shall include:

Item No.	Description	Qty	U/M
1	Cold End Full Sector Baskets	2	Sets
2	Hot End Full Sector Baskets	2	Sets
3	Hot & Cold Radial Seals;	2	Sets
	Holding Strips; Heavy Fasteners	2	Sets
4	Hot & Cold Circ. Seals;	2	Sets
	Holding Strips; Fasteners	2	Sets
5	Hot & Cold Post Seals	2	Sets
6	Hot End Circ. Clamp Assy.	2	Sets

### 2.13.3 Service Engineer

Service engineer from manufacturer shall perform:

Inspection during field construction and approval of construction methods/quality.

Field performance test on each unit in operation over operating load range.

### PART 3 EXECUTION

#### 3.1 MODIFICATION OF BOILER AND AUXILIARY EQUIPMENT

Equipment shall be installed as indicated and in accordance with manufacturers' instructions.

Alternations to HTHW generators shall be made in accordance with the established standards, procedures, and applicable codes. Maintenance of the HTHW generator ASME stamp certification shall be ensured. Alternations to HTHW generators shall not be initiated without authorization of a special boiler inspector authorized by the State of Montana and the National Board of Boiler and Pressure Vessel Inspectors. Contractor performing alterations to HTHW generators shall hold a National Board "R" stamp. Special boiler inspector shall inspect HTHW generator alterations.

#### 3.2 FIELD PAINTING AND COATING

Except as otherwise specified, ferrous metal shall be cleaned, prepared, and painted as specified in Section 09900 PAINTS AND COATINGS. Exposed pipe covering shall be painted as specified in Section 09900 PAINTS AND COATINGS. Aluminum sheath over insulation shall not be painted.

#### 3.3 TESTS

##### 3.3.1 Hydrostatic Tests

Following modification of tubes, HTW generator No. 1 and No. 3 shall be tested hydrostatically and proved tight under a gauge pressure of 1-1/2 times the specified working pressure. Following the installation of all piping and boiler house equipment, but before the application of any insulation, hydrostatic tests shall be made and the system proved tight under gauge pressures of 1-1/2 times the specified working pressure. Tests shall be made under the direction of, and subject to, the approval of the Contracting Officer. The Contractor shall adjust all equipment and controls before the scheduled operational test. A testing schedule shall be submitted at least 15 days before scheduled test.

Note: The boilers each have isolation valves, though they cannot be guaranteed to hold.

a. The boiler MAWP's are 500#.

b. Each boiler has two safety relief valves, one set at 500# and one set at 515#.

c. The safety valves have 4"-300# flanged inlets and 6"-150# flanged outlets.

##### 3.3.1.1 Water Sides Including Fittings and Accessories

Water sides shall be hydrostatically tested in accordance with the requirements of ASME BPVC SEC I and ASME BPVC SEC VIII D1 as applicable.

##### 3.3.1.2 Generator Casing, Air Casings, and Ducts

~~Air casing and ducts exterior to the generators shall be tested pneumatically at the maximum working pressure. The soap bubble or smoke bomb method shall be used to verify tightness. Gas sides of the generators normally operated under pressure shall be tested for tightness at 1 1/2 times the predicted operating pressure in the furnace at maximum predicted output. For this test the generator shall be tightly sealed with a suitable means to blank off all openings. Air shall be admitted to the generator until the test pressure is reached and then shall be held. If in a 10 minute period the pressure drop does not exceed 5 inches water gauge, the casing shall be regarded as tight and accepted. Air pressure and smoke bomb or comparative CO(2) readings shall be used for induced draft generators.~~

Leak testing shall be limited to work performed under this contract as follows:

a. New Furnace Tube Work:

Pressurize furnace to +0.15 inches of water using F.D. fan and O.F.A. fan; smoke bomb test.

b. Burner Windboxes:

Temporarily block new refractory throat; pressurize using new burner F.D. fan; soap test.

c. Combustion Air Ductwork:

Close under grate blast gate (at windbox); pressurize using existing F.D. fan; soap test.

d. Flue Gas Breeching:

Close spray dryer inlet damper and spray dryer baghouse bypass damper; pressurize furnace using F.D. fan and O.F.A. fan; smoke bomb test.

### 3.3.2 Capacity and Efficiency Tests, Burners Only

The capacity and efficiency at the specified capacity of the generator shall be determined in accordance with the ASME PTC 4.1 for steam generating units adjusted for High Temperature Hot Water units. The efficiency shall be determined by the direct input-output method and shall be checked with the loss method computation. Test runs shall be made at the maximum capacity for 4 hours; at the minimum capacity and at 50 percent capacity for 2 hours each, respectively. Test reports and performance curves shall be submitted to the Contracting Officer. Before any operational tests are conducted, the system shall be correctly balanced within 5 percent of that indicated. Corrections and adjustments shall be made as necessary to produce the required conditions. Approved methods shall be used to measure all rates of flow. The efficiency and general performance tests on the boilers shall be conducted by a qualified test engineer furnished by the Contractor, and observed by a representative of the Contracting Officer. Testing apparatus shall be set up, calibrated, tested, and readied for testing the boiler before the arrival of the representative of the Contracting Officer. Calibration curves or test results furnished by an independent testing laboratory for each instrument, meter, gauge, and thermometer to be used in efficiency and capacity test shall be furnished before the test. A test report including logs, heat balance calculations, and tabulated results together with conclusions shall be delivered in quadruplicate. An analysis of the fuel being burned on the test shall be submitted to the Contracting Officer. The analysis shall include all pertinent data tabulated in the ASME PTC 4.1 abbreviated efficiency test. The Contractor shall provide and install all necessary piping, valves, controls, and heat exchanger to provide a load for testing each HTW generator. If any system load is available, the Contracting

Officer will provide for loading the heating system for the test, but full-load capability will probably require the supplementary heat exchanger for the test. Should Item No. 0009, Provide Load Simulator System, not be awarded, it will be acceptable to postpone testing, without penalty to the Contractor, until such time as the Government can provide a full system load from existing buildings and equipment.

### 3.3.3 Operating Tests, Burners Only

After adjustment and achievement of stable operation of the HTW generators, each shall be tested continuously for 12 hours, minimum, to demonstrate control and operational conformance to the requirements of this specification under varying load conditions ranging from the specified capacity to the minimum burner turndown ratio without on-off cycling. In each case, the operating tests shall cover the periods for the capacities tabulated below:

#### Waterwall Watertube Boilers

Time (minimum)	Percent of Capacity
First 2 hours	20
Next 2 hours	50
Next 2 hours	75
Next 6 hours*	100

\* The efficiency tests may be conducted either concurrently with the operating tests or separately at the option of the Contractor.

### 3.3.4 Operating Tests, Burners and Stoker

After adjustment and achievement of stable operation of the HTW generators, each shall be tested continuously for 12 hours, minimum, to demonstrate control and operational conformance to the requirements of this specification under varying load conditions ranging from the specified capacity to the minimum burner and stoker turndown ratio without on-off cycling. In each case, the operating tests shall cover the periods for the capacities tabulated below:

#### Waterwall Watertube Boilers

Time (minimum)	Boiler Percent of Capacity	Burners Heat Input
First 2 hours	35	10 x 10 MMBtu/hr
Next 2 hours	50	10 x 10 MMBtu/hr
Next 2 hours	75	12 x 10 MMBtu/hr
Next 6 hours*	100	15 x 10 MMBtu/hr

\* The efficiency tests may be conducted either concurrently with the operating tests or separately at the option of the Contractor.

### 3.3.5 Test of Natural Gas Fuel Burning Equipment

- a. Test of fuel burning equipment shall demonstrate that equipment installed will meet requirements of specifications, and that overall efficiency is as specified, with not over 15 percent excess

air, can be obtained with burners operating at 100 percent capacity without flame impingement on any combustion chamber wall, floor, baffle or watertube. Protect the grates from overheating.

- b. Test shall include all boiler and burner interlocks, safety interlocks, combustion controls, actuators, valves, controllers, gauges, thermometers, pilot lights, switches, etc. prior to combustion testing. All malfunctioning components shall be replaced. Submit an itemized data record sheet of this component testing.
- c. Each boiler control system and all boiler appurtenances shall be calibrated and set to ensure the specified performance. The fuel burner, forced-draft fan, controls, etc. shall be fully coordinated, manually capable, and automatically controllable to hold the required settings. The boiler fuel burning system shall be continuously variable throughout the specified operating range without manual adjustment of burner, register or nozzle, and turndown shall be achieved without manual adjustment. Testing apparatus shall be set up, calibrated, tested and ready for use prior to final combustion testing. Calibration certificates for all test instruments shall be furnished with test data.

#### 3.3.5.1 Sequencing

The HTW generator shall start, operate, and stop in accordance with the specified operating sequence.

#### 3.3.5.2 Flame Safeguard

The operation of the flame safeguard control on gas-fired burners shall be verified by simulated flame and ignition failures. Burners having continuous or intermittent pilots shall be tested by simulating main flame failure while the pilot is burning. The trial-for-pilot ignition, trial-for-main-flame ignition, combustion control reaction, and valve closing times shall be verified by stop watch.

- a. Immunity to Hot Refractory: The burner shall be operated at high fire until the combustion chamber refractory reaches maximum temperature. The main fuel valve shall then be closed manually. The combustion safeguard shall drop out immediately causing the safety shutoff valves to close within the specified control reaction and valve closing times.
- b. Pilot Intensity Required: The fuel supply to the pilot flame shall be gradually reduced to the point where the combustion safeguard begins to drop out (sense "no flame") but holds in until the main fuel valve opens. At this point of reduced pilot fuel supply, the pilot flame shall be capable of safely igniting the main burner. If the main fuel valve can be opened on a pilot flame of insufficient intensity to safely light the main flame, the generator shall be rejected.
- c. Turndown Ratio: The specified turndown ratio shall be verified by firing at the minimum firing rate.

- d. HTW Generator Limit and Fuel Safety Interlocks: Safety shutdown shall be caused by simulating interlock actuating conditions for each generator limit and fuel and safety interlock. Safety shutdowns shall occur in the specified manner.
- e. Combustion Controls: The accuracy range and smoothness of operation of the combustion controls shall be demonstrated by varying the demand throughout the entire firing range required by the turndown ratio specified for the burner and stoker and in the case of automatic sequenced burners by further varying the firing rate to require on-off cycling. The control accuracy shall be as specified.
- f. Safety Valves: Safety valves on HTW generators shall not be tested under operating conditions.

### 3.4 CLEANING OF HTW GENERATORS AND PIPING

#### 3.4.1 HTW Generator Cleaning

After the hydrostatic tests have been made, and before performance of the operating tests, the boiler tubes modified under this project, from the upper header to the lower header shall be thoroughly and effectively cleaned of foreign materials. Wherever possible, surfaces to be cleaned that are in contact with water shall be wire brushed to remove loose material, the fire side need not be cleaned. The Contractor may use the following procedure or may submit his own standard procedure for review and approval by the Contracting Officer. HTW generators shall be filled with a solution consisting of the following proportional ingredients for every 1000 gallons of water, and operated at approximately 30 to 50 psig for a period of 24 to 48 hours:

24 lb. caustic soda; 8 lb. sodium nitrate; 24 lb. disodium phosphate, anhydrous; and 1/2 lb. approved wetting agent.

Chemicals in the above proportions, or as otherwise approved, shall be thoroughly dissolved in the water before being placed in the HTW generator. After the specified boiling period, the boilers shall be allowed to cool, and then drained and thoroughly flushed. Piping shall be cleaned by operating the HTW generators for a period of approximately 48 hours.

### 3.5 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installing, adjusting, and testing of the equipment. Contractor shall provide a minimum of two (2) weeks of burner manufacturer's representative on site for combustion control adjustment. Scheduling shall coincide with the visit of the manufacturer's representative for the variable frequency drives for the ID fan motors. Service engineers shall startup, calibrate and place in automatic operation the following:

1. Burner & Burner Management System
2. Bypass dampers and controls

## 3. I.D. fan motor VFD

The following additional field services shall be provided:

1. One day of field labor to witness loop testing of burner management field wiring. Indicated in writing if not satisfied with all field wiring at the end of this period, or wiring will be treated as acceptable.
2. Three days of field assistance during boiler "ASME power code test". The above assistance time periods are not necessarily contiguous. Field service engineer shall oversee and manage the boiler "boil-out", burner adjustment, ASME power code test, and Demonstration. This field service engineer will not be replaced during startup without prior written notice and consent of the Contracting Officer. If any phase of startup or commissioning is delayed because additional parts are required, the burner and burner management service engineer shall remain in the field.
3. System will be acceptable when the system is in automatic control operating at 10 MMBtu/hour load changes in one (1) minute from low load to high load or high to low load, or intermittent swing loads without noticeable pulsation, and the manufacturer's service engineer is not adjusting controllers on natural gas. The following performance guarantees shall be demonstrated to the Contracting Officer. The system shall be operated within the range of 10 MMBtu/hour to 50 MMBtu/hour (heat input) with load swings of 10 MMBtu/hour/minute in either direction. All measurements will be made using 15 minute averaging. The system shall be operated in the automatic mode only without burner and combustion controls adjustment. The following guarantees shall be demonstrated:

	Natural Gas Only
Particulate Matter EPA Method 1-5 (270 degrees F Filter)	0.005 lbs/10 million Btu
Particulate Matter (Opacity EPA Method 9)	Less than 10%
Nitrogen Oxides (NO & NO2) EPA Method 7E	0.15 lbs/million Btu Heat Input
Carbon Monoxide EPA Method 10B	0.11 lbs/million Btu Heat Input
From Minimum Load, Heat Input	20%
To Maximum Load, Heat Input	100%

4. Provide five (5) man days of operational training by the burner service engineer. The service shall not adjust the system during this week. This week will also be used as the operational acceptance test. If the service engineer needs to adjust the burner or controls, then this week will be repeated at no additional cost.

5. Retain the services International Boiler, Inc. to inspect and approve all generator tube work and casing/insulation work.

#### 3.5.1 Field Training

A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of 2 weeks of normal working time and shall start after the system is functionally complete and adjusted, but prior to final acceptance tests. Field training shall cover all of the items contained in the approved operating and maintenance instructions. Field training time is separate from startup and adjustment.

-- End of Section --

## SECTION 16120A

## INSULATED WIRE AND CABLE

## 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.

## ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS5 (Oct 1987; 9th Ed) Thermoplastic and Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 35 kV

AEIC CS6 (Oct 1987; 5th Ed; Rev Mar 1989) Ethylene Propylene Insulated Shielded Power Cables Rated 5 Through 69 kV

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC 7 (1988) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NEMA WC 8 (1988) Ethylene-Propylene-Rubber- Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

## 1.2 SUBMITTALS

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

## SD-03 Product Data

Installation Instructions; G.

The Contractor shall submit cable manufacturing data as requested.

## SD-06 Test Reports

Tests, Inspections, and Verifications; G.

Six (6) certified copies of test reports shall be submitted by the contractor.

### 1.3 DELIVERY, STORAGE, AND HANDLING

Furnish cables on reels or coils. Each cable and the outside of each reel or coil, shall be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel of cable shall contain only one continuous cable without splices. Cables for exclusively dc applications, as specified in paragraph HIGH VOLTAGE TEST SOURCE, shall be identified as such. Shielded cables rated 2,001 volts and above and shall be reeled and marked in accordance with Section I of AEIC CS5 or AEIC CS6, as applicable. Reels shall remain the property of the Contractor.

### 1.4 PROJECT/SITE CONDITIONS

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Wire Table

Wire and cable shall be furnished in accordance with the requirements of the detailed requirements specified herein.

#### 2.1.2 Rated Circuit Voltages

All wire and cable shall have minimum rated circuit voltages in accordance with Table 3-1 of NEMA WC 7 or NEMA WC 8.

#### 2.1.3 Conductors

##### 2.1.3.1 Material

Conductors shall conform to all the applicable requirements of Section 2 of NEMA WC 7 or Part 2 of NEMA WC 8 as applicable and shall be annealed copper. Copper conductors may be bare, or tin- or lead-alloy-coated, if required by the type of insulation used.

##### 2.1.3.2 Size

Minimum wire size shall be No. 12 AWG for power and lighting circuits; No. 10 AWG for current transformer secondary circuits; No. 14 AWG for potential transformer, relaying, and control circuits; No. 16 AWG for annunciator circuits; and No. 19 AWG for alarm circuits. Minimum wire sizes for rated circuit voltages of 2,001 volts and above shall not be less than those listed for the applicable voltage in Table 3-1 of Section 3 of NEMA WC 7 or Part 3 of NEMA WC 8, as applicable.

##### 2.1.3.3 Stranding

Conductor stranding classes cited herein shall be as defined in Appendix L of NEMA WC 7 or NEMA WC 8, as applicable. Lighting conductors No. 10 AWG and smaller shall be solid or have Class B stranding. Any conductors used between stationary and moving devices, such as hinged doors or panels, shall have Class H or K stranding. All other conductors shall have Class B or C stranding, except that conductors shown on the drawings, or in the schedule, as No. 12 AWG may be 19 strands of No. 25 AWG, and conductors shown as No. 10 AWG may be 19 strands of No. 22 AWG.

#### 2.1.4 Insulation

#### 2.1.5 Cabling

Individual conductors of multiple-conductor cables shall be assembled with flame-and moisture-resistant fillers, binders, and a lay conforming to Part 5 of NEMA WC 8, except that flat twin cables will not be permitted. Fillers shall be used in the interstices of multiple-conductor round cables with a common covering where necessary to give the completed cable a substantially circular cross section. Fillers shall be non-hygroscopic material, compatible with the cable insulation, jacket, and other components of the cable. The rubber-filled or other approved type of binding tape shall consist of a material that is compatible with the other components of the cable and shall be lapped at least 10 percent of its width.

#### 2.1.6 Dimensional Tolerance

The outside diameters of single-conductor cables and of multiple-conductor cables shall not vary more than 5 percent and 10 percent, respectively, from the manufacturer's published catalog data.

### 2.2 INSTALLATION INSTRUCTIONS

The following information shall be provided by the cable manufacturer for each size, conductor quantity, and type of cable furnished:

- a. Minimum bending radius, in inches - For multiple-conductor cables, this information shall be provided for both the individual conductors and the multiple-conductor cable.
- b. Pulling tension and sidewall pressure limits, in pounds.
- c. Instructions for stripping semiconducting insulation shields, if furnished, with minimum effort without damaging the insulation.
- d. Upon request, compatibility of cable materials and construction with specific materials and hardware manufactured by others shall be stated. Also, if requested, recommendations shall be provided for various cable operations, including installing, splicing, terminating, etc.

### 2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

#### ~~2.3.1 Cable Data~~

~~Manufacture of the wire and cable shall not be started until all materials to be used in the fabrication of the finished wire or cable have been approved by the Contracting Officer. Cable data shall be submitted for approval including dimensioned sketches showing cable construction, and sufficient additional data to show that these specifications will be satisfied.~~

#### 2.3.2 Inspection and Tests

Inspection and tests of wire and cable furnished under these specifications shall be made by and at the plant of the manufacturer, and shall be

witnessed by the Contracting Officer or his authorized representative, unless waived in writing. The Government may perform further tests before or after installation. Testing in general shall comply with Section 6 of NEMA WC 7 or Part 6 of NEMA WC 8. Specific tests required for particular materials, components, and completed cables shall be as specified in the sections of the above standards applicable to those materials, components, and cable types. Tests shall also be performed in accordance with the additional requirements specified below.

#### 2.3.2.1 Reports

Results of tests made shall be furnished. No wire or cable shall be shipped until authorized. Lot number and reel or coil number of wire and cable tested shall be indicated on the test reports.

#### PART 3 EXECUTION (NOT APPLICABLE)

-- End of Section --

## SECTION 16403A

## MOTOR CONTROL CENTERS, SWITCHBOARDS AND PANELBOARDS

## 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.

## ASME INTERNATIONAL (ASME)

ASME B1.1 (1989) Unified Inch Screw Threads (UN and UNR Thread Form)

ASME B1.20.1 (1983; R 1992) Pipe Threads, General Purpose (Inch)

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1 (1993) Molded Case Circuit Breakers and Molded Case Switches

NEMA ICS 1 (1993) Industrial Control and Systems

## NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1993) National Electrical Code

## UNDERWRITERS LABORATORIES (UL)

UL 44 (1991; Rev thru Jan 1995) Rubber- Insulated Wires and Cables

UL 489 (1991; Rev thru Dec 1994) Molded Case Circuit Breakers and Circuit Breaker Enclosures

UL 1063 (1993; Rev thru Oct 1994) Machine-Tool Wires and Cables

## 1.2 SYSTEM DESCRIPTION

These specifications include the design, fabrication, assembly, wiring, testing, and delivery of the items of equipment and accessories and spare parts listed in the Schedule and shown on the drawings.

## 1.2.1 Rules

The equipment shall conform to the requirements of NFPA 70 unless more stringent requirements are indicated herein or shown. NEMA rated and UL listed equipment has been specified when available. Equipment must meet NEMA and UL construction and rating requirements as specified. No equivalent will be acceptable. The contractor shall immediately notify the

Contracting Officer of any requirements of the specifications or contractor proposed materials or assemblies that do not comply with UL or NEMA. International Electrotechnical Commission (IEC) rated equipment will not be considered an acceptable alternative to specified NEMA ratings.

#### 1.2.2 Coordination

The general arrangement of the motor control centers, switchboards and panelboards is shown on the contract drawings. Any modifications of the equipment arrangement or device requirements as shown on the drawings shall be subject to the approval of the Contracting Officer. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. All equipment shall be completely assembled at the factory. The motor control centers and switchboards may be disassembled into sections, if necessary, for convenience of handling, shipping, and installation.

#### 1.2.3 Standard Products

Material and equipment shall be standard products of a manufacturer regularly engaged in their manufacture and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. All materials shall conform to the requirements of these specifications. Materials shall be of high quality, free from defects and imperfections, of recent manufacture, and of the classification and grades designated. All materials, supplies, and articles not manufactured by the Contractor shall be the products of other recognized reputable manufacturers. If the Contractor desires for any reason to deviate from the standards designated in these specifications, he shall, after award, submit a statement of the exact nature of the deviation, and shall submit, for the approval of the Contracting Officer, complete specifications for the materials which he proposes to use.

#### 1.2.4 Nameplates

Nameplates shall be made of laminated sheet plastic or of anodized aluminum approximately 4 millimeters (1/8 inch) thick, engraved to provide white letters on a black background. The nameplates shall be fastened to the panels in proper positions with anodized round-head screws. Lettering shall be minimum 15 millimeters (1/2 inch) high. Nameplate designations shall be in accordance with lists on the drawings, and as a minimum shall be provided for the following equipment:

- a. Motor Control Centers
- b. Individual items of equipment mounted in the Motor Control Centers
- c. Switchboards
- d. Individually-mounted circuit breakers in Switchboard
- e. Group-mounted circuit breakers in Switchboard
- f. Panelboards
- g. Individually-mounted circuit breakers in Panelboard

Equipment of the withdrawal type shall be provided with nameplates mounted on the removable equipment in locations visible when the equipment is in place.

### 1.3 SUBMITTALS

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

#### SD-02 Shop Drawings

Drawings; G,  
Shop Drawings; G.

The Contractor shall, within 30 calendar days after date of receipt by him of notice of award, submit for the approval of the Contracting Officer six (6) copies of outline drawings of all equipment to be furnished under this contract, together with weights and overall dimensions. Drawings shall show the general arrangement and overall dimensions of the motor control centers, switchboards, and panelboards. These drawings shall show space requirements, details of any floor supports to be embedded in concrete and provisions for conduits for external cables.

Motor Control Centers and Parts; G.

The Contractor shall, within 30 calendar days after date of receipt by him of notice of award, submit for the approval of the Contracting Officer six (6) copies of electrical equipment drawings. An individual wiring diagram for each motor control center shall be submitted. Wiring diagrams shall be in a form showing physical arrangement of the control center with interconnecting wiring shown by lines or by terminal designations (wireless). A single-line diagram, equipment list and nameplate schedule shall be provided for each motor control center.

#### SD-03 Product Data

Equipment; G.

The Contractor shall within 30 calendar days after date of receipt by him of notice of award submit for approval six (6) copies of such descriptive cuts and information as are required to demonstrate fully that all parts of the equipment will conform to the requirements and intent of the specifications. Data shall include descriptive data showing typical construction of the types of equipment proposed, including the manufacturer's name, type of molded case circuit breakers or motor circuit protectors, performance capacities and other information pertaining to the equipment. Six (6) sets of characteristic curves of the individual breaker trip element shall be submitted.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

The equipment shall be shipped as completely assembled and wired as feasible so as to require a minimum of installation work. Each shipping section shall be properly match marked to facilitate reassembly, and shall be provided with removable lifting channels with eye bolts for attachment of crane slings to facilitate lifting and handling. Any relay or other device which cannot withstand the hazards of shipment when mounted in place on the equipment shall be carefully packed and shipped separately. These devices shall be marked with the number of the panel which they are to be mounted on and fully identified. All finished painted surfaces and metal work shall be wrapped suitably or otherwise protected from damage during shipment. All parts shall be prepared for shipment so that slings for handling may be attached readily while the parts are in a railway car or transport truck. All spare parts and accessories shall be carefully packaged and clearly marked.

#### 1.5 MAINTENANCE

##### 1.5.1 Accessories and Tools

A complete set of accessories and special tools unique to equipment provided and required for erecting, handling, dismantling, testing and maintaining the apparatus shall be furnished by the Contractor.

##### 1.5.2 Spare Parts

Spare parts shall be furnished as specified below. All spare parts shall be of the same material and workmanship, shall meet the same requirements, and shall be interchangeable with the corresponding original parts furnished.

- a. 2 - Fuses of each type and size.
- b. 1 - Circuit breaker auxiliary switch.
- c. 2 - Operating coils for each size ac contactor.
- d. 1 - Operating coil for each size dc contactor.
- e. 2 - Complete sets of 3-pole stationary and moving contact assemblies for each size ac contactor.
- f. 1 - Complete set of 2-pole stationary and moving contact assemblies for each size dc contactor.
- g. 3 - Contactor overload relays of each type and rating, each relay with a complete set of contact blocks.
- h. 1 - spare set of heater elements for each heater rating provided.
- i. 2 - Indicating lamp assemblies of each type.
- j. 1 - Control transformer of each type and rating.
- k. 1 - Control relay of each type and rating.
- l. 1 - Contactor auxiliary contact of each type.

- m. 4 - One quart containers of finish paint for indoor equipment.
- n. 2 - One quart containers of the paint used for the exterior surfaces of outdoor equipment.
- o. 4 - Keys for motor control center door lock.

## PART 2 PRODUCTS

### 2.1 CONNECTIONS

All bolts, studs, machine screws, nuts, and tapped holes shall be in accordance with ASME B1.1. The sizes and threads of all conduit and fittings, tubing and fittings, and connecting equipment shall be in accordance with ASME B1.20.1. All ferrous fasteners shall have rust-resistant finish and all bolts and screws shall be equipped with approved locking devices. Manufacturer's standard threads and construction may be used on small items which, in the opinion of the Contracting Officer, are integrally replaceable, except that threads for external connections to these items shall meet the above requirements.

### 2.2 MOLDED CASE CIRCUIT BREAKERS

Molded case circuit breakers shall conform to the applicable requirements of NEMA AB 1 and UL 489. The circuit breakers shall be manually-operated, shall be quick-make, quick-break, common trip type, and shall be of automatic-trip type unless otherwise specified or indicated on the drawings. All poles of each breaker shall be operated simultaneously by means of a common handle. The operating handles shall clearly indicate whether the breakers are in "On," "Off," or "Tripped" position and shall have provisions for padlocking in the "Off" position. Personnel safety line terminal shields shall be provided for each breaker. The circuit breakers shall be products of only one manufacturer, and shall be interchangeable when of the same frame size. Where indicated on the drawings, circuit breakers shall be provided with shunt trip devices.

#### 2.2.1 Trip Units

Except as otherwise noted, the circuit breakers, of frame sizes and the trip unit ratings as shown on the drawings, shall be provided with combination thermal and instantaneous magnetic or solid state trip units. The Government reserves the right to change the indicated trip ratings, within frame limits, of the trip devices at the time the shop drawings are submitted for approval. The breaker trip units shall be interchangeable and the instantaneous magnetic trip units shall be adjustable on frame sizes larger than 150 amperes. Nonadjustable instantaneous magnetic trip units shall be set at approximately 10 times the continuous current ratings of the circuit breakers. Solid state trip units, where indicated, shall also have adjustable long time pick-up and delay, short time pick-up and delay, and ground fault pick-up and delay.

#### 2.2.2 480-Volt AC Circuits

Circuit breakers for 480-volt or 277/480-volt ac circuits shall be rated 600 volts ac, and shall have an UL listed minimum interrupting capacity of 22,000 symmetrical amperes at 600 volts ac.

## 2.3 WIRING

All control wire shall be stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44 or Type MTW meeting UL 1063, and shall pass the VW-1 flame tests included in those standards. Hinge wire shall have Class K stranding. Current transformer secondary leads shall be not smaller than No. 10 AWG. The minimum size of control wire shall be No. 14 AWG. Power wiring for 480-volt circuits and below shall be of the same type as control wiring and the minimum size shall be No. 12 AWG. Special attention shall be given to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

## 2.4 TERMINAL BLOCKS

Control circuit terminal blocks for control wiring shall be molded or fabricated type with barriers, rated not less than 600 volts. The terminals shall be removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts. The terminals shall be not less than No. 10 in size and shall have sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. The terminal arrangement shall be subject to the approval of the Contracting Officer and not less than four (4) spare terminals or 10 percent, whichever is greater, shall be provided on each block or group of blocks. Modular, pull apart, terminal blocks will be acceptable provided they are of the channel or rail-mounted type. The Contractor shall submit data showing that the proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

### 2.4.1 Types of Terminal Blocks

#### 2.4.1.1 Short-Circuiting Type

Short-circuiting type terminal blocks shall be furnished for all current transformer secondary leads and shall have provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks shall meet the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

#### 2.4.1.2 Load Type

Load terminal blocks rated not less than 600 volts and of adequate capacity shall be provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits except those for feeder tap units. The terminals shall be of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, screws shall have hexagonal heads. Conducting parts between connected terminals shall have adequate contact surface and cross-section to operate without overheating. Each connected terminal shall have the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

### 2.4.2 Marking Strips

White or other light-colored plastic marking strips, fastened by screws to each terminal block, shall be provided for wire designations. The wire numbers shall be made with permanent ink. The marking strips shall be reversible to permit marking both sides, or two marking strips shall be furnished with each block. Marking strips shall accommodate the two sets of wire numbers. Each device to which a connection is made shall be assigned a device designation in accordance with NEMA ICS 1 and each device terminal to which a connection is made shall be marked with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, additional wire and cable designations for identification of remote (external) circuits shall be provided for the Government's wire designations. Prints of drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

## 2.5 MOLDED CASE CIRCUIT BREAKERS AND WIRING FOR MCCS

### 2.5.1 Molded Case Circuit Breakers in Unit Compartments

Molded case circuit breakers for installation in unit compartments shall meet the requirements of paragraph MOLDED CASE CIRCUIT BREAKERS above.

### 2.5.2 ring for Motor Control Centers

All wiring shall meet the requirements of paragraph WIRING above. Heavy-duty clamp type terminals shall be provided by the Contractor for terminating all power cables entering the control centers.

#### 2.5.2.1 Contractor's Wiring

The Contractor's wiring shall be formed into groups, suitably bound together, properly supported and run straight horizontally or vertically. There shall be no splices in the wiring. The manufacturer's standard pressure-type wire terminations for connections to internal devices will be acceptable. Terminal blocks shall be added for wiring to devices having leads instead of terminals. Ring tongue indented terminals shall be used on all wires terminated on control terminal blocks for external or interpanel connections and at shipping splits. All stud terminals shall have contact nuts and either locking nuts or lockwashers.

#### 2.5.2.2 External Connections

Power and control cables will enter the control centers at the top.

#### 2.5.2.3 Terminal Blocks

Terminal blocks shall meet the requirements of paragraph TERMINAL BLOCKS above. In no case shall the terminals provided for circuit breakers or contactors accommodate less than the number or size of conductors shown on the drawings. Special attention shall be given to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

PART 3 EXECUTION (NOT APPLICABLE)

~~SECTION B  
SUPPLIES/SERVICES AND PRICES~~

<del>ITEM</del>	<del>DESCRIPTION</del>	<del>EST</del>	<del>U/M</del>	<del>UNIT</del>	<del>AMOUNT</del>
		<del>QTY</del>		<del>PRICE</del>	
<del>0001</del>	<del>480 VOLT, 3 PHASE, UNIT MOTOR CONTROL CENTER (NO. _____)</del>	<del>1</del>	<del>LS</del>	<del>EACH</del>	<del>\$ _____</del>
<del>000X</del>	<del>480 VOLT, 3 PHASE, MOTOR CONTROL CENTER (NO. _____)</del>	<del>1</del>	<del>LS</del>	<del>EACH</del>	<del>\$ _____</del>
<del>000X</del>	<del>480 VOLT, 3 PHASE, POWER DISTRIBUTION SWITCHBOARD (NO. _____)</del>	<del>1</del>	<del>LS</del>	<del>EACH</del>	<del>\$ _____</del>
<del>000X</del>	<del>480 VOLT, 3 PHASE, POWER DISTRIBUTION PANELBOARD (NO. _____)</del>	<del>1</del>	<del>LS</del>	<del>EACH</del>	<del>\$ _____</del>
<del>000X</del>	<del>ACCESSORIES AND SPARE PARTS</del>	<del>1</del>	<del>LOT</del>	<del>XXXX</del>	<del>\$ _____</del>
<del>000X</del>	<del>CONTRACT DATA (PART 1, THE SCHEDULE) (SEE DD FORM 1423, EXHIBIT B)</del>	<del>XXX</del>	<del>XXX</del>	<del>NSP</del>	<del>XXXXXXXXXXXX</del>

-- End of Section --



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## SECTION 16415A

## ELECTRICAL WORK, INTERIOR

## 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 C39.1 (1981; R 1992) Requirements for Electrical Analog Indicating Instruments

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 1 (1995) Hard-Drawn Copper Wire

ASTM B 8 (1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM D 709 (2000) Laminated Thermosetting Materials

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1 (1993) Molded Case Circuit Breakers and Molded Case Switches

NEMA FU 1 (1986) Low Voltage Cartridge Fuses

NEMA ICS 1 (1993) Industrial Control and Systems

NEMA ICS 2 (1993) Industrial Controls and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC

NEMA ICS 3 (1993) Industrial Control and Systems Factory Built Assemblies

NEMA ICS 6 (1993) Industrial Control and Systems, Enclosures

NEMA MG 1 (1998) Motors and Generators

NEMA MG 10 (1994) Energy Management Guide for Selection and Use of Polyphase Motors

NEMA OS 1 (1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA WD 1 (1999) General Requirements for Wiring Devices

NEMA WD 6 (1997) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2000) Life Safety Code

NFPA 70 (2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1004 (1994; Rev thru Nov 1999) Electric Motors

UL 198B (1995) Class H Fuses

UL 198C (1986; Rev thru Feb 1998) High-Interrupting-Capacity Fuses, Current-Limiting Types

UL 198D (1995) Class K Fuses

UL 198E (1988; Rev Jul 1988) Class R Fuses

UL 198G (1988; Rev May 1988) Fuses for Supplementary Overcurrent Protection

UL 198H (1988; Rev thru Nov 1993) Class T Fuses

UL 198L (1995; Rev May 1995) D-C Fuses for Industrial Use

UL 20 (1995; Rev thru Oct 1998) General-Use Snap Switches

UL 467 (1993; Rev thru Apr 1999) Grounding and Bonding Equipment

UL 486A (1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors

UL 486B (1997; Rev Jun 1997) Wire Connectors for Use with Aluminum Conductors

UL 486C (1997; Rev thru Aug 1998) Splicing Wire Connectors

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 50	(1995; Rev thru Nov 1999) Enclosures for Electrical Equipment
UL 508	(1999) Industrial Control Equipment
UL 510	(1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 512	(1993; Rev thru Mar 1999) Fuseholders
UL 514A	(1996; Rev Dec 1999) Metallic Outlet Boxes
UL 514B	(1997; Rev Oct 1998) Fittings for Cable and Conduit
UL 6	(1997) Rigid Metal Conduit
UL 674	(1994; Rev thru Oct 1998) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations
UL 698	(1995; Rev thru Mar 1999) Industrial Control Equipment for Use in Hazardous (Classified) Locations
UL 83	(1998; Rev thru Sep 1999) Thermoplastic-Insulated Wires and Cables
UL 845	(1995; Rev thru Nov 1999) Motor Control Centers
UL 877	(1993; Rev thru Nov 1999) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 886	(1994; Rev thru Apr 1999) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 98	(1994; Rev thru Jun 1998) Enclosed and Dead-Front Switches
UL Elec Const Dir	(1999) Electrical Construction Equipment Directory

## 1.2 GENERAL

### 1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated or shown.

### 1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be carefully coordinated with mechanical or structural features prior to installation and positioned according to architectural reflected ceiling plans; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate the electrical requirements of the mechanical work and provide all power related circuits, wiring, hardware and structural support, even if not shown on the drawings.

### 1.2.3 Special Environments

#### 1.2.3.1 Weatherproof Locations

Wiring, Fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations.

#### 1.2.3.2 Ducts, Plenums and Other Air-Handling Spaces

Wiring and equipment in ducts, plenums and other air-handling spaces shall be installed using materials and methods in conformance with NFPA 70 unless more stringent requirements are indicated in this specification or on the contract drawings.

### 1.2.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

### 1.2.5 Nameplates

#### 1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled

letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4 inch High Letters	Minimum 1/8 inch High Letters
Panelboards	Control Power Transformers
Starters	Control Devices
Safety Switches	Instrument Transformers
Motor Control Centers	
Transformers	
Equipment Enclosures	
Switchgear	
Switchboards	
Motors	

Each panel, section, or unit in motor control centers, switchgear or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

#### 1.2.6 As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish 2 sets of as-built drawings to the Contracting Officer.

#### 1.2.7 Recessed Light Fixtures (RLF) Option

The Contractor has the option to substitute inch-pound (I-P) RLF to metric RLF.

### 1.3 SUBMITTALS

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

#### SD-02 Shop Drawings

Interior Electrical Equipment; G,

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the

Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

- a. Transformers.
- b. Switchgear.
- c. Battery system including calculations for the battery and charger.
- d. Voltage regulators.
- e. Grounding resistors.
- f. Motors and rotating machinery.
- g. Motor control centers.
- h. Busway systems.
- i. Single line electrical diagrams including primary, metering, sensing and relaying, control wiring, and control logic.
- j. Sway bracing for suspended luminaires.

Structural drawings showing the structural or physical features of major equipment items, components, assemblies, and structures, including foundations or other types of supports for equipment and conductors. These drawings shall include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of equipment and components and the relative arrangement and physical connection of related components. Weights of equipment, components and assemblies shall be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic forces shall be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings shall show the provisions for leveling, anchoring, and connecting all items during installation, and shall include any recommendations made by the manufacturer.

Electrical drawings including single-line and three-line diagrams, and schematics or elementary diagrams of each electrical system; internal wiring and field connection diagrams of each electrical device when published by the manufacturer; wiring diagrams of cabinets, panels, units, or separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; field connection diagrams that show the termination of wiring routed between separate items of equipment;

internal wiring diagrams of equipment showing wiring as actually provided for this project. Field wiring connections shall be clearly identified.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons why, shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

#### SD-03 Product Data

Fault Current and Protective Device Coordination Study; G.

The study shall be submitted along with protective device equipment submittals. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Manufacturer's Catalog; G.

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; G.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

Installation Procedures.

Installation procedures for rotating equipment, transformers, switchgear, battery systems, voltage regulators, and grounding resistors. Procedures shall include diagrams, instructions, and precautions required to install, adjust, calibrate, and test devices and equipment.

As-Built Drawings; G

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be

added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

Onsite Tests; G,

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-06 Test Reports

Factory Test Reports; G.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

Field Test Plan; G.

A detailed description of the Contractor's proposed procedures for onsite test submitted 20 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports; G.

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.
- h. Final position of controls and device settings.

#### SD-07 Certificates

##### Materials and Equipment

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

#### 1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

#### PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

#### 2.1 CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

#### 2.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

#### 2.1.2 Aluminum Conductors

Aluminum conductors shall not be used except where extending existing aluminum circuits.

#### 2.1.3 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, Type THHN/THWN conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type THW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

#### 2.1.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

#### 2.1.5 Tray Cable or Power Limited Tray Cable

UL listed; Type TC or PLTC.

### 2.2 CIRCUIT BREAKERS

#### 2.2.1 MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489 and UL 877 for circuit breakers and circuit breaker enclosures located in hazardous (classified) locations. Circuit breakers may be installed in panelboards, switchboards, enclosures, motor control centers, or combination motor controllers.

##### 2.2.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper and aluminum conductors in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-

pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

#### 2.2.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

#### 2.2.1.3 Cascade System Ratings

Circuit breakers used in series combinations shall be in accordance with UL 489. Equipment, such as switchboards and panelboards, which house series-connected circuit breakers shall be clearly marked accordingly. Series combinations shall be listed in the UL Recognized Component Directory under "Circuit Breakers-Series Connected."

#### 2.2.1.4 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 150 amperes.

#### 2.2.2 Solid-State Trip Elements

Solid-state circuit breakers shall be provided as shown. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-state sensing shall measure true RMS current with error less than one percent on systems with distortions through the 13th harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be torodial construction, encased in a plastic housing filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100 percent continuous duty. Circuit breakers shall have tripping features as shown on the drawings and as described below:

- a. Long-time current pick-up, adjustable from 50 percent to 100 percent of continuous current rating.

- b. Adjustable long-time delay.
- c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.
- d. Adjustable short-time delay.
- e. Short-time I square times t switch.
- f. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.
- g. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but not greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap will not be permitted. Zone-selective interlocking shall be provided as shown.
- h. Fixed or Adjustable ground-fault delay.
- i. Ground-fault I square times t switch.
- j. Overload and short-time and ground-fault trip indicators shall be provided.

## 2.3 CONDUIT AND TUBING

### 2.3.1 Rigid Metal Conduit

UL 6.

## 2.4 CONDUIT AND DEVICE BOXES AND FITTINGS

### 2.4.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514A.

### 2.4.2 Boxes, Outlet for Use in Hazardous (Classified) Locations

UL 886.

### 2.4.3 Boxes, Switch (Enclosed), Surface-Mounted

UL 98.

### 2.4.4 Fittings for Conduit and Outlet Boxes

UL 514B.

### 2.4.5 Fittings For Use in Hazardous (Classified) Locations

UL 886.

## 2.5 CONNECTORS, WIRE PRESSURE

### 2.5.1 For Use With Copper Conductors

UL 486A.

#### 2.5.2 For Use With Aluminum Conductors

UL 486B.

#### 2.6 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

#### 2.7 ENCLOSURES

NEMA ICS 6 or UL 698 for use in hazardous (classified) locations, unless otherwise specified.

##### 2.7.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

##### 2.7.2 Circuit Breaker Enclosures

UL 489.

##### 2.7.3 Circuit Breaker Enclosures for Use in Hazardous (Classified) Locations

UL 877.

#### 2.8 LOW-VOLTAGE FUSES AND FUSEHOLDERS

##### 2.8.1 Fuses, Low Voltage Cartridge Type

NEMA FU 1.

##### 2.8.2 Fuses, High-Interrupting-Capacity, Current-Limiting Type

Fuses, Class G, J, L and CC shall be in accordance with UL 198C.

##### 2.8.3 Fuses, Class K, High-Interrupting-Capacity Type

UL 198D.

##### 2.8.4 Fuses, Class H

UL 198B.

##### 2.8.5 Fuses, Class R

UL 198E.

##### 2.8.6 Fuses, Class T

UL 198H.

##### 2.8.7 Fuses for Supplementary Overcurrent Protection

UL 198G.

#### 2.8.8 Fuses, D-C for Industrial Use

UL 198L.

#### 2.8.9 Fuseholders

UL 512.

### 2.9 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

### 2.10 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to NEMA MG 1 and UL 1004 for motors; NEMA MG 10 for energy management selection of polyphase motors; and UL 674 for use of motors in hazardous (classified) locations. In addition to the standards listed above, motors shall be provided with efficiencies as specified in the table "MINIMUM NOMINAL EFFICIENCIES" below and all motors shall be "inverter duty" rated, to allow use with VFD's without loss of motor life.

#### 2.10.1 Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

#### 2.10.2 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motor efficiencies indicated in the tables apply to general-purpose, single-speed, polyphase induction motors. Applications which require definite purpose, special purpose, special frame, or special mounted polyphase induction motors are excluded from these efficiency requirements. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

MINIMUM NOMINAL MOTOR EFFICIENCIES  
OPEN DRIP PROOF MOTORS

<u>kW</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
0.746	82.5	85.5	80.0
1.12	86.5	86.5	85.5
1.49	87.5	86.5	86.5
2.24	89.5	89.5	86.5
3.73	89.5	89.5	89.5
5.60	91.7	91.0	89.5

7.46	91.7	91.7	90.2
11.2	92.4	93.0	91.0
14.9	92.4	93.0	92.4
18.7	93.0	93.6	93.0
22.4	93.6	93.6	93.0
29.8	94.1	94.1	93.6
37.3	94.1	94.5	93.6
44.8	95.0	95.0	94.1
56.9	95.0	95.0	94.5
74.6	95.0	95.4	94.5
93.3	95.4	95.4	95.0
112.0	95.8	95.8	95.4
149.0	95.4	95.8	95.4
187.0	95.4	96.2	95.8
224.0	95.4	95.0	95.4
261.0	94.5	95.4	95.0
298.0	94.1	95.8	95.0
336.0	94.5	95.4	95.4
373.0	94.5	94.5	94.5

## TOTALLY ENCLOSED FAN-COOLED MOTORS

<u>kw</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
0.746	82.5	85.5	78.5
1.12	87.5	86.5	85.5
1.49	88.5	86.5	86.5
2.24	89.5	89.5	88.5
3.73	89.5	89.5	89.5
5.60	91.7	91.7	91.0
7.46	91.7	91.7	91.7
11.2	92.4	92.4	91.7
14.9	92.4	93.0	92.4
18.7	93.0	93.6	93.0
22.4	93.6	93.6	93.0
29.8	94.1	94.1	93.6
37.3	94.1	94.5	94.1
44.8	94.5	95.0	94.1
56.9	95.0	95.4	94.5
74.6	95.4	95.4	95.0
93.3	95.4	95.4	95.4
112.0	95.8	95.8	95.4
149.0	95.8	96.2	95.8
187.0	95.6	96.2	95.9
224.0	95.4	96.1	95.8
261.0	94.5	96.2	94.8
298.0	94.5	95.8	94.5
336.0	94.5	94.5	94.5
373.0	94.5	94.5	94.5

MINIMUM NOMINAL MOTOR EFFICIENCIES  
OPEN DRIP PROOF MOTORS

<u>HP</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
1	82.5	85.5	80.0
1.5	86.5	86.5	85.5

2	87.5	86.5	86.5
3	89.5	89.5	86.5
5	89.5	89.5	89.5
7.5	91.7	91.0	89.5
10	91.7	91.7	90.2
15	92.4	93.0	91.0
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	93.6
60	95.0	95.0	94.1
75	95.0	95.0	94.5
100	95.0	95.4	94.5
125	95.4	95.4	95.0
150	95.8	95.8	95.4
200	95.4	95.8	95.4
250	95.4	96.2	95.8
300	95.4	95.0	95.4
350	94.5	95.4	95.0
400	94.1	95.8	95.0
450	94.5	95.4	95.4
500	94.5	94.5	94.5

## TOTALLY ENCLOSED FAN-COOLED MOTORS

<u>HP</u>	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
1	82.5	85.5	78.5
1.5	87.5	86.5	85.5
2	88.5	86.5	86.5
3	89.5	89.5	88.5
5	89.5	89.5	89.5
7.5	91.7	91.7	91.0
10	91.7	91.7	91.7
15	92.4	92.4	91.7
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	94.1
60	94.5	95.0	94.1
75	95.0	95.4	94.5
100	95.4	95.4	95.0
125	95.4	95.4	95.4
150	95.8	95.8	95.4
200	95.8	96.2	95.8
250	95.6	96.2	95.9
300	95.4	96.1	95.8
350	94.5	96.2	94.8
400	94.5	95.8	94.5
450	94.5	94.5	94.5
500	94.5	94.5	94.5

## 2.11 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

### 2.11.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Panelboards supplying non-linear loads shall have neutrals sized for 200 percent of rated current.

### 2.11.2 Motor Starters

Combination starters shall be provided with circuit breakers.

### 2.11.3 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

### 2.11.4 Low-Voltage Motor Overload Relays

#### 2.11.4.1 General

Thermal and magnetic current overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 seconds. Slow units shall be used for motor starting times from 8 to 12 seconds. Quick trip units shall be used on hermetically sealed, submersible pumps, and similar motors.

#### 2.11.4.2 Construction

Manual reset type thermal relay shall be bimetallic construction. Automatic reset type thermal relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

#### 2.11.4.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

### 2.11.5 Automatic Control Devices

## 2.11.5.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

## 2.11.5.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

## 2.11.5.3 Manual/Automatic Selection

- a. Where combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch (marked MANUAL-OFF-AUTOMATIC) shall be provided for the manual control.
- b. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.
- c. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

## 2.12 RECEPTACLES

## 2.12.1 Heavy Duty Grade

NEMA WD 1. Devices shall conform to all requirements for heavy duty receptacles.

## 2.13 SPLICE, CONDUCTOR

UL 486C.

## 2.14 SNAP SWITCHES

UL 20.

## 2.15 TAPES

## 2.15.1 Plastic Tape

UL 510.

### 2.15.2 Rubber Tape

UL 510.

### 2.16 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

## PART 3 EXECUTION

### 3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

### 3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit. Where cables and wires are installed in cable trays, they shall be of the type permitted by NFPA 70 for use in such applications. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified. Wire fill in conduits located in Class I or II hazardous areas shall be limited to 25 percent of the cross sectional area of the conduit.

#### 3.2.1 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 1/2 inch. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Penetrations of above grade floor slabs, time-rated partitions and fire walls shall be firestopped in accordance with Section 07840A, "FIRESTOPPING". Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by NFPA 70. Raceways shall not be installed under the firepits of boilers and furnaces and shall be kept 6 inches away from parallel runs of flues, steam pipes and hot-water pipes. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding. Wiring installed in underfloor raceway system shall be suitable for installation in wet locations.

##### 3.2.1.1 Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pounds per square inch tensile

strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

#### 3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

#### 3.2.1.3 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment shall be prevented during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

#### 3.2.1.4 Supports

Metallic conduits and tubing, and the support system to which they are attached, shall be securely and rigidly fastened in place to prevent vertical and horizontal movement at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.

### 3.2.1.5 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 definitions.

### 3.2.1.6 Communications Raceways

Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirement that no length of run shall exceed 50 feet for 1/2 inch and 3/4 inch sizes, and 100 feet for 1 inch or larger sizes, and shall not contain more than two 90-degree bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1 inch size or larger shall not be less than ten times the nominal diameter.

### 3.2.2 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

#### 3.2.2.1 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

#### 3.2.2.2 Use of Aluminum Conductors in Lieu of Copper

Aluminum conductors shall not be used, except where extending existing aluminum wiring.

#### 3.2.2.3 Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

- a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material equivalent to the conductor insulation.

#### 3.2.2.4 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

- a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for 3-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).  
277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).  
120/240-volt, 1-phase: Black and red.

- b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.
- c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

### 3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by NFPA 70. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 24 inches. The total combined area of all box openings in fire rated walls shall not exceed 100 square inches per 100 square feet. Maximum box areas for individual boxes in fire rated walls vary with the manufacturer and shall not exceed the maximum specified for that box in UL Elec Const Dir. Only boxes listed in UL Elec Const Dir shall be used in fire rated walls.

### 3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes for metallic raceways shall be listed for the intended use when located in normally wet locations, when flush or surface mounted on outside of exterior surfaces, or when located in hazardous areas. Boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for mounting lighting fixtures shall be not less than 4 inches square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Cast-metal boxes with 3/32 inch wall thickness are acceptable. Large size boxes shall be NEMA 12 or as shown. Boxes in other locations shall be sheet steel except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit and tubing or nonmetallic sheathed cable system, when permitted by NFPA 70. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

### 3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 12 inch long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

### 3.3.3 Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 1/4 inch from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

### 3.3.4 Installation in Overhead Spaces

In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box.

### 3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast-metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be of steel with baked enamel finish or impact-resistant plastic and shall be satin finish corrosion resistant steel or satin finish chromium plated brass. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

### 3.5 RECEPTACLES

#### 3.5.1 Single and Duplex, 15 or 20-ampere, 125 volt

Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall be of ivory to match color of switch handles in the same room or to harmonize with the color of the respective wall, and supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Switched receptacles shall be the same as other receptacles specified except that the ungrounded pole of each suitable receptacle shall be provided with a separate terminal. Only the top receptacle of a duplex receptacle shall be wired for switching application. Receptacles with ground fault circuit interrupters shall have the current rating as indicated, and shall be UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided as required by NFPA 70 and as indicated on the drawings.

### 3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall be ivory. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be rated 20-ampere 277-volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be

red. Dimming switches shall be solid-state flush mounted, sized for the loads.

### 3.7 FUSES

Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination. Time-delay and non-time-delay options shall be as specified.

#### 3.7.1 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class J RK1 RK5 shall have tested interrupting capacity not less than 100,000 amperes. Fuse holders shall be the type that will reject all Class H fuses.

#### 3.7.2 Continuous Current Ratings (Greater than 600 Amperes)

Service entrance and feeder circuit fuses (greater than 600 amperes) shall be Class L, current-limiting, time-delay with 200,000 amperes interrupting capacity.

#### 3.7.3 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

### 3.8 MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 208-volt systems shall have a nameplate rating of 200 volts. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual horsepower ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

### 3.9 MOTOR CONTROL

Each motor or group of motors requiring a single control and not controlled from a motor-control center shall be provided under other sections of these specifications with a suitable controller and devices that will perform the

functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

### 3.9.1 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

### 3.9.2 Safety Controls

Safety controls for boilers shall be connected to a 2-wire, 120 volt grounded circuit supplied from the associated boiler-equipment circuit. Where the boiler circuit is more than 120 volts to ground, safety controls shall be energized through a two-winding transformer having its 120 volt secondary winding grounded. Overcurrent protection shall be provided in the ungrounded secondary conductor and shall be sized for the load encountered.

### 3.10 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

### 3.11 EQUIPMENT CONNECTIONS

Wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

#### 3.11.1 Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

#### 3.11.2 Installation of Government-Furnished Equipment

Wiring shall be extended to the equipment and terminated.

### 3.12 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section 09900, "PAINTS AND COATINGS".

### 3.13 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

### 3.14 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 7 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

#### 3.14.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

~~3.14.2 Cable Tests~~

~~The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:~~

~~$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$~~

~~Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.~~

## 3.14.2 Low Voltage Cable Tests

- a. Continuity test.
- ~~b. Insulation resistance test.~~

## 3.14.3 Motor Tests

- a. Phase rotation test to ensure proper directions.
- b. Operation and sequence of reduced voltage starters.
- c. High potential test on each winding to ground.
- d. Insulation resistance of each winding to ground.
- e. Vibration test.
- f. Dielectric absorption test on motor and starter.

## 3.14.4 Circuit Breakers, Molded Case

- a. Insulation resistance test phase-to-phase, all combinations.
- b. Insulation resistance test phase-to-ground, each phase.
- c. Closed breaker contact resistance test.
- d. Manual operation of the breaker.

## 3.15 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

## 3.16 FIELD SERVICE

### 3.16.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 16 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations. A VHS format video tape of the entire training shall be submitted.

### 3.16.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

### 3.17 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

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