PART III
STATEMENT OF WORK

PART 1 - GENERAL REQUIREMENTS

1.01 THE REQUIREMENT

It is required that there be designed, manufactured, delivered, and installed in accordance with the contract provisions and clauses, these specifications, and the drawings listed in Part IV (Drawings, General), hereof, three (3) digital turbine governor control systems and generator shaft vibration monitoring systems, as stated in the schedule, for Headgate Rock Powerplant, Headgate Rock Hydroelectric Power Project, Arizona-California. The equipment being furnished under these specifications is required for the control and production of power at the above-named installation. The above work shall be performed concurrently with the associated exciter and turbine runner replacement contract work and the Contractors shall coordinate their individual work efforts and schedules to complete respective jobs on time.

1.02 GENERAL DESCRIPTION OF POWERPLANT

Headgate Rock Dam was completed in 1941. It was constructed to raise the water level of the Colorado River to provide permanent gravity-flow diversion facilities for irrigation of land on the Arizona side of the Colorado River Indian Reservation.

Water for operation of the three turbine units is supplied from Lake Moovalya via the radial gate intake structure to the powerplant located at the toe of Headgate Rock Dam. After passing through the turbines, the water is discharged into the Colorado River.

The Headgate Powerplant is located immediately downstream from the existing radial spillway gates 8, 9, and 10. It is located on the Colorado River about 14.4 miles below Parker Dam and one mile north of the town of Parker, Arizona, within the Colorado River Indian Reservation.

The location of the powerplant is shown on Drawings Nos. 1 (1117-D-2), 2 (1117-D-3) and 3 (1117-D-4). The powerplant consists of three 9,100-hp horizontal-shaft axial-flow Kaplan type, hydraulic turbines, each driving a 6,500-kW, 60-Hz, 75-rpm, generator.

The governor control systems and associated appurtenant parts and shaft vibration monitoring systems shall be delivered to the Headgate Rock Powerplant service bay areas located at:

U.S. Bureau of Reclamation
Headgate Rock Powerplant
Parker, Arizona

1.03 SUBMITTAL REQUIREMENTS

a. General. - The Contractor shall furnish all materials and perform all work required for furnishing submittals to the Government, in accordance with clause 52.236-21, “Specifications and Drawings for Construction,” this paragraph, table C1 (List of submittals), and the requirements in the clauses and specifications of this contract.

The word "submittals" shall be interpreted to include drawings, data, manuals, certifications, test reports, curves, samples, color chips or charts, brochures, and other items furnished by the Contractor for approval, informational, or other purposes.

b. List of submittals. - Table C1 (List of submittals) lists submittals required by this contract except those submittals which are required conditionally, required by entities other than the Bureau of Reclamation, or which are periodic in nature. Any submittal required to be submitted by the Contractor, but which is not listed in the table, shall be submitted in accordance with the applicable requirements of this contract. In case of a conflict between the requirements of this paragraph and the requirements included elsewhere in this contract, the requirements elsewhere shall take precedence over the requirements contained in this paragraph.

c. Submittals. - Each item in table C1 (List of submittals) has been assigned an RSN (Required Submittal Number). The "Submittals required" column of the table specifies the material to be submitted for each RSN. All of the material specified for an RSN will be considered a complete set; and where the material required for an RSN is specified as separate or distinguishable parts, a complete set shall include all parts. Only complete sets shall be submitted.

The number of complete sets to be submitted, and the location to which they are to be mailed, shall be in accordance with the "No. of sets to be sent to:" column of the table, except as provided below for sets of original material.

When an RSN involves submittal of original (non-copied material, all original material, or as much thereof as is necessary to form a complete set, shall be included in just one complete set. This "originals" set shall be sent to the proper address, given in subparagraph f. below, as determined by the "Responsible code" column of the table and the following:

(1) CO indicates Contracting Officer.

(2) RE indicates Regional Engineer.

(3) TSC indicates Technical Service Center.

The "originals" set shall be counted as one of the complete sets required to be submitted under the "No. of sets to be mailed to:" column of the table.

For each RSN, the Contractor shall submit complete sets of required submittal material under the cover of a transmittal letter. At the Contractor's option, complete sets for more than one RSN may be submitted under cover of the same transmittal letter, provided they have the same responsible code designation as shown in the table. The Contractor's transmittal letter shall include:

(1) Reference to Bureau of Reclamation contract number and title.

(2) Identification of responsible code as shown in the table.

(3) Complete list of RSN(s) for which material is being submitted.

(4) For each RSN, number of complete sets and list of materials included.

(5) For each RSN, identification of the submittal as an initial submittal or a resubmittal.

Each drawing submitted by the Contractor shall have the Contractor's or supplier's title and drawing number on it. Drawings and data shall be marked with the Bureau of Reclamation contract number, the RSN number, and the bidding schedule item number.

Manufacturer's data for commercial products or equipment, such as catalog cut sheets, shall be clearly marked in a manner that will be evident when reproduced to indicate the item(s) to be furnished. The data shall be sufficiently comprehensive to identify the manufacturer's name, type, model, size, and characteristics of the product or equipment. The data shall fully demonstrate that the product or equipment to be provided meets the requirements of these specifications.

d. Review of submittals furnished for approval. - The time required for review of submittals or resubmittal furnished under an RSN for approval will not begin until the Government receives complete sets of all the submittal materials required for that particular RSN. The number of calendar days required for review of drawings or data submitted or resubmitted for approval will include the date the drawings or data are received by the Government, and will extend through the date of return mailing to the Contractor.

Except as otherwise provided in the specifications for specific submittals, the Government will require 25 calendar days for review of each submittal or resubmittal furnished by the Contractor for approval, and this review time will apply to each separate submittal or resubmittal whether the submittals are approved, not approved, or returned for revision.

If the Government uses time in excess of the specified number of calendar days for review of any submittal or resubmittal, additional time, not to exceed the excess time, will be added to the time allowed the Contractor for delivery of the materials or equipment affected by such excess time, to the extent it is demonstrated that the excess time caused delay. If the Government's review of two or more separate submittals or resubmittals is late and results in concurrent days of excess time, such days will be counted only once in computing an extension of the completion date. Further, if the Contractor fails to make complete approval submittals in the sequence and within the time periods specified in this solicitation, and thus precludes the Government from approving or considering for approval such submittals within the specified calendar day period, then the Contractor shall not be entitled to an extension of time allowed for delivery of the materials or equipment.

Adjustment for Government delay in approving requests for approval of shop drawings or other technical data shall be made only to the extent that (1) Government approval was required under this contract, and (2) the requests for approval were properly and timely submitted and approvable. Any such adjustment shall be subject to the terms of paragraphs (b) and (c) of the Suspension of Work clause of this contract; however, no such delay shall be deemed to be a “suspension order” as the term is used in that clause.

Unless otherwise specified, one set of the submittals required for approval will be returned to the Contractor either approved, not approved, or conditionally approved, and also marked to indicate changes if required. Submittals that are not approved or that require changes or revisions shall be revised and resubmitted for approval, and shall show changes and revisions with revision date. All requirements specified for the initial submittal shall apply to any resubmittals required. Unless otherwise specified, all submittals which are to be resubmitted shall be resubmitted by the Contractor within 25 calendar days after the Contractor has received the Government's comments.

Any manufacturing done or shipment made before approval of the drawings and data shall be at the Contractor’s risk. Approval by the Contracting Officer of the Contractor’s drawings and data shall not be held to relieve the Contractor of any part of the Contractor’s responsibility to meet all of the requirements of these specifications or of the responsibility for the correctness of the Contractor’s drawings.

e. Right to use Contractor's drawings. - In accordance with the clause in section I entitled "Rights in Data-General," Reclamation expressly reserves the right to use, reproduce in whole or in part, to distribute, and to reuse any and all such drawings, whether copyrighted, proprietary, or not, in connection with the following:

(1) Installation, maintenance, replacement, and repair of the articles to be furnished under these specifications.

(2) Making any and all such drawings and reproductions thereof available to subsequent bidders and Contractors, where necessary for fabricating and furnishing articles connected with, dependent upon, or duplicating the articles to be furnished hereunder.

The depositing of all such drawings with Reclamation shall constitute a license to Reclamation to use said drawings in the manner hereinabove stated.

f. Addresses. - The Contractor shall submit the submittals to the applicable addresses listed below as required by Table 1 (List of submittals).

The Contractor shall also send a copy of the transmittal letter to each of the addresses listed below that are not sent the submittal.

Submittals shall be submitted as required by Table 1 (List of submittals) to:

(1) Contracting Officer, Bureau of Reclamation, Attn: LC-3110, P.O. Box 61470, Boulder City NV 89006-1470.

(2) Regional Engineer, Bureau of Reclamation, Attn: LC-6000, P.O. Box 61470, Boulder City NV 89006-1470.

(3) Technical Service Center, mail to: Bureau of Reclamation, Attn: D-8160, P.O. Box 25007, Denver CO 80225.

g. Cost. - Unless otherwise specified, no separate payment will be made for preparing and furnishing submittals to the Government, and the cost thereof shall be included in the prices bid in the schedule for the applicable items of work requiring the submittals or other items of work.

h. Submittal table. -

Table 1 - List of submittals

RSN	Item	Reference provision, clause, or paragraph	Respon-sible code	Submittals required	No. of sets to be sent to:*			Due date or delivery time
					CO	COR	TSC	
C1	Hazardous materials	III.1.6	COR	Material safety data sheets	1	1	0	Not less than 45 days prior to jobsite delivery of each hazardous material
C2	Lubricating oils, hydraulic fluids, and gear oils	III.2.5	COR	Approval data	0	1	1	At least 30 days before delivery to jobsite
C3	Disposal of hazardous waste	III.4.01	COR	Hazardous waste manifest	1	1	0	Upon disposal
M1	Governor Approval data	III.1.4.b.(1)	D-8420	Layout drawings	0	1	3	Within 90 days after Award of Contract
M2	Governor Approval data	III.1.4.b.(1)	D-8420	Detail drawings	0	1	3	Within 90 days after Award of Contract
M3	Governor Approval data	III.1.4.b.(1)	D-8420	Assembly drawings	0	1	3	Within 90 days after Award of Contract
M4	Governor Approval data	III.1.4.b.(1)	D-8420	Installation plan and drawings	0	1	3	Within 90 days after Award of Contract
M5	Governor Approval data	III.1.4.b.(1)	D-8420	Design data	0	1	3	Within 90 days after Award of Contract
M6	Governor Approval data	III.1.4.b.(1)	D-8420	Commercial products data	0	1	3	Within 90 days after Award of Contract
M7	Governor Approval data	III.6.10	D-8420	Performance test procedures	0	1	3	Within 60 days of performance tests
M8	Governor Approval data	III.1.4.b.(1)	D-8420	Shop test reports	0	1	3	Before shipment

RSN	Item	Reference provision, clause, or paragraph	Respon-sible code	Submittals required	No. of sets to be sent to:*			Due date or delivery time
					CO	COR	TSC	
M9	Shaft vibration monitoring system Approval data	III.1.4.b.(1)	D-8420	Commercial products data	0	1	3	Within 90 days after Award of Contract
M10	Governor Final data	III.1.4.b.(2)	D-8420	Service manuals	0	1	3	Within 30 days before shipment
M11	Governor Final data	III.1.4.b.(2)	D-8420	Final as-built drawings	0	1	1	Within 30 days after completion
M12	Shaft vibration monitoring system Final data	III.1.4.b.(2)	D-8420	Service manuals	0	1	3	Within 30 days before shipment
M13	Shaft vibration monitoring system Final data	III.1.4.b.(2)	D-8420	Final as-built drawings	0	1	1	Within 30 days after completion
E1	Governor electrical and electronic equipment Approval drawings	III.1.5.b.	D-8430	Equipment layout diagram drawings (Government format)	0	1	3	Within 90 days after Award of Contract
E2	Governor electrical and electronic equipment Approval drawings	III.1.5.b.	D-8430	Schematic diagram drawings (Government format)	0	1	3	Within 90 days after Award of Contract
E3	Governor electrical and electronic equipment Approval drawings	III.1.5.b.	D-8430	Wiring diagram drawings (Government format)	0	1	3	Within 90 days after receipt of approval of RSNs E1, E2, and E4
E4	Governor electrical and electronic equipment Approval drawings	III.1.5.c.	D-8430	Manufacturer's data	0	1	3	Within 90 days after Award of Contract
E5	Governor electrical and electronic equipment Final data	III.1.5.e.	D-8430	Check prints	0	1	0	Shipped with equipment
E6	Governor electrical and electronic equipment Final data	III.1.5.f.	D-8430	Final drawings	0	1	1	Within 30 days after completion
E7	Governor electrical and electronic equipment Final data	III.1.5.h.	D-8430	Operation and maintenance manuals	0	1	1	Within 30 days before shipment

RSN	Item	Reference provision, clause, or paragraph	Respon-sible code	Submittals required	No. of sets to be sent to:*			Due date or delivery time
					CO	COR	TSC	
R1	Coating materials	III.9.1.c.	D-8180	(1) Product data and application sheets	0	1	1	Not less than 45 days prior to use of coating materials
				(2) Purchase orders	0	1	1	
				(3) Certifications	0	1	1	
				(4) Samples	0	0	1	
R2	Coating	III.9.1.c.	COR	Written evidence of coating applicator qualifications	0	1	0	At least 30 days prior to beginning coating

* CO indicates Contracting Officer, COR indicates Contracting Officer's Representative, and TSC indicates Technical Service Center. For mailing addresses, see “Addresses” subparagraph of “Submittal Requirements.”

1.04 MECHANICAL DRAWINGS AND DATA TO BE FURNISHED BY THE CONTRACTOR

a. General. - Submittals shall be in accordance with this paragraph and paragraph 1.03 (Submittal Requirements).

All drawings submitted by the Contractor shall have the Contractor’s or suppliers title and drawing number on each drawing. Drawings and data shall show Bureau of Reclamation contract number and bid schedule item number. All dimensions shall be in feet and inches and all wording, signs, symbols, etc., shall be in English.

Drawings for approval shall be Standard D-size drawing, 22" by 34". Approval drawings shall be full-size prints made from original drawings.

Approval of the Contractor’s drawings and data shall not be held to relieve the Contractor of any part of the Contractor’s responsibility to meet all of the requirements of these specifications or of the responsibility for the correctness of the Contractor’s drawings.

The Contractor shall not commence manufacturing or ship any equipment for which Government approval is required until all the required drawings and data for the particular item have been reviewed and approved. Any fabrication or procurement performed or shipment made before approval of the drawings and data shall be at the Contractor’s risk.

b. Submittals. - The Contractor shall submit the following:

(1) Approval Drawings and Data. - Before proceeding with fabrication or procurement of material and in accordance with the requirements listed in Table 1 (List of submittals), the Contractor shall submit to the Government for approval checked

drawings and data listed below under the heading “Approval of the following is required.”

Where approval data are required for commercial products or equipment, the Contractor shall submit complete identifying data giving the manufacturer’s name, type, model, size, characteristics, and electrical rating of the equipment. When a catalog sheet is submitted, the particular item proposed shall fully demonstrate that the equipment provided meets the requirements of these specifications. One copy of the approved data will be returned to the Contractor.

When revised drawings are submitted for approval, the changes from the previous submittals shall be clearly identified on the drawings, with every revision made during the life of the contract shown by number, date, and subject in a revision block and a notation shall be in the drawing margin to permit rapid location of the revision. The drawings shall be clear and legible in all respects.

Approval of the following is required:

(a) Layout drawings of governor electro-hydraulic interface components showing location within cabinet.

(b) Detail drawings of all parts and all components of governor. Each detail drawing shall contain a bill of material for all parts shown on the drawing.

(c) Assembly drawings, including cross-sections, of new governor hydraulic interface components and actuator cabinet equipment layout, and showing details of the connection required to mate the speed signal generator to generator shaft.

(d) Installation plan and drawings outlining and detailing the specific methods and procedures the Contractor plans to use in removing and replacing the digital and hydraulic governor interface components and other associated equipment required under this contract. The plan shall describe in detail how the Contractor proposes to physically remove, orientate, and install new proportional (pilot) valves for the existing gate and blade main distributing valves within the governor actuator cabinet. Drawings shall include details and views showing the locations of all equipment mounted within the actuator cabinet and on the outside of the cabinet panels. Drawings shall include overall views and layouts of the actuator cabinet panels showing locations of the new digital meters and digital governor control interface components.

(e) Net weight, in pounds, of new speed signal generator and housing.

(f) Net weight, in pounds, of new governor proportional (pilot) valve assembly.

(g) Commercial products data for all governor components.

(h) Commercial products data for shaft vibration monitoring system and associated components.

(i) Shop test reports. - The Contractor shall submit the electro-hydraulic interface component shop test reports before governors are shipped.

(2) Final Data. - Drawings that are a part of final data requirements shall show all changes and revisions, with revision dates, made up to the time the equipment is completed and ready for shipment. The contractor shall place a Bureau of Reclamation identifying number in the lower right-hand corner of each drawing. The identifying number shall be lettered neatly in black ink or shall be superimposed by means of black lettering on a white paper background. The Government will furnish a list of the identifying numbers at the Contractor's request. In the Contractor's request, the Contractor shall state the total number of drawings for which identifying numbers are required.

An index list shall be furnished by the Contractor indicating the Contractor's drawing numbers and drawing titles, and Bureau of Reclamation identifying numbers. The index list shall be identified by the contract number and title of project.

Four bound copies of service manuals shall be furnished. Each shall contain complete parts identification lists; lists of special tools, and accessories and detailed instructions for the installation, dismantling, operation, and maintenance of the equipment. A reduced-size print of each pertinent drawing shall be included in each manual.

When test records or reports are required, the Contractor shall furnish two copies, unless otherwise specified in Table 1 (List of submittals).

The Contractor shall furnish the final drawings in the form of a high quality full-size original D-size plot and drawing files on CD-ROM disk in AutoCAD format (*.DXF or the *.DWG format).

One set of blackline prints of AutoCAD drawings on CD-ROM disk shall be shipped with the equipment furnished under this contract. The drawings shall be marked to show all changes up to the time the equipment is shipped.

As-built prints following installation of the equipment shall be provided following installation.

The Contractor shall submit the following final data at the time shown in Table 1 (List of submittals):

(a) Service manual, including complete operating and maintenance instructions. Each shall contain complete parts identification lists: lists of special tools, and accessories and detailed instructions for the installation, dismantling, operation, and maintenance of the equipment. A reduced-size print of each pertinent drawing shall be included in each manual.

(b) As-built full-size blackline prints of governor and shaft vibration monitoring system components and equipment including bills of material in the form of a high quality original plot and on CD-ROM in AutoCAD format.

c. Cost. - The cost of furnishing mechanical drawings and data shall be included in the prices bid in the schedule for the items for which the drawings and data are required.

1.05 ELECTRICAL DRAWINGS AND DATA TO BE FURNISHED BY THE CONTRACTOR

a. General. - All electrical drawings and data shall be in accordance with this paragraph; paragraph 1.03 (Submittal Requirements); and paragraph 6.06 (Electrical control and indicating devices). All drawings and data shall be written in English, shall be made expressly for this contract (typical drawings will not be acceptable), shall be complete and accurate in their content, and shall be legible. Freehand sketches will not be accepted. The units of measurements shall be given in the United States Customary System.

The drawings shall be prepared using graphical symbols and device function numbers conforming with the applicable standards of ANSI Y32.2, Y32.9, and IEEE C37.2; and as shown on drawing 91 (104-D-1150).

The Government reserves the right to require the Contractor to make any changes in the equipment design and drawings which may be necessary to make the equipment and drawings conform to the requirements of these specifications, without additional cost to the Government.

When revised drawings are resubmitted, the changes from the previous submittal shall be clearly identified on the drawings. The submittal letters shall describe the reasons for significant changes.

After the approval drawings and data have been submitted and returned approved, with or without comments, the Contractor shall make no further changes to the design without the approval of the Contracting Officer.

b. Approval drawings prepared in Government format. - The approval drawings required by the following subparagraphs shall be prepared in Government format and in a form as shown on drawing 92 (104-D-1152). The drawings shall be prepared using computer drafting equipment and shall be drawn to scale.

The approval drawings shall be D-size prints as defined in ANSI Y14.1 and shall be made from the original drawings. The Government will provide specific title block information at the time the drawings are first submitted for approval.

(1) Schematic diagram drawings. - The schematic diagram drawings shall be furnished in accordance with the requirements shown on drawing 91 (104-D-1150). Each drawing shall show the functional operation, with any unusual or nonstandard operation fully described; the ratings and/or values of all devices shown on the diagram; all contacts, including spare contacts, for the associated relay or contactor coil; and complete cross-referencing between the drawings.

The schematic diagram drawings that show control and protective relaying circuits shall be drawn in vertical ladder form. Each ladder shall be shown with rung numbers (20 per vertical line) which are located adjacent to the associated rungs. The rung numbers shall be unique per circuit.

The conductor designations shall be as shown on the drawings in the specifications or shall be developed by the Contractor. The conductor designations developed by the Contractor shall consist of a circuit prefix, a rung number, and a unique rung wire letter such as 5P15C (“5"-Unit Number, “P”- Protection Circuit, “15-Rung Number, “C”- Unique Rung Wire Letter).

The Government reserves the right to revise any or all conductor or device designations shown on the Contractor’s drawings at the time the drawings are first approved at no change in contract price or completion time.

The applicable switch developments for each control switch, each limit switch, and each position switch shall be shown on the pertinent drawing(s) or one drawing may be furnished by the Contractor which shows the switch development for all switches.

(2) Wiring diagram drawings. - The Contractor shall assure that the wiring diagram drawings and the actual equipment wiring agree with the schematic diagram drawings. The wiring diagram drawings shall:

(a) Show the exact location where the equipment is mounted on each panel. Each panel shall be shown on a separate drawing as viewed from the wiring side of the panel.

(b) Identify each item of equipment. Control and protective devices shall be identified with the (NEMA) device number as shown on the specifications drawings. Components such as fuses and resistors shall be identified as to their value.

(c) Show point-to-point wiring as shown on drawing 93 (104-D-1165).

(d) Show cables, cable and individual wire designations, and connections to external circuits. The cable designations shall be in accordance with the drafting standards of the Bureau of Reclamation and shall be similar to the typical designations shown on drawing 93 (104-D-1165).

c. Approval drawings and data prepared in manufacturer's format. - The drawings and data listed in this subparagraph require no specific format other than the manufacturer's standard.

(1) The equipment layout diagram drawings shall show the dimensions of all equipment; and the location of all devices and items of equipment including nameplates, terminal blocks, wiring ducts, bus, and other features in their relative physical locations.

(2) The manufacturer's data for each device or item of equipment, such as catalog cut sheets, shall include the manufacturer's name and address and comprehensive product information including catalog number, type, style, or model number, electrical ratings, and dimensions. Where several items are listed on the same data sheet, the data being submitted for approval shall be clearly marked. The data shall fully demonstrate that the device and/or item of equipment proposed meets the requirements of these specifications. The manufacturer's data shall include a reference to the RSN number(s) that it is being submitted for.

d. Contractor's conference. - At an appropriate time, within 30 days after receipt of notice to proceed and upon written request of the Contracting Officer, the Contractor shall send responsible engineering representatives to the powerplant to review with Government personnel the drawings and data requirements, and the technical requirements of the specifications. This conference shall coincide with the field examination required under 6.01 of these specifications.

The Contractor's representatives shall be fully informed of the intent of the Contractor with respect to the equipment to be furnished and the coordination necessary to complete the electrical design. In addition, they shall be thoroughly familiar with the requirements of the specifications. The Contracting Officer will notify the Contractor at least 10 days in advance of the date set for the conference.

e. Check prints. - At the time the equipment is shipped, the Contractor shall furnish one complete set of full-size original plots or blackline prints of the equipment wiring diagram drawings for use by the Government. The check prints shall be made from the original drawings that have been revised as applicable to show the equipment at the time of shipment. These check prints will be available to the Contractor, and any changes or revisions made during installation shall be shown on these check prints and returned to the Government at the time the installation is completed.

f. Final drawings. - The Contractor shall furnish final drawings in the form of a digital record and an original paper plot. The final drawings shall show all as-built changes, including revision dates, made to the equipment during installation. The Contractor shall furnish the final drawings in the form of a high quality full size original D size plot and on 3-1/2-inch floppy disks or compact disks in the AutoCAD format (*.dwg) or the Drawing Transfer Format (*.dxf).

g. Test reports. - The Contractor shall submit to the Government, certified copies of test reports, where required, for the equipment. The tests that are required for various items of equipment are defined within the individual equipment paragraphs elsewhere in these specifications.

The test reports shall be in a typed 8-1/2-by-11-inch format and shall be bound together.

h. Operation and maintenance instruction books. - Each set of this material shall be assembled into one or more books with an enclosing cover.

The operation and maintenance instruction book(s) shall include:

(1) An index sheet at the front of each book which provides page or index tab number information for each device or item of equipment in the book.

(2) Manufacturer's operation and maintenance procedures; installation details, as necessary; and catalog data sheets for each device or item of equipment.

(3) A list of recommended spare parts and components.

(4) Complete parts lists for all replacement parts.

(5) Copies of all drawings (in the form of half-size prints) and bills of material, both revised to reflect approval comments.

i. Cost. - The cost of furnishing electrical drawings and data shall be included in the prices bid in the schedule for the items for which the drawings and data are required, which prices shall include the following:

(1) Performing all required designs.

(2) Coordinating the Contractor's design with that provided by the Government.

(3) Coordinating and cooperating with other Government Contractors.

(4) Providing electrical drawings and data; operation and maintenance instruction books; and test reports for the new governor electrical equipment.

(5) Participating in a Contractor's conference with the Government.

1.06 SUBMISSION OF MATERIAL SAFETY DATA SHEETS FOR HAZARDOUS MATERIALS

After award of contract, the Contractor shall submit updated List of Hazardous Materials (LHM) and Material Data Sheets (MSDS) in accordance with the requirements of paragraphs (e) of clause 52.223-3, "Hazardous Material Identification and MaterialSafety Data."

The Contractor shall submit the updated LHM and completed MSDS and identification and certification for each material in accordance with paragraph 1.03 (Submittal Requirements). Copies of the LHM and completed MSDS shall be submitted to the Bureau of Reclamation, Regional Engineer, Attn: LC-6000, PO Box 61470, Boulder City, NV 89006-1470. The Contractor shall not deliver any hazardous material to the jobsite which was not included on the original LHM prior to acceptance of the Contractor's MSDS by the Regional Engineer.

The cost of complying with this paragraph shall be included in the applicable prices bid in the schedule for the items for which the hazardous materials are required.

PART 2 - MATERIALS AND WORKMANSHIP

2.01 MATERIALS AND WORKMANSHIP - RECLAMATION

a. Materials. - In accordance with the clause entitled “Material and Workmanship,” all materials furnished by the Contractor shall be new and of the most suitable grade for the purpose intended considering strength, ductility, and best engineering practice.

Except as specified, materials shall conform to Federal specifications or standards, or, if there are no applicable Federal Specifications, materials shall conform to the applicable specifications or standards of ANSI (American National Standards Institute), ASTM (American Society for Testing and Materials), ASME (American Society of Mechanical Engineers), SAE (Society of Automotive Engineers), IEEE (Institute of Electrical and Electronic Engineers), NEMA (National Electrical Manufacturers Association, NFPA (National Fire Protection Association), or other nationally recognized standards organization. If the Contractor proposes to deviate from, or to use materials not covered by, the aforementioned specifications and standards, the Contractor shall submit, for approval, the justification for and exact nature of the deviation, and complete specifications for the materials proposed for use.

Parts shall be made accurately to standard gauge where possible. Threads, including but not limited to those of bolts, nuts, screws, taps, pipes, and pipefittings shall be unified screw threads conforming to ANSI B1.1-89 Unified Inch Screw Threads (UN and UNR Thread Form) or B1.20.1-83 (Revised 1992) Pipe Threads, General Purpose (Inches). For internal connections only, the Contractor will be permitted to deviate from the ANSI standards, provided the Contractor furnishes a complete set of taps and dies as might be required to facilitate repair or replacement.

All fasteners shall be permanently marked with a symbol identifying the manufacturer and with symbol(s) indicating grade, class, type, and other identifying marks in accordance with reference or applicable standards.

b. Workmanship. - The Contractor shall be responsible for the accurate manufacture and fabrication of materials in accordance with best modern practice and the requirements of these specifications, notwithstanding minor errors or omissions therein.

Liberal factors of safety and adequate shock-absorbing features shall be used throughout designs, especially for parts subjected to variable stress or shock, including alternating or vibrating stress or shock. Shock-absorbing features and parts subject to vibration shall include provisions which prevent components from loosening.

2.02 MATERIALS TO BE FURNISHED BY THE CONTRACTOR

The Contractor shall bear all cost of transporting all materials from the Contractor's shipping point(s) to the Headgate Rock Powerplant service bay area.

The Contractor shall be responsible for all materials during periods of transportation and for any necessary storage and protection of materials prior to their delivery. See clause

WBR 1452.247-900, Preparation For Shipment And Handling. The Government will inspect and take inventory of materials at the time of their arrival at the storage areas.

The Contractor shall furnish all materials required for completion of the work. The words "material" or materials" as used in these specifications to denote items furnished by the Contractor shall be construed to mean equipment, machinery, product, component, or any other item required to be incorporated in the work.

When a separate item which includes the furnishing of any material is provided in the schedule, the cost of furnishing, storing, hauling, and handling shall be included in the price bid for that item. When a separate item is not provided in the schedule for furnishing any material required to be furnished by the Contractor, the cost of furnishing, storing, hauling, and handling shall be included in the price bid for the work for which the material is required.

Materials furnished by the Contractor shall be of the type and quality described in these specifications. The Contractor shall make diligent effort to procure the specified materials from any and all sources, but where because of Government priorities or other causes, materials required by these specifications become unavailable, substitute materials may be used: Provided, That no substitute materials shall be used without prior written approval of the Contracting Officer, said written approval to state the amount of the adjustment, if any, to be made in favor of the Government. The Contracting Officer's determination as to whether substitution shall be permitted and as to what substitute materials may be used shall be final and conclusive. If the substitute materials approved are of less value to the Government or involve less cost to the Contractor than the materials specified, an adjustment shall be made in favor of the Government, and where the amount involved or the importance of the substitution warrants, a deductive modification to the contract will be issued. No payments in excess of prices bid in the schedule will be made because of substitution of one material for another or because of the use of one alternate material in place of another.

2.03 REFERENCE SPECIFICATIONS AND STANDARDS

Materials, Contractor design, construction work, and other requirements which are specified by reference to Federal Specifications, Federal Standards, or other standard specifications or codes shall be in compliance with the editions or revisions thereof stated in the specifications. In the event of conflicting requirements between a referenced specification, standard, or code and these specifications, these specifications shall govern.

Unless otherwise specified, all materials that will become a part of the completed work shall be new and shall conform to the Federal or other specifications and standards referred to herein. Where reference specifications numbers are designated throughout these specifications, they refer to Federal Specifications unless otherwise noted. In the event that the materials are not covered by Federal or other specifications, the materials furnished shall be of standard commercial quality. Where types, grades, or other options offered in the reference specifications are not specified in these specifications, the material furnished will be acceptable if it is in accordance with any one of the types, grades, or options offered.

Copies of many of the Federal Specifications and Standards may be examined at the office of the Bureau of Reclamation, Denver Office, building 67, Denver Federal Center, West Sixth

Avenue and Kipling Street, Denver, Colorado. Single copies of Federal Specifications and standards may be obtained without charge from any one of the General Services Administration Business Service Centers. See provision paragraph 52.212-1(i).

Bureau of Reclamation Specifications and Standards may be obtained from the Bureau of Reclamation, Attn D-8170, PO Box 25007, Denver CO 80225. This address may also be used to order the various manuals and standard specifications printed, reprinted, or published while the Bureau of Reclamation was officially named the Water and Power Resources Service. All references to Water and Power Resources Service or any form derivative thereof shall be considered synonymous with the Bureau of Reclamation.

Addresses for obtaining some industrial and governmental (other than Federal and Bureau of Reclamation specifications and standards) specifications, standards, and codes are listed in the provision entitled "Availability of Specifications Not Listed in the GSA Index of Federal Specifications, Standards and Commercial Item Descriptions."

The Contractor shall maintain at place of manufacture, a copy of all specifications, standards, codes, manuals, and other documents that are referenced in these specifications and that are pertinent to the materials being installed or work proceeding at that time. These shall be available for use by the Contracting Officer and the Contracting Officer's representatives.

In accordance with the clause entitled "Material and Workmanship," the references to materials, wherein manufacturer's products or brands are specified by "brand name or equal" purchase descriptions, are made as standards of comparison only as to type, design, character, or quality of the article required, and do not restrict bidders or the Contractor to the manufacturer's products or to the specific brands named. It shall be the responsibility of the Contractor to prove equality of materials and products to those referenced and to provide all descriptive information, test results, and other evidence as may be necessary to prove the equality of materials or products which the Contractor offers as being equal to those referenced.

2.04 LUBRICATING OILS, HYDRAULIC FLUIDS, AND GEAR OILS

a. General. - In accordance with Section 6002 of P.L. 94-580, Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act and Environmental Protection Agency’s (EPA) Guideline for Federal Procurement of Lubricating Oils Containing Re-refined oil, 40 CFR Part 252, lubricating oils furnished as end items, as components of end items, or used in performing work under this contract shall contain re-refined oil to the maximum extent possible, but in no case less than 25 percent re-refined oil, without jeopardizing the intended end use of the items.

For the purposes of this paragraph, “ lubricating oil” shall designate petroleum-based products, and shall include engine lubricating oils, hydraulic fluids, and gear oils, but shall exclude marine and aviation oils. “Re-refined oil” shall mean used oil from which physical and chemical contaminants acquired through previous use have been removed by a refining process.

b. Submittals. - Submittals shall be in accordance with this paragraph and paragraph 1.03 (Submittal Requirements).

(1) Approval data. - The Contractor shall submit the following data for approval:

(a) Source(s) or refiner(s) of virgin and re-refined lubricating oil.

(b) Material description and quantity.

(c) Certificate of quantity, by percentage, of re-refined oil in the lubricating oil.

(d) For each lubricating oil that does not contain at least 25 percent re-refined oil, the reason for not furnishing lubricating oil that does contain at least 25 percent re-refined oil, including certified documentation that the use of lubricating oil containing at least 25 percent re-refined oil will jeopardize the intended end use of the item. Such determination shall be based on technical performance information and identify any performance criteria that cannot be certified by lubricating oil containing at least 25 percent re-refined oil.

c. Cost. - The cost of complying with this paragraph shall be included in the prices bid in the schedule for the items for which the lubricating oils are required.

2.05 WELDING

a. General. - All welding shall be performed by the electric-arc method, by a process that excludes the atmosphere from the molten metal, and where practicable, under procedure control using automatic machines. Machined surfaces of parts affected by welding shall be machined to final dimensions after welding. Machined surfaces of parts requiring stress relief shall be machined to final dimensions after parts have been stress relieved. AWS Z49.1 shall apply to all welding performed.

b. Design and fabrication. - The design and fabrication of welded parts subject to stress due to hydraulic pressure and of other principal stress-carrying parts shall be in accordance with ASME B31.1 Power Piping Code, or the Standard Code for Arc and Gas Welding in Building Construction AWS code D1.1. All butt welds shall be of the full-penetration type; however, back gouging will not be required. Stress relieving of above parts will not be required.

c. Welding qualifications. - The qualification of welding procedures, welders, and welding operators shall conform either to that of the ASME B31.1 Power Piping Code, or to the Standard Qualification Procedure of AWS code D1.1, at the Contractor's option.

2.06 WIRING CHECKOUT AND TESTS

a. General. - After the installation is complete and all equipment is wired, and at a time agreed to by the Contractor and the Government, representatives of the Contractor and the Government shall make arrangements to perform a wiring checkout and tests of the installation.

The Contractor shall furnish all materials that are required for the wiring checkout and tests. The Contractor shall notify the Government in writing at least 72 hours in advance of the time the tests are to be made in order that the tests may be witnessed by the Government.

b. Wiring Checkout and Tests. - Prior to the operational testing of the governor, the Contractor shall perform a wiring checkout and tests as listed below.

The wiring checkout shall include all equipment supplied by the Contractor and, as a minimum shall include a wire-by-wire, terminal-by-terminal (point-to-point) check for the following:

(1) Continuity.

(2) Insulation resistance.

(3) Proper wire tagging at each end of the insulated conductors.

c. Responsibility. - While performing the wiring checkout and tests, the Contractor shall retain full responsibility for the removal and replacement of any wiring connections that may be required in the processing of the checkout. The Contractor shall be responsible for and shall replace at his own expense any insulated conductors which may be damaged in the checkout process, unless this damage results from negligence by the Government, as determined by the Contracting Officer.

d. Cost. - The cost of performing the wiring checkout and tests shall be included in the prices bid in the schedule for the items for which the wiring checkout and tests are required, which price shall include the cost of all labor and materials required by this paragraph.

PART 3 - LOCAL CONDITIONS

3.01 PROTECTION OF EXISTING INSTALLATIONS

a. General. - In performing work in the powerplant, the Contractor shall take all necessary precautions to safeguard existing installations. The Contractor shall obtain the location of embedded conduit, pipe, cable, and other embedded items before performing any drilling or cutting of concrete, and shall protect adjacent installations during construction operations.

The Contractor shall furnish, install, and maintain adequate protection as needed to safeguard personnel and existing facilities from harm due to construction operations. Such protection shall be subject to approval of the Contracting Officer.

All protective installations shall be arranged to permit operations of the existing equipment and facilities by the Government while work under these specifications is in progress. The Contractor shall remove all protective installations provided by the Contractor after they have served their purpose. The materials furnished by the Contractor to provide protection shall remain the property of the Contractor and, after removal, shall be removed from the worksite.

The Contractor shall not discharge anything but clear water into the building drainage system. No dust shall be permitted to enter the ventilating systems.

Drawings included in these specifications show the items of existing materials and equipment but do not purport to show all equipment and materials existing at the worksite.

b. Enclosures. - Enclosures shall be construed by the Contractor as required to prevent dust, spalls, chips, grit, and other foreign material from endangering personnel and contaminating or damaging equipment during construction operations.

Enclosures shall be subject to approval of the Contracting Officer. Enclosures shall be sufficient to confine the Contractor's operations to the immediate work area, and to prevent contaminating and damaging mechanical and electrical installations.

c. Damages. - The Contractor shall repair, at the Contractor's expense, any damage to existing installations due to the Contractor's operations or failure to provide proper protection, or at the option of the Contracting Officer, any such damage may be repaired by the Government, and the Contractor will be backcharged for the cost thereof.

d. Cost. - The cost of all protection as described in these specifications, including the cost of furnishing all necessary materials and constructing and removing protective installations, shall be included in the applicable prices bid in the schedule for the items for which the protection is required.

3.02 ELECTRIC POWER FOR CONSTRUCTION PURPOSES

The Contractor may, at its option, furnish power for his operation. If the Contractor elects to use power made available by the Government, this power will be limited to the existing

following circuits: use of 15-20 amp single phase, 60 hertz outlets at 120 volts and 60 amp, 3 phase, 60 hertz at 480 volt.

The Contractor shall negotiate with the Facility Manager, Parker Dam, California, for establishing such electric power service. No charge will be made for the use of such power.

3.03 WATER FOR CONSTRUCTION PURPOSES

a. General. - Water from sources within the powerplant will be available to the Contractor for construction purposes. Sources for obtaining water will be designated by the Contracting Officer's Representative. Such water may be used for construction purposes at no cost to the Contractor. The Contractor shall provide all means of conveying water to points of use.

b. Cost. - The cost of providing necessary facilities and conveying water to points of use shall be included in the prices bid in the schedule for other items.

3.04 GOVERNMENT-OWNED CRANE AVAILABLE FOR CONTRACTOR'S USE

The existing overhead crane in the powerplant will be available for use by the Contractor. The crane has a capacity of 50 tons. Use of the crane shall be coordinated with Government operations and approved by the Contracting Officer's Representative. No charge will be made for use of the crane.

The Government shall operate the crane. The Contractor shall provide and perform all necessary rigging.

PART 4 - ENVIRONMENTAL QUALITY PROTECTION

4.01 CLEANUP AND DISPOSAL OF WASTE MATERIALS

a. General. - The Contractor shall be responsible for the cleanup and disposal of waste materials and rubbish. The disposal of waste materials and rubbish shall be in accordance with applicable Federal, State, and local laws and regulations, with applicable requirements of Reclamation's publication "Reclamation Safety and Health Standards," and with the requirements of this paragraph. Should a conflict exist in the requirements of cleanup and disposal of waste materials, the most stringent requirement shall apply.

The Contractor shall keep records of the types and amounts of waste materials produced, and of the disposal of all waste materials on or off the jobsite.

If the Contractor fails to perform the work required by this paragraph, the work may be performed by the Government, and the Contractor will be backcharged for the cost of such work. The Contractor's surety or sureties shall be liable for such payment until received by the Government.

b. Submittals. - The Contractor shall submit copies of hazardous waste manifests in accordance with paragraph 1.03 (Submittals Requirements).

c. Cleanup. - The Contractor shall keep work and storage areas free from accumulations of waste materials and rubbish, and before completing the work, shall remove all temporary facilities, rubbish, unused materials, concrete forms, and other like materials, which are not a part of the permanent work.

In addition, the Contractor will be required to conduct an environmental site assessment at the following Contractor use locations:

(1) All hazardous waste accumulation areas;

(2) All hazardous materials and petroleum dispensing and storage areas where the aggregate storage of hazardous materials or petroleum at the site is or has been over 110 gallons.

This site assessment shall be performed by a qualified environmental consultant or equivalent and shall document through appropriate analytical sampling that the site is free of the effects of contamination (i.e., contaminant concentrations less than State action cleanup levels).

d. Disposal of hazardous waste and materials. - Materials or wastes, defined as hazardous by 40 CFR 261.3; Federal Standard 313, as amended; or by other Federal. State, or local laws or regulations, used by the Contractor or discovered in work or storage areas, shall be disposed of in accordance with these specifications and applicable Federal, State, and local laws and regulations. Unknown waste materials that may be hazardous shall be tested, and the test results shall be submitted to the Contracting Officer for review.

Waste materials known or found to be hazardous shall be disposed of in approved treatment or disposal facilities. Hazardous wastes shall be recycled whenever possible.

Waste materials discovered at the construction site shall immediately be reported to the Contracting Officer. If the waste may be hazardous, the Contracting Officer may order delays in the time of performance or changes in the work, or both. If such delays or changes are ordered, an equitable adjustment will be made in the contract in accordance with the applicable clauses of the contract.

e. Disposal of nonhazardous waste materials. - Waste materials including, but not restricted to, refuse, garbage, sanitary wastes, industrial wastes, and oil and other petroleum products, shall be disposed of by the Contractor by removal from the construction area. Waste materials shall be removed prior to completion of the work under these specifications. All materials removed shall become the property of the Contractor.

Where waste materials are to be dumped, they shall be dumped only in an approved sanitary landfill. The Contractor shall make any necessary arrangement with private parties and county officials pertinent to locations and regulations of such landfills, and shall pay any fees or charges required for such dumping.

f. Cost. - Except as provided above, the cost of the cleanup and disposal of waste materials in accordance with this paragraph shall be included in the prices bid in the schedule for other items.

PART 5 - REMOVAL OF EXISTING EQUIPMENT

5.01 GENERAL

The Contractor shall identify from drawings and during the site visit where existing equipment termination points are located for complete removal of identified components. Termination points of oil piping and electrical conduit and associated wiring shall be appropriately tagged and labeled for re-connection to new governor components.

5.02 MECHANICAL AND ELECTRICAL EQUIPMENT

a. General. - The Contractor shall remove and dispose of existing mechanical and electrical equipment associated with the three respective existing powerplant governors. The existing governor actuator cabinet will be retained and new equipmnet will be mounted in and on this cabinet.

The existing pilot valve assemblies for the three gate and blade main oil distributing valves shall be carefully removed and delivered complete by the Contractor to the COR, who will determine which of the assemblies will remain the property of the Government for use as possible spare parts for other Reclamation governor units. Those gate and blade pilot valve assemblies not retained by the Government shall be disposed of by the Contractor in accordance with the requirements of these specifications.

b. Existing equipment protection. - The Contractor shall protect equipment in and around existing governor actuator cabinet where work is to be performed for removal of cabinet mechanical and electrical components in accordance with paragraph 3.01 (Protection of Existing Installations).

c. Equipment to be removed. - The mechanical and electrical equipment to be removed from each respective governor is listed below:

(1) Ballhead control column. - The ballhead control column and associated speed control components; speed adjustment, gate limit, gate position mechanisms and devices; 3-D cam blade positioning equipment and respective gears and linkages; oil motor drives, compensating dashpot, normal and emergency shutdown solenoids and other associated components no longer required for use with the new digital governor control system components and installed inside the governor actuator cabinet and on the cabinet panels, shall be removed. All metal piping and electrical conduit and associated wiring shall be disconnected at appropriate locations where they enter the cabinet before removal of this equipment.

(2) Pilot valve assemblies. - The existing pilot valve assemblies for the gate and blade main oil distributing valves and associated oil piping and connections shall be removed from the governor actuator cabinet.

New proportional (pilot) valves for interfacing the new digital controls with the existing gate and blade main oil distributing valves and associated interconnecting oil piping

will be furnished and installed by the Contractor to the top of the sump tank inside the actuator cabinet under this contract.

(3) Governor position restoring systems. - Gate and blade restoring shafts, levers, cables, sheaves, and associated hardware and components for the existing governor gate and blade position restoring systems shall be removed from governor actuator cabinet, cable chases, and servomotor pit.

(4) Actuator cabinet panel meters. - The existing panel meters located in the existing governor actuator cabinet panels shall be removed from their respective locations. All wiring to the existing panel meter shall be disconnected and the wires properly labeled. This will identify the proper wiring for the new panel meters during reconnection.

New 4-20 mA cabinet panel meters will be furnished and installed on the existing governor actuator cabinet panels at the approximate locations of the existing meters under this contract.

(5) Generator shaft vibration monitoring system. - The existing generator shaft vibration monitoring system probes, drivers, cables, monitor, and associated hardware and conduit shall be removed from their respective locations within the powerplant for each unit.

The new shaft vibration monitoring system components will be furnished and installed at the respective locations of the existing equipment under this contract.

5.03 COST

The cost of removing existing mechanical and electrical equipment shall be included in the respective applicable lump-sum price bid in the schedule for installing and field testing the new equipment for which the particular items identified above are associated.

PART 6 - DIGITAL GOVERNOR CONTROLS, MECHANICAL AND ELECTRICAL FEATURES

6.01 GENERAL

These governor controls will replace the existing controls used to control the three horizontal-shaft, axial-flow Kaplan type hydraulic turbine units at Headgate Rock Powerplant used for the production of power. The existing mechanical-hydraulic Woodward Governor Company governors at Headgate Rock Powerplant were furnished under Bureau of Reclamation Specifications No. DS-7658 in 1988.

Prior to proceeding with the design of the digital governor controls, the Contractor shall make a field examination of the existing governors, review the available drawings and data, and make any additional measurements that may be needed. Copies of pertinent drawings and data in the possession of the Bureau of Reclamation will be made available to the Contractor at the Headgate Rock Powerplant. The drawings and data are as complete as possible. However, it is anticipated that the Contractor will need to make some field measurements to verify and supplement the available drawings and data. The Contractor shall provide 2 weeks' notice to the Contracting Officer's Representative prior to the field examination. The field examination shall coincide with the Contractor's Conference required under 1.05.d of these specifications.

The new unit governor hydraulic control components will be required to be supplied with piping located such that they can be connected directly to the existing oil piping and associated interface components located inside the existing governor actuator cabinet. It will be the Contractor's responsibility to identify from the drawings and field examination what connections are required and to design these connections so they are compatible with the existing and new hydraulic components.

The removal of existing governor equipment and installation of the new digital governor controls and appurtenant parts and any necessary field modifications shall be performed by the Contractor under the direct supervision of the Contractor's erecting engineer.

The existing turbine units at Headgate Rock Powerplant were designed to operate under net effective heads from a minimum of 13 feet to a maximum of 20 feet at a rated speed of 75 revolutions-per-minute.

6.02 REFERENCES

The publications with approval or revision date listed below form a part of this specification to the extent referenced.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

Standard	Date	Title
ASME B16.5	1988	Pipe Flanges and Flanged Fittings (ASME/ANSI)
ASME	1986	Boiler and Pressure Vessel Code
ASME B31.1	1982	Power Piping Code

Standard	Date	Title
ASME Y14.1	1995	Decimal Inch Drawing sheet size and format (ASME/ANSI)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

Standard	Date	Title
IEEE C37.2	Dec. 10, 1996	Standard Electrical Power System Device Function Numbers and Contact Designations (ANSI/IEEE)

AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

Standard	Date	Title
ANSI B1.1	1989	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	1992	Pipe Threads, General Purpose (Inches)
ANSI Y32.9	Jan. 1, 1972	Graphic Symbols for Electrical Wiring and Layout Diagrams Used in Architecture and Building Construction (ANSI/IEEE)

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION (NEMA)

Standard	Date	Title
NEMA ICS-1	Jan. 1, 1993	Industrial Control and Systems General Requirements
NEMA FU 1	1986	Low Voltage Cartridge Fuses
NEMA WC 3	1992	Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

AMERICAN WELDING SOCIETY (AWS)

Standard	Date	Title
AWS D1.1	1998	Structural Welding Code - Steel
AWS Z49.1	1994	Safety in Welding, Cutting and Applied Processes

6.03 TYPE AND DESCRIPTION

The governor controls for the hydraulic turbines at Headgate Rock Powerplant shall be of the oil-pressure, cabinet-actuator, digital-electronic-hydraulic type. The fundamental speed-governing functions including speed sensing, development of the governing control signal, its modification with stabilizing terms, insertion of speed changer signal (speed/load level), and speed droop shall all be developed digitally. Physical control of the turbine gate and blade positioning servomotors is to be accomplished hydraulically. The transmission of control from

the governor electronics to the turbine gate servomotor system shall be in the form of a gate position setpoint signal. This gate position setpoint control signal shall be electronic. The turbine wicket gates are to be controlled by the existing hydraulic servomotors via a new proportional valve (electro-hydraulic interface) and feedback system so as to correspond exactly to the position called for by the governor gate position setpoint signal. The transmission of control from the governor electronics to the turbine blade servomotor system shall be in the form of a blade position setpoint signal generated via a blade angle control function (digital-electronic) residing in the controller. This blade position setpoint control signal shall be electronic. The turbine blades are to be controlled by the existing hydraulic servomotor via a new proportional valve (electro-hydraulic interface) and feedback system so as to correspond exactly to the position called for by the governor blade position setpoint signal. The governor controls and auxiliary equipment shall be of a type having an established reputation for satisfactory and reliable hydroelectric service, and their operation shall be guaranteed by the Contractor.

The unit governor controls shall be complete with new proportional (pilot) valves for the existing gate and blade main distributing valves to servomotors providing the required electro-hydraulic interface with the digital controls, a speed signal generator (SSG) device for providing speed sensing for speed-rated switching functions and tachometer indication, interconnecting oil piping, wiring, instrumentation, controls, and indicating devices with all parts and accessories required to make a complete unit for regulating the speed and controlling the wicket gate opening and blade position of the turbine.

The new actuator proportional (pilot) valves for each governor shall be installed on the oil sump tank on or near the existing gate and blade main distributing valves in the actuator cabinet. The proportional (pilot) valve ports shall be connected by piping to the existing main distributing valves to form a complete and operational hydraulic control system for interfacing with the new digital governor controls

All gauges and indicating and control devices for the governor shall be mounted on the front of the actuator cabinet located in the same relative positions as the existing cabinet as shown on the drawings. Any new panels that are provided shall be hinged so that they may be easily swung open to give ready access to all electro-hydraulic components and control devices.

Each governor shall be capable of interfacing with existing automatic synchronizing equipment and be adaptable for Automatic Generation Control (AGC) through direct interaction with the existing SCADA (Supervisory Control and Data Acquisition) system.

The basic governor speed control system is to be of the lead-lag integral type. The preferred configuration of stabilization system, shown in Configuration 5, drawing 89 (40-D-7013), consists of the speed signal routed through lead-lag filters and delivered to the integrator input with the speed changer signal (speed/load level), speed-droop signal, and speed-no-load offset. This configuration is preferred for its superior range, flexibility of adjustment, and low susceptibility to drift.

The preliminary settings shown for Configuration 5, drawing 89 (40-D-7013) are illustrative. The preliminary settings for the configuration will be furnished to the Contractor. Modifications of the configuration shown will be acceptable upon approval, provided that performance equal

or superior to the performance provided by the configuration is attained. Full details to establish equivalency will be required as set forth in provision 52.212-2, Evaluation--Commercial Items, subparagraph 3.(b)(4), Design Innovations/Performance Enhancements and Warranties. Evaluation of the modifications of the configuration, as to their equivalence or superiority of performance to the performance of the above-specified configuration will be made by the Contracting Officer.

The normal on-line governor control mode shall be speed droop control using a lead-lag-integral controller (or equivalent). Permanent speed-droop type of feedback from the gate position signal or the gate position setpoint signal is required to achieve the best transient response. A means for offsetting the speed-no-load droop signal shall be provided. With the governor in this mode, the governing algorithm shall be developed such that it maintains the proper gains and time constants to control generation based on the unit setpoint, and to control the speed of the unit if the unit is isolated or islanded. The unit speed control gains shall not be increased to improve the responsiveness to the generation setpoint (speed changer setpoint).

A feed-forward gain and ramping scheme shall be provided to achieve the desired response rate for setpoint changes if the unit is connected to a large electric power grid. Since it is possible for the unit to be connected to an isolated or islanded load with the unit breaker closed, the governor shall be provided with a means for determining if the unit is connected to a large grid that will disable the fast ramping when the unit is isolated or islanded. Features of this isolation detection scheme shall include an adjustable frequency deadband, an adjustable means for determining the ratio of power output changes to frequency changes when the wicket gate servomotors are moving, a method for disabling the fast ramping, and a method for automatically restoring the fast ramping when the unit is again connected to a large grid.

6.04 GENERAL PERFORMANCE AND CAPACITY REQUIREMENTS

a. Performance. - The governors shall meet or exceed the following minimum performance requirements:

(1) Stability. - With the governor, in speed reference control mode, controlling the turbine operating at rated speed and no load, the isolated operation shall not result in speed oscillation with an excess of plus or minus 0.1 percent of rated speed.

(2) Sustained generator operation. - With the governor, in speed droop control mode, controlling the turbine at rated speed and all steady-state power outputs between zero and maximum power output inclusive, the steady-state power stability index shall not exceed 1.0 percent of rated power output when operating at 5 percent droop.

(3) Load ramping performance. - With the governor, in speed reference control mode, controlling the turbine with the generator connected to a large power system, adjustment of the speed changer (speed/load level) shall result in ramping of the gate position setpoint signal at an adjustable rate between 5 seconds and 500 seconds. The response shall be a true ramp; an exponential approximation is not permissible. The ramp rate shall be independent of the rate of change of the speed changer. The speed changer shall also have an adjustable ramp rate of 10 to 500 seconds for each

10 percent of range. A second independently adjustable ramp rate, selectable by a contact closure shall be provided for AGC ramping.

(4) Generator load rejection performance. - Following rejection to zero of any load, speed shall be returned to speed-no-load, as modified by the speed changer (speed/load level) signal and permanent speed droop signal, in a stable manner. This is defined as no more than one underspeed deviation not to exceed 5 percent and one overspeed deviation not to exceed 5 percent subsequent to the initial overspeed deviation.

(5) Speed droop. - The speed droop shall be adjustable between 0 and 10 percent. Speed droop shall be a linear function with respect to gate position.

(6) Dead band. - The dead band at rated speed shall not exceed 0.02 percent of the rated speed at any gate setting.

(7) Dead time. - The dead time for a sudden load change of more than 1.0 percent of the capacity of the turbine shall not exceed 0.1 second. The dead time for any frequency change larger than 0.05 Hz shall not exceed 0.1 second.

(8) Speed signal. - The speed-sensing signal which shall be derived from both a toothed wheel on the generator shaft and a generator potential transformer (PT) shall not be affected by variations in the voltage or current of the main generator or exciters or of the power system to which the generator is connected. Variation of the toothed-wheel speed signal, as a function of vibration or normal lateral movement of the main shaft, shall not exceed 0.1 percent. Variation of the generator-potential-derived speed signal shall not exceed 0.05 percent under steady-state conditions. The speed-sensing system shall respond with phase lag less than 30 degrees at all frequencies up to 1 Hertz. Digital filtering may be used to achieve these required levels.

(9) Speed changer adjustment. - The range of adjustment of the speed of the turbine shall be from 85 percent rated speed at no load and zero speed droop to 110 percent rated speed at rated load and maximum 10 percent speed droop.

(10) Speed response. - The speed-response elements shall be capable of effecting movement of the turbine gates in consequence of speed variations of the turbine of 0.02 percent or less.

(11) Governor time adjustment. - The governor shall be designed to operate the turbine gates through a full gate-opening stroke or a full gate-closing stroke in not less than 8 seconds and shall be capable of being adjustable for operation through either full gate stroke up to a maximum of 20 seconds. The governor shall be designed to operate the turbine blades through a full gate-opening stroke or a full gate-closing stroke in not less than 50 seconds and shall be capable of being adjustable for operation through either stroke up to a maximum of 80 seconds. The gate and blade adjustments shall positively restrict the oil flow and shall be arranged

to prevent movement of the turbine gates at a faster rate than the maximum rate to which the adjustment is set.

b. Capacity. - The new digital governor shall have a capacity of not less than that of the original unit with a minimum normal operating oil pressure of 900 pounds per square inch, which is the capacity of the existing turbine gate servomotors, and shall be able to supply an adequate quantity of oil to the servomotors to operate the turbine gates through a complete closing or complete opening stroke in 8 seconds with minimum normal operating pressure in the pressure tank and with the maximum head of 20 feet on the turbine.

The velocity of the oil in the pipe ports of each actuator and in the piping between each actuator and respective servomotor(s) shall not exceed 15 feet per second.

6.05 MATERIAL REQUIREMENTS, MECHANICAL EQUIPMENT

a. General. - The primary mechanical components comprising the governor servomotor control system are described in these paragraphs.

b. Submittals. - Submittals shall be in accordance with this paragraph, paragraph 1.03 (Submittal Requirements), and paragraph 1.04 (Mechanical Drawings and Data to be Furnished by the Contractor).

The Contractor shall submit the following drawings and data:

(1) Layout drawings
(2) Detail drawings
(3) Assembly drawings
(4) Installation plan and drawings
(5) Design data
(6) Commercial products data
(7) Shop test reports
(8) Service manuals
(9) Final as-built drawings

c. Materials. -

(1) Hydraulic Gate Actuator Control System. - The hydraulic gate actuator control system is the portion of the governor that converts the electronic setpoint (calculated by the speed control algorithm) into movement of the wicket gate servomotors. The actuator control system shall be capable of being tuned to have a closed-loop 3-dB bandwidth of at least 0.8 Hz while simultaneously having a maximum value of the frequency response of less than 0.1 dB above the low frequency (steady-state) value. Equivalent time-domain performance criteria are 10-90 percent rise time of less than 0.25 second with simultaneous overshoot less than 5 percent.

The actuator control system shall consist of a new proportional (pilot) valve used in conjunction with the existing main oil distributing valve with gate position and gate velocity feedback and electronic circuitry constituting a closed-loop control system as

shown on drawing 90 (40-D-7014) or an equivalent control system for positioning the gate servomotors to an electronic setpoint.

The small-signal valve system sensitivity (or open-loop servosystem gain) shall be adjustable over such range as to produce ratios of main servomotor velocity to electronic setpoint output on an open-loop stroke/second basis, adjustable from 1:1 to 10:1. Servosystem-gain adjustment may be accomplished mechanically by an adjustable pilot-to-main valve restoring ratio or electrically by an adjustable gain in the power amplifier or electro-hydraulic transducer. With both position and velocity feedback from the wicket gate servomotor, the velocity and position of the wicket gates will be forced to closely correspond with the velocity and position of the pilot servomotor on a 1:1 basis. The higher valve sensitivities (open-loop gains) used with position and velocity feedback will serve to minimize the inherent valve nonlinearities for small valve displacements without excessive oil usage, and to minimize time lag of the main servomotor and gates for small movements. Servomotor velocity is never to exceed that for full travel in the minimum time shown in paragraph 6.04 (General Performance and Capacity Requirements).

Second-order time lags within the servosystem necessitate supplementing the gate position feedback with some velocity feedback or transient gain augmentation to maintain stable positioning when using the higher valve sensitivities (or servosystem gains). Velocity feedback (or equivalent transient gain) may be accomplished either by mechanical-hydraulic means or by electrical means. The velocity feedback (K_V) shall be adjustable from 0 to 1 per unit (1-per-unit velocity feedback signal equal 1-per-unit input signal when servomotor velocity equals one stroke per second). The principal time constant of the valve system at the maximum valve sensitivity (maximum gain) shall not be greater than 0.2 second.

The maximum open-loop gain (ratio of main servomotor velocity to electronic setpoint output) specified for the actuator control system is on the basis that lap of the main distributing valve does not exceed 0.005-per-unit or 0.5 percent of the travel from neutral position to the valve position required to produce full travel in the minimum time shown in paragraph 6.04 (General Performance and Capacity Requirements). If a greater proportion of lap is employed, the available open-loop gain or velocity ratio must be increased in similar proportion.

The actuator control system shall position the turbine servomotors to equal the setpoint output signal from the digital controller. The servomotor position shall match this signal within an accuracy of +0.5 percent of servomotor stroke. The forward gain of the servomotor control system shall be sufficiently adjustable to be able to achieve maximum servomotor rate with a 5 percent mismatch between the setpoint output signal and the actual servomotor position.

If an electronic interface is used in the actuator control system, it shall receive a position setpoint signal from the digital controller and produce a mechanical or hydraulic output to operate the main control valve. The electronic interface shall be designed in a failsafe manner such that loss of either its power source or its setpoint signal shall cause an immediate closure of the turbine gate servomotors to the

shutdown position with full squeeze and an immediate operation of the governor shutdown and lockout relay.

The new proportional (pilot) valve shall be capable of interfacing with the digital controller and the main oil distributing valve to operate the turbine gate servomotors through a full opening or closing stroke at the minimum normal operating oil pressure and minimum time shown in paragraph 6.04 (General Performance and Capacity Requirements).

Position feedback from each turbine servomotor shall be from a highly reliable, non-contacting type position transducer. Redundant feedback shall be provided with a fully-independent position transducer system located on each of the turbine unit gate servomotors employing separate conduit routing to separate analog inputs at the governor processor. Each position transducer shall be as specified in paragraph 6.06 (Electrical Control and Indicating Devices). Each transducer shall be mounted as close to the turbine servomotor as is possible in order to minimize errors introduced by mechanical connections. If the connection to the servomotor is under tension to eliminate backlash in the transducer system, it shall be arranged such that breakage of this connection will result in a closure of the wicket gates.

A position feedback mismatch detection function shall be provided with an adjustable threshold (of 0-10 percent in 0.1 percent steps). If the mismatch between the position feedback transducers exceeds the threshold, this function shall cause an alarm, but not affect the normal operation of the governor. If either position feedback fails or goes out of range, an alarm shall be generated and control shall be transferred to the other transducer. If both transducers fail or go out of range, an immediate closure of the turbine gate servomotors to shutdown position with full squeeze and an immediate operation of the governor shutdown and lockout relay shall occur.

(2) Hydraulic Blade Actuator Control System. - The hydraulic blade actuator control system is the portion of the governor that converts the electronic setpoint (calculated by a blade angle algorithm) into movement of the runner blade servomotor. The actuator control system shall be capable of being tuned to have a closed-loop 3-dB bandwidth of at least 0.0.05 Hz while simultaneously having a maximum value of the frequency response of less than 0.1 dB above the low frequency (steady-state) value. Equivalent time-domain performance criteria are 10-90 percent rise time of less than 7.5 seconds with simultaneous overshoot less than 5 percent.

The actuator control system shall consist of a new proportional (pilot) valve used in conjunction with the existing main oil distributing valve with blade position feedback and electronic circuitry constituting a closed-loop control system as shown on drawing 90 (40-D-7014) or an equivalent control system for positioning the blade servomotor to an electronic setpoint.

Servomotor velocity is never to exceed that for full travel in the minimum time shown in paragraph 6.04 (General Performance and Capacity Requirements).

The blade actuator control system shall position the runner blade servomotor to equal the setpoint output signal from the digital controller. The servomotor position shall match this signal within an accuracy of +0.5 percent of servomotor stroke. The forward gain of the servomotor control system shall be sufficiently adjustable to be able to achieve maximum servomotor rate with a 5 percent mismatch between the setpoint output signal and the actual servomotor position.

If an electronic interface is used in the actuator control system, it shall receive a position setpoint signal from the digital controller and produce a mechanical or hydraulic output to operate the main control valve. The electronic interface shall be designed in a failsafe manner such that loss of either its power source or its setpoint signal shall cause an immediate movement of the runner blade servomotor to the shutdown position and an immediate operation of the governor shutdown and lockout relay.

The new proportional (pilot) valve shall be capable of interfacing with the digital controller and the servomotor main control valve to operate the runner blade servomotor through a full opening or closing stroke at the minimum normal operating oil pressure and minimum time shown in paragraph 6.04 (General Performance and Capacity Requirements).

Position feedback from the runner blade servomotor shall be from a highly reliable, non-contacting type position transducer. The position transducer shall be as specified in paragraph 6.06 (Electrical Control and Indicating Devices). The transducer shall be mounted as close to the runner blade servomotor as is possible in order to minimize errors introduced by mechanical connections. If the connection to the servomotor is under tension to eliminate backlash in the transducer system, it shall be arranged such that breakage of this connection will result in a closure of the wicket gates.

If the blade position feedback fails or goes out of range, an alarm shall be generated, an immediate closure of the turbine gate servomotors to shutdown position with full squeeze and an immediate operation of the governor shutdown and lockout relay shall occur.

(3) Governor Actuator Cabinet. - The existing governor actuator cabinet shall house the new electro-hydraulic interface components and digital-electronic control devices. The oil sump tank serves as the base for the gate and blade actuators and oil pumping units. The new controls and instrumentation will be mounted on the governor actuator cabinet. The governor actuator cabinet is located as shown on Drawings Nos. 4 (1117-D-8) and 7 (1117-D-11).

The design and layout of the new equipment within the governor actuator cabinet panels and the new controls and instrumentation mounted on the cabinet shall present a neat and pleasing appearance in size, shape, and arrangement.

All piping, conduit, and wiring within the cabinet will be furnished and installed by the Contractor at the site under the direct supervision of the Contractor's erecting engineer. All small piping and wiring shall be concealed neatly inside the cabinet.

The existing governor actuator cabinet will totally enclose all the regulating equipment, except as specifically stated otherwise.

The indicating meters and control devices shall be mounted on the front panel of the existing governor actuator cabinet and shall be arranged as depicted on the drawings for the existing governor control panel.

Openings in the top of the cabinet are provided to admit wiring to the terminal blocks. The location of these openings in the governor actuator cabinet are as indicated on the drawings.

(4) Metal Piping and Tubing. - The Contractor shall furnish, with electro-hydraulic interface, all associated piping and tubing connecting the various components located within the governor actuator cabinet. The piping and tubing shall be of such size that the velocity of the oil will not exceed 15 feet per second at the maximum rate shown in paragraph 6.04 (General Performance and Capacity Requirements).

Piping and tubing shall be seamless steel. Flared, flareless, and compression type tubing fittings may be used for tube sizes not exceeding 2 inches in diameter (O.D.). Piping larger than 2 inches in diameter shall be provided with steel flanges and fittings. All pipe, tube, fittings, and flanges subject to operating oil pressure shall be standard manufacture and suitable for service with an allowable working pressure not less than 110 percent of maximum normal operating pressure.

All fittings and flanges in the sump system and other piping systems not subject to operating oil pressure shall conform to the 150-pound ASME/ANSI B16.5.

Wherever feasible, long-radius pipe bends shall be used. The entire piping system shall be welded insofar as practicable, leaving only such connections as may be necessary for erection or possible subsequent dismantling for repair. Welding of branches, headers, bends, and associated piping components, shall be done in the shop insofar as possible, consistent with the requirements for shipment and erection. The Contractor shall provide tapped bosses where required on the pipelines for drain connections.

All valves necessary for the operation of the system shall be furnished by the Contractor.

The piping shall be thoroughly pickled, cleaned, and the interior coated with oil before shipment. Prior to shipment, wood flange covers or other suitable means shall be provided to prevent the entrance of foreign matter into the piping during shipment or while awaiting installation.

All necessary studs, bolts, cold-finished nuts, washers, hangers, supports, oil-resistant gaskets, and associated components, required in connection with field assembly of the governor oil piping system, shall be furnished by the Contractor.

(5) Oil for Governor Use. - The Contractor shall furnish the governor oil used to perform the governor shop tests identified in paragraph 6.10 (Shop and Field Tests).

The governor oil used shall have a viscosity of between 315 to 355 seconds standard Saybolt test at 100 °F.

(6) Nameplates. - Cast, embossed, or stamped letters will not be permitted on any of the Government-designed equipment shown on the drawings or described in these paragraphs. However, small brass nameplates giving manufacturer's name, address, date, and other pertinent data may be provided for various major components of fabricated equipment.

Nameplates for commercial products shall be the manufacturer's standard nameplate.

The Contractor shall provide a nameplate for each indicating and control device located on the outside of the governor cabinet. The nameplate shall explicitly identify each device with the ANSI designation.

6.06 ELECTRICAL CONTROL AND INDICATING DEVICES

a. General. - The digital electronic governor shall be furnished with the electrical control and indicating devices specified in subparagraph h. below and shall be designed to interface with the existing unit control, protection, and annunciation circuits.

b. Submittals. - Submittals shall be in accordance with this paragraph, paragraph 1.03 (Submittal Requirements), and paragraph 1.05 (Electrical Drawings and Data to be Furnished by the Contractor).

The Contractor shall submit the drawings and data listed below:

(1) Equipment layout diagram drawings

(2) Schematic diagram drawings

(3) Wiring diagram drawings

(4) Manufacturer’s data

(5) Check prints

(6) Final drawings

(7) Operation and maintenance manuals. - In addition to the requirements of paragraph 1.05 (Electrical Drawings and Data to be Furnished by the Contractor), the following data shall be included in the instruction book:

(a) A complete and detailed description of the governor operation. The description shall be written in coherent narrative form, shall be indexed, and shall provide a complete step-by step explanation of the operation of the governor circuits through the following sequences:

1. Normal startup.
2. Normal shutdown.
3. Emergency shutdown (load rejection).
4. Operation of and recommended settings and programing for all auxiliary circuits, such as brakes, and protective circuits, in the manual and automatic mode.

The explanation must be explicitly written and arranged so that Government field and operating personnel can easily follow it step-by-step.

(8) Processor program listings, control block diagrams, ladder logic diagrams, or flow control drawings of the governor processor program.

c. Operating requirements. - The new governor shall operate with the existing unit control, protection, and annunciation circuits.

(1) Unit “off-line” mode of operation. - The unit “off-line” mode of operation is defined as operation with the unit running and the unit breaker open. When the unit is in the “off-line” mode of operation, the governor shall use the speed reference control mode to maintain unit speed such that the generator frequency stays within the range defined in paragraph 6.04 (General Performance and Capacity Requirements). The governor shall be provided with means at the governor to select the default unit “off-line” mode of operation.

(2) Unit synchronizing. - The unit shall be synchronized before changing from the “off-line” to the “on-line” mode of operation. The governor, when it is in the speed reference control mode, shall use contacts from the synchronizer to control the speed of the unit. The governor will not be required to close the unit breaker or to process any synchronizing voltages.

(3) Unit “on-line” mode of operation. - The unit “on-line” mode of operation is defined as operation with the unit running and the unit breaker closed.

(4) Speed sensing. - The speed sensing signal shall be derived from both a toothed wheel on the generator shaft and a generator regulating potential transformer (PT). The PT-derived speed signal shall be the primary source and shall be used for all governor speed functions. The toothed-wheel-derived speed signal may be used during startup before excitation is applied and if the PT signal fails. If either speed signal fails or goes out of range, an alarm shall be generated and control shall be

transferred to the other signal without affecting the normal operation of the governor. If both speed signals fail, immediate closure of the turbine gate servomotors to the shutdown position with full squeeze and an immediate operation of the governor shutdown and lockout relay.

(5) Normal shutdown. - Normal shutdown of the unit is accomplished by the existing control circuits. The unit is unloaded by lowering the speed adjustment to speed-no-load. When the unit reaches the speed-no-load condition, the unit breaker is tripped. After the unit breaker is tripped, the governor normal shutdown solenoid is deenergized.

(6) Emergency shutdown. - Emergency shutdown of the unit is accomplished by the existing control circuits. The unit protection trips the unit breaker and then deenergizes the governor emergency shutdown relay which deenergizes and locks out the governor shutdown solenoid. In addition, the governor returns the gate limit to squeeze and the speed changer settings to the speed-no-load position.

(7) Governor Trouble. - The governor shall initiate a trouble alarm to the Government annunciator circuits and to the communications link for the following conditions:

(a) Failure of one speed signal.

(b) Failure of any output indicators.

(c) Failure of any other non-critical governor components.

(8) Governor Failure. - The governor shall immediately close the turbine gate servomotors to the shutdown position with full squeeze, initiate a failure alarm to the Government annunciator circuits, the communications link, and initiate an immediate operation of the governor shutdown and lockout relay for the following conditions:

(a) Failure of either the gate position or blade position transducers.

(b) Failure of both speed signals.

(c) Failure of the governor processor.

(d) Failure of the actuator control system (loss of power or setpoint signal).

(e) Failure of any other critical governor components.

d. Digital Processor. - The governor processor shall have the following capabilities:

(1) Speed. - The processor shall be able to simultaneously run the frequency and speed transducers, the main speed control algorithm, and the actuator control system with an update rate of 10 milliseconds or less. It shall also be able to run all other processors simultaneously with an update rate of 10 milliseconds or less. The processor loading shall be less than 90% while running all specified tasks.

(2) Program Memory. - The processor program shall be stored in non-volatile memory, so that the program will be saved indefinitely with no external power applied to the processor board. All governor memory shall be parity memory that will generate an alarm on failure.

(3) Failure Detector. - The governor shall have a failure detection feature that immediately initiates operation of the governor shutdown and lockout relay upon processor malfunction.

(4) Programming. - The processor shall be capable of being programmed at the governor without any additional equipment in a high level language using ladder logic or block diagrams. All hardware and software required to make program changes shall be provided as a part of the contract. The contract shall also include a 400 MHz laptop computer with at least a 3.5" floppy drive, CD-ROM, 5 GB hard drive, 64MB of RAM, 56.6 KB modem, 12" viewable screen and all required cables and software to program the digital governor controller.

e. Governor Parameter Inputs. - The governor shall be provided with the following inputs:

(1) Unit PTs (2 open delta-4200-120 volt)

(2) Headwater elevation - 4-20 mA transducer interface

(3) Tailwater elevation - 4-20 mA transducer interface

f. Communication Link. - A serial communication link that supports the MODBUS protocol shall be provided. This link shall support control and indication of all governor operation.

g. Discrete Contact Inputs. - The governor shall have a minimum of sixteen (16) inputs capable of using discrete contact closures wetted with 125 volt direct current.

h. Control and indicating devices. - The control and indicating devices provided with the governor shall be in accordance with the requirements listed below. All devices shall be mounted in the governor control cabinet except those devices that are required to be provided for the existing main control boards.

(1) Gate Limit. - The gate limit shall prevent the gate position setpoint signal from exceeding the limit. The gate limit shall be operated electrically from the main control board (CCA), the governor electrical control cabinet, and via the serial communication link. The gate limit adjustment (rate of setpoint change) shall be from 0 to 100 percent gate or 100 to 0 percent gate and shall be adjustable over a range of 10 to 60 seconds.

(2) Gate Limit Position Indication. - The gate limit position shall be displayed on a meter that is located on each of the governors and on new Contractor provided meters that will be installed on each of the existing main control boards by the Government. The governor shall use a 4 to 20 mA signal that corresponds to a gate limit position that ranges between 0 and 100 percent.

(3) Gate Limit Position Outputs. - The gate limit position outputs shall be separately adjustable over the range 0 to 100%. The outputs shall be designated and set to operate as shown on drawings 11 (1117-D-491), 12 (1117-D-492), and 15 (1117-D-496), and shall be rated at least 1.25 amp inductive at 125 volts direct current.

(4) Speed Changer (speed/load level). - The speed changer shall establish the setpoint for governor control in the speed reference and speed droop control modes. Nominal speed changer adjustment shall be from 100% to 105% or 105% to 100% with full range of 85 to 120%. The rate of setpoint change from 85 to 120% shall be adjustable over the range of 5 to 250 seconds.

(5) Speed Changer Position Indication. - The speed changer position shall be displayed on a meter located on each of the governors and on new Contractor provided meters that will be installed on each of the main control boards by the Government. The governor shall use a 4 to 20 mA signal that corresponds to the speed changer position that ranges from 85 to 120 percent.

(6) Speed Droop. - The speed droop shall control the amount of speed droop of the turbine. The speed droop adjustment shall be adjustable from 0 to 10 percent at the governor. Speed droop shall be able to be displayed at the governor.

(7) Normal Shutdown Device. - The normal shutdown device shall be a solenoid-operated device and be suitable for continuous operation at 125 volts D.C.

(8) Normal Shutdown Device Auxiliary Relay. - The normal shutdown device auxiliary relay shall meet the requirements for auxiliary relays described in subparagraph j. The output contacts shall be designated and set to operate as shown on drawings 11 (1117-D-491), 12 (1117-D-492), and 15 (1117-D-496), and shall be rated at least 1.25 amp inductive at 125 volts direct current.

(9) Emergency Shutdown and Lockout Device. - The emergency shutdown and lockout device shall be suitable for continuous operation at 125 volts D.C. and shall meet the requirements for auxiliary relays described in subparagraph j. The output contacts shall be designated and set to operate as shown on drawings 11 (1117-D-491), 12 (1117-D-492), and 15 (1117-D-496), and shall be rated at least 1.25 amp inductive at 125 volts direct current.

(10) Gate Position Indication. - The gate position shall be displayed on a meter located on each of the governors and on Contractor-provided meters that will be installed on each of the main control boards by the Government. The governor shall use a 4 to 20 mA signal that corresponds to gate position that ranges between 0 and 100 percent.

(11) Gate Position Outputs. - The gate position outputs shall be separately adjustable over the range 0 to 100%. The contacts shall be designated and set to operate as shown on drawings 11 (1117-D-491), 12 (1117-D-492), and

15 (1117-D-496), and shall be rated at least 1.25 amp inductive at 125 volts direct current.

(12) Dead Stop, and Breakaway Indication Outputs. - The governor shall be capable of detecting the rotation of the generating unit in one degree units and at a speed as low as 0.25 revolutions per minute. The outputs shall be contacts set to operate the Dead Stop/Breakaway light on the control boards, and shall be rated at least 1.25 amp inductive at 125 volts direct current.

(13) Main Overspeed Switches. - The main overspeed switches shall be provided with two electrically separate, form “C”, snap-action type switches. The switches shall be rated 5 amps at 125 volts D.C.; be designated and set to operate as shown on drawing 12 (1117-D-492).

(14) Unit Speed Indication. - The unit speed shall be displayed on a meter located on each of the governors and on Contractor provided meters to be installed on the main control boards by the Government. The governor shall use a 4 to 20 mA signal that corresponds to the unit speed that ranges between 0 and 100 percent.

(15) Unit Speed Outputs. - The governor shall be provided with three separately adjustable output contacts, adjustable over the range of 0 to 150%. The output contacts shall be rated at least 1.25 amp inductive at 125 volts direct current.

(16) Blade Position Indication. - The blade position shall be displayed on a meter located on each of the governors and on Contractor-provided meters that will be installed on each of the main control boards by the Government. The governor shall use a 4 to 20 mA signal that corresponds to blade position (angle) that ranges between 0 and 100 percent.

i. Governor control equipment cabinet. - The Contractor shall use the existing governor control equipment cabinet to house all the electrical devices, electronic equipment, input and output cards, digital electronics and terminal blocks required by these specifications. If the existing cabinet is not large enough to accommodate the new equipment required by these specifications then the Contractor shall provide a new cabinet to replace the existing cabinet. If the Contractor provides a new cabinet that cabinet shall meet the following requirements:

(1) Be NEMA type 12.

(2) Have a rack type support system and an auxiliary stand off panel at the rear of the cabinet.

(3) Have doors with three point latches. The doors shall be provided with gaskets and locking handles.

(4) Have a interior light operated by a light switch.

(5) Have one duplex, 20 amperes, 120 volts A.C., 3 wire grounded type plug receptacle.

(6) Have an internal wire gutter system with removable covers.

(7) Have sufficient terminal blocks to accommodate all new and existing external circuits with approximately 20 percent spare terminal points.

(8) Have means to support cables leaving the bottom of the cabinet.

(9) Have interior surfaces of the cabinet and auxiliary mounting panels that are painted white.

j. Auxiliary relays. - The auxiliary relays shall be in accordance with the following:

(1) Be of the dustproof, surface-mounted, front connected, switchboard type.

(2) Have coils suitable for operating continuously at 140 volts D.C.

(3) Have contacts rated at least 1.25 amp inductive at 125 volts D.C.

k. Control and transfer switches. - The control and transfer switches shall be in accordance with the following salient characteristics:

(1) Be of the rotary type and be insulated for 600 volts.

(2) Have switch contacts that are of the enclosed, replaceable, self-cleaning, wiping action type. The contacts of each switch shall be electrically separate. Switches having contacts with pushbutton-type contact action will not be acceptable.

(3) Have contacts rated 10 amps at 125 volts D.C.

(4) Have rectangular, front-of-panel, escutcheon plates that are engraved with the switch positions. The switches and escutcheon plates shall be provided in accordance with drawing 87 (40-D-5324).

(5) Be General Electric Co., type SB-M, SB-1, or SB-10, as manufactured by the General Electric Co., 205 Great Valley Parkway, Malvern PA 19355; Electroswitch, type W, W2, or series 24, as manufactured by the Electroswitch Unit of Electroswitch Corp., 180 King Avenue, Weymouth MA 02188; or equal.

l. Pushbuttons and push-to-test indicating lights. - The pushbuttons and the push-to-test indicating lights shall be in accordance with the following:

(1) Be suitably rated for the intended application.

(2) Each indicating light assembly shall be of the push-to-test type.

(3) Each indicating light assembly shall have colored lenses that are red, green, white, or amber, as required. The light assembly lamps shall be replaceable from the front of the panels.

m. Signal conditioners and transducers. - The signal conditioners and transducers shall be in accordance with the following:

(1) Be of the surface mounted, front connected type and be rated for the intended application.

(2) Any transducers provided shall have 4 to 20 mA outputs and be compatible with the meter circuit in which they are used. The transducer output range shall span the required display range of the primary metered quantity.

(3) Have a repeatability of ± 0.1% or better of the span.

(4) Be powered from the governor's 125 volts D.C. power that is supplied from the plant battery.

(5) Have separately adjustable zero and span calibration capability.

n. Indicating meters. - The indicating meters that are provided for the governor, gate limit position, gate position, speed changer position, unit speed and blade position shall be of the manufacturer's standard. The Contractor shall also provide indicating meters to replace existing meters on the main control boards that are associated with the governor. The meters that are provided for the main control boards will be installed by the Government. These meters shall be in accordance with the following:

(1) Be approximately 4-1/4 inches square with a minimum scale arc length of 6.8 inches and a minimum scale angle of 250°, unless otherwise specified.

(2) Have scale engravings that correspond to the primary measured quantity's range.

(3) Have an accuracy of 1% of full scale.

(4) Be capable of operating without requiring an external power supply.

o. Electronic equipment power supplies. - The power supplies for the governor shall be in accordance with the following:

(1) The input power supplies, transducers, auxiliary relays, and other necessary control functions shall be taken from the unit control 125 volts DC control bus. With the exception of unit metering PT inputs for control intelligence use only, no other power supply is available.

(2) Be rated for 125% of the total governor electrical and electronic equipment load.

p. Speed sensing devices. - The governor shall be provided with speed sensing devices. These devices shall meet the requirements of paragraph 6.04 (General Performance and Capacity Requirements) and the following:

(1) One speed sensing device shall be mounted on the generator shaft. It shall use a toothed wheel and proximity probes to generate a signal that is converted by the governor to a representation of the unit speed.

(2) The second sensing device shall use the existing unit PT signals. The governor shall use this to develop a representation of the unit speed.

q. PT circuit test devices. - The governor shall be provided with PT test devices for the PT input circuits that will be provided to the governor. The test device shall be arranged to completely isolate the governor internal circuits from the external instrument transformers. The test devices shall be provided with means for testing, either from an external power source using multi-pole test plugs, or from the instrument transformers by means of single-pole or multi-pole test plugs provided by the Contractor for this purpose.

r. Terminal blocks. - The Contractor shall use existing governor terminal blocks for external control and power wiring. If the Contractor provides new terminal blocks, they shall be in accordance with the following salient characteristics:

(1) Be rated at least 600 volts and 30 amperes. The terminal blocks shall be of the molded-block type, shall accommodate ring lugs 7/16-inch wide (diameter) at the terminal screws, and shall have binding-head or washer-head screws with serrated or grooved-contact surfaces, or lockwashers.

(2) Terminal blocks for power wiring shall be rated at least 600 volts and 120 amperes.

(3) Be provided with molded-insulating barriers between the terminals and shall have removable covers and marking strips.

(4) Be Buchanan, catalog numbers B104 through B112 for control wiring and No. 416 for power wiring, as manufactured by Buchanan Construction Products, Esna Park Drive, Hackettstown NJ 07840; Marathon, catalog numbers 1604 through 1612 for control wiring and No. 142 for power wiring, as manufactured by Marathon Electric Manufacturing Corp., Marathon Special Products Division, 13300 Van Camp Road, Bowling Green OH 43402; General Electric Co., type EB-25 for control wiring, as manufactured by the General Electric Co., 205 Great Valley, Malvern PA 19355; or equal.

s. Fuses and fuse holders. - The governor shall be provided with fuses and fuseholders that are rated 600 volts and are UL listed. The fuseholders shall be of the block type with side barriers. The fuses shall be of the indicating type and shall meet the requirements of NEMA FU1.

t. Governor cabinet wire. - The wire that is used for the governor control cabinet internal wiring shall be NEC type SIS wire; shall be No. 14 AWG with copper conductor; shall be class K stranded in accordance with NEMA standard No. WC 3; shall be rated 600 volts; and shall be UL listed. Switchboard wire for annunciator circuits may be No. 16 AWG. Wire for lights and receptacles shall be No. 12 AWG.

u. Terminal connectors. - The terminal connectors shall be heavy-duty, pre-insulated, pressure-crimp type with ring tongues. The connectors shall be tin-plated copper, shall have a serrated inner barrel, shall have 600-volt rated nylon insulation with an insulation support sleeve for vibration resistance, and shall be UL listed. Each connector shall be compatible with the conductor for which it is used and with the terminal to which it will be connected.

v. Nameplates. - Nameplates shall be provided for all items of equipment and devices, and shall be mounted next to each item of equipment or device. The nameplates shall be fabricated from a laminated phenol resin material, (1/16 inch) thick, with semi-matte black surfaces, and a white center. The size of each nameplate shall be in accordance with drawing 88 (40-D-6187). The nameplates shall be engraved with the equipment or device designation.

6.07 INSTALLATION

a. General. - The Contractor shall be responsible for the installation of the new digital governor control equipment in accordance with the drawings and the manufacturer's installation instructions and recommendations. The governor equipment shall be installed under the supervision of a qualified erecting engineer from the governor manufacturer at no additional cost to the Government.

The Contractor is required to submit an "installation plan" for installing the new digital governor control system components in the existing governor actuator cabinet to the COR for review and approval before proceeding with fabrication of the new governor control equipment.

After erection, the oil pressure system shall be tested with governor oil at 110 percent of the normal maximum operating pressure. The test pressure shall be maintained for a period of not less than 30 minutes after all leaks have been stopped.

b. Actuator cabinet panel meters. - New panel meters shall be installed on the exterior of the existing governor actuator cabinet at the approximate location of the old meters as determined by the Contractor.

The cables and wiring that were disconnected from the governor for removal of existing components shall be reconnected to the new governor components in accordance with the approved schematic and wiring diagram drawings. However, if the Contractor determines that the existing cables and wiring are not of sufficient length, the Contractor shall remove the existing cables and shall furnish and install new cable in accordance with specification section 7.04 Insulated Conductors. The Government will terminate the cables at the main control board end.

c. Proportional valves for main oil distributing valves. - New proportional (pilot) valves for interfacing the new digital controls with the existing gate and blade main oil distributing valves and associated interconnecting oil piping shall be installed by the Contractor on the inside of the existing governor actuator cabinet at a convenient location for direct connection to the main control valves.

d. Speed sensing device and main over-speed switch. - The Contractor shall install the speed sensing device with main over-speed switch and insulated conductors required for connecting the new speed sensing device and main over-speed switch to the new digital governor control system equipment. The Contractor shall determine the routing of the new insulated conductors subject to the approval of the Government.

e. Governor electronic equipment. - The Contractor shall install the governor electronic equipment in the existing governor electrical equipment cabinet and wire all inputs/outputs to the existing terminal blocks.

f. Governor accumulator tank pressure and level switches. - The Contractor shall install electrical conduit and insulated conductors required for connecting the existing pressure and level switches to the new governor control equipment. The Contractor shall determine the routing of the new electrical conduit subject to the approval of the Government.

g. Metal piping. - The installation of metal piping shall be in accordance with paragraph 6.05 (Material Requirements, Mechanical Equipment) All oil and drain piping connections between the new proportional (pilot) control valve ports and the existing distributing valve connections shall be made to provide a complete and operational system. Extreme care shall be taken to ensure that all parts of the oil system of the governor are clean before oil is placed in the new system components.

6.08 SPARE PARTS

There shall be supplied with the governors, and included in the price offered in the schedule, the following spare parts in the quantities listed. The listed spare parts and quantities indicated are the total required for all threes governors as a group.

ITEM	QUANTITY REQUIRED
Complete proportional valve assemblies (Electro-Hydraulic Interface) for main distributing valves	2 of each used type
LVDT (Linear Variable Differential Transformers) to monitor gate main distributing valve spool position	1 of each used type
RVDT (Rotary Variable Differential Transformers) to monitor blade main distributing valve spool position	1 of each used type

ITEM	QUANTITY REQUIRED
MLDT (Magnetostrictive Linear Differential Transducers) for providing gate and blade restoring	1 of each used type
Any printed circuit card/module	1 of each used type
Auxiliary relays	2 of each used type
Indicating light lamps	50% of total amount installed
Signal conditioners	2 of each used type
Transducers	2 of each used type
Power supplies	2 of each used type
Velocity pickups, drive bearings and bushings, and drive amplifiers for speed sensing device	2 of each used type
Fuses	4 of each used type
Solenoid coils	2 of each used type

All spare parts furnished shall be interchangeable with and shall be of the same materials and workmanship as the identical parts of the governors furnished under this solicitation. The spare parts shall be shipped with the first governor.

Payment for the above spare parts shall be made at the per unit price bid therefor in the schedule. The price bid shall include the cost of delivering the spare parts to the Government storage facility as directed by the Government.

6.09 SPECIAL TOOLS AND ACCESSORIES

There shall be furnished and included in the price quoted in the schedule for furnishing, shop testing, and delivering one digital governor control system and appurtenant parts, one complete set of special tools which may be necessary or convenient for assembling, installing, aligning, or dismantling the governor control system components. There shall also be included with each governor control system, all bolts, studs, lubricating devices, and other appurtenances that may be required to make the governor a complete unit ready for operation. The special tools shall be new and unused and furnished with a storage cabinet.

The Contractor shall provide all necessary processor programming tools, hardware and software, and accessories (ie. laptop computer, modules for communication and downloading to digital controller and all required cables) as required for making program changes.

The Contractor shall furnish a complete list of special tools and accessories he proposes to furnish.

6.10 SHOP AND FIELD TESTS

The governor and auxiliary equipment shall be completely assembled in the supplier's shop and tested, so far as practicable, at a pressure of 110 percent of the normal maximum pressure. The operating medium used for testing shall be lubricating oil of the type identified in paragraph 6.05 (Material Requirements, Mechanical Equipment). The various parts shall be properly matchmarked and doweled to insure correct assembly and alinement in the field.

Operational tests shall be performed on the following equipment or devices to demonstrate that specifications requirements have been met:

(1) Speed switches.

(2) Local and remote indicators.

(3) Automatic-manual governor control transfer devices.

(4) Manual governor control devices.

(5) Control switches.

(6) Speed indicators.

(7) Limit switches.

(8) Position indicators.

All the above equipment and devices shall be set accurately in the factory so that the governor control system will be ready to be placed in service without further setting. The timing of the governor shall be set in the shop to cause a complete closing stroke of the turbine gates in 20 seconds and a complete opening stroke in 20 seconds. Final setting of the governor timing will be made by the Government after installation.

The digital governor control system components shall be shipped complete and ready for operation and installation in the existing governor actuator cabinet with the exception of the external piping and wiring. The entire system subject to governor oil pressure will be tested after erection under a pressure of 110 percent of the maximum working oil pressure.

Shop tests shall be performed on the governor digital-hydraulic controls to demonstrate that they meet the performance requirements of these specifications. At least 60 days prior to the performance tests, the governor manufacturer shall furnish a description of the procedures to be used in making the tests. Shop tests shall be performed on data or similar equipment submitted to show that the speed responsive element varies essentially directly with the speed of the shaft driving the speed signal generator for all rates of acceleration and deceleration up to 105 percent of rated speed per second.

After the equipment has been tested in the shop as specified above, the Contractor shall submit for approval four certified copies of all test reports.

Shipping of the equipment shall be withheld until the approval of the test reports for the equipment are received from the Contracting Officer. Approval of the shop tests shall no way relieve the Contractor of the responsibility for furnishing equipment that meets the requirements of these specifications. The Government reserves the right to reject any equipment which does not meet the performance requirements as revealed by the factory and/or field tests.

Oil piping and hydraulic control valve components shall be cleaned.

The new oil piping and hydraulic control valve components located within the actuator cabinet shall be cleaned. Before proceeding with field testing of the digital-hydraulic governor control system components and equipment, Reclamation will drain, flush, and refill complete governor oil system (pressure accumulator tank, sump tank, gate and blade servomotors and associated piping) with clean, filtered hydraulic oil. The Contractor shall install new oil filters in appropriate new governor control system components, where applicable, before beginning field testing.

The digital-hydraulic governor control system components and equipment shall be shipped complete and ready for operation, with the exception of the external piping and wiring.

Operational field tests shall be performed by the Contractor to verify operability of the new digital-hydraulic governor control systems. All operational field tests shall have step-by-step procedures written up and submitted for approval to the COR at least 30 days prior to performing any tests.

6.11 PAYMENT

Payment for furnishing, shop testing, and delivering the digital governor control systems and appurtenant parts will be made at the applicable lump-sum price bid in the schedule.

Payment for installing and field testing the digital governor control systems and appurtenant parts will be made at the applicable lump-sum price bid in the schedule.

PART 7 - GROUNDING, ELECTRICAL CONDUIT, AND INSULATED CONDUCTORS

7.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

Standard	Date	Title
ASTM B 3	1995	Soft or Annealed Copper Wire
ASTM B 8	4/10/99	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

Standard	Date	Title
IEEE 383	1974	Test of Class IE Electric Cables, field Splices, and Connections for Nuclear Power Generating Stations
IEEE 837	1989	Qualifying Permanent Connections Used in Substation Grounding

NATIONAL FIRE PROTECTION ASSOCIATION, INC/NATIONAL ELECTRICAL CODE (NEC)

Standard	Date	Title
NFPA 70	8/5/98	National Electrical Code 1999 Edition
NEC 300-19	1999	Supporting Conductors in Vertical Raceways

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

Standard	Date	Title
NEMA C80.1	1995	Rigid Steel Conduit - Zinc Coated (GRC)
NEMA WC 7	1992	Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

7.02 GROUNDING

a. General. - The Contractor shall furnish and install ground cable and associated materials and shall connect the new governor and associated equipment to the existing powerplant grounding system in accordance with the requirements of this paragraph.

b. Materials. -

(1) Ground cable. - The ground cable shall be annealed bare-copper cable, concentric stranded, in accordance with ASTM B 8, class B. The solid wires used in forming the copper cable shall be in accordance with ASTM B 3.

(2) Cable connectors. - The cable connectors shall be of the welded, bolted solderless or compression type and shall have a current-carrying capacity equal to the cable with which they are to be used. All connectors for the ground cables, including fittings, lugs, bolts, nuts, and washers, shall be a copper alloy containing not more than 4 percent zinc. All bolted solderless or compression type connectors shall meet the requirements of IEEE standard No. 837.

c. Installation. - All new equipment, including electrical conduit, shall be connected to the existing grounding system with No. 4 AWG ground cable except the governor actuator cabinet shall be connected to the existing grounding system with No. 4/0 AWG ground cable.

Paint, enamel, scale, oil, grease, or other foreign nonconductive material shall be removed from the point of contact on the metal surfaces before the ground connections are made. After the connections are made, paint or galvanizing material on the metal finishes that is damaged or removed as a result of the connections, shall be repaired to the Contracting Officer's satisfaction.

d. Cost. - The cost of furnishing and installing ground cable and associated materials and of connecting the new governor and associated equipment to the existing grounding system shall be included in the respective applicable lump-sum price bid in the schedule for installing and field testing digital governor control system(s) and appurtenant parts, which lump-sum prices shall include the cost of all labor and materials required by this paragraph.

7.03 ELECTRICAL CONDUIT

a. General. - The Contractor shall furnish and install electrical conduit and accessories, and associated materials; and shall utilize, connect to, and extend existing conduit required for the installation of the new governor and associated equipment. All materials shall be UL listed.

Conduit accessories for the electrical conduit shall include:

(1) Fittings such as caps, connectors, nipples, reducers, elbows, pipe plugs, locknuts, bondnuts, bushings, expansion couplings, seals (excluding wall penetration seals), and any other fittings required for proper installation of the generator switchgear assemblies.

(2) Threaded joint compound; protective sealant; materials for sealing ends of conduits terminating at outdoor boxes, panelboards or cabinets; supports and clamps, complete with bolts, washers, and nuts; and other devices required to

complete the electrical conduit system and to fasten, clamp, attach, and support each conduit in place.

b. Materials. - Materials for the electrical conduit shall conform to the following requirements.

(1) Rigid steel conduit, zinc coated.

(2) Conduit sealing bushings. - The bushings shall seal against liquid, gas, and vapor seepage, and shall be non-toxic, non-shrinking, and fire retardant.

(3) Protective sealant. - The sealant shall be water repellant and shall be resistant to peeling and cracking.

c. Installation. - The conduit shall be installed in accordance with the applicable requirements of the NEC and NFPA, and the requirements listed below.

(1) The Contractor shall determine the routing of all conduit. The Contractor's proposed conduit routing shall be subject to the approval of the Contracting Officer.

(2) The conduit shall be installed with all necessary fittings and supports, and bends shall be gradual and smooth to permit pulling insulated conductors without undue stress or damage to these conductors or the conduit. The conduit runs and bends shall be free from kinks, indentations, or flattened surfaces. Metal conduit bends made in the field shall have not less than the minimum radii required by the NEC and shall be bent cold to prevent damage to protective coating. No factory bends shall be used. Burrs and sharp corners at the ends of metal conduit shall be removed.

(3) Male threads of rigid metal conduit joints shall be coated with a suitable graphite or zinc sealing material before making joints, and shall be tightened securely to ensure electrical continuity and to prevent the entrance of moisture or foreign material.

(4) Bushings or Chase-type nipples shall be installed on the ends of conduit to protect the insulation of the insulated conductors from abrasion. Locknuts and bondnuts shall be installed to provide tight ground connections between conduit and boxes, panelboards, and cabinets.

(5) The ends of conduits terminating at all boxes, panelboards, or cabinets shall be sealed with a sealing material or sealing bushings to prevent air circulation through the conduits into the boxes, panelboards, or cabinets. The seals shall be installed in accordance with the manufacturer's instructions.

d. Cost. - The cost of furnishing and installing electrical conduit and accessories, and associated materials; and of utilizing, connecting to, and extending existing conduit required for the installation of the new governor control system and associated equipment shall be included in the respective applicable lump-sum price bid in the schedule for

installing and field testing digital governor control system(s) and appurtenant parts, which lump-sum prices shall include the cost of all labor and materials required by this paragraph.

7.04 INSULATED CONDUCTORS

a. General. - The Contractor shall furnish and install insulated conductors required for the installation of the new governor and associated equipment. The insulated conductors shall be in accordance with this paragraph.

(1) Definitions. - For the purposes of this paragraph, the following definitions shall apply:

(a) Cable. - Cable, cables, wire, or wires of one or more insulated conductors.

(b) Power cable. - Cable that is used for power loads including receptacle outlets, motors, alternating- and direct-current distribution circuits, lighting circuits, and cable that is used for controlling heating, ventilating, air-conditioning, and lighting equipment.

(c) Control cable. - Cable that is used for control, metering, indication, annunciation, and relaying circuits; and circuits not identified as power circuits.

(d) Instrumentation cable. - Cable that is used in tranducer output circuits.

b. Submittals. - Submittals shall be in accordance with this paragraph, paragraph 1.03 (Submittal Requirements), and paragraph 1.05 (Electrical Drawings and Data to be Furnished by the Contractor)

The Contractor shall submit the data listed below.

(1) Manufacturer's data.

c. Materials. - Materials shall be as follows:

(1) Cable, general. - All cable shall:

(a) Be manufactured no more than 24 months prior to the bid opening date.

(b) Be round, except for 2-conductor cable with parallel conductors.

(c) Have ASTM class B or C copper conductor.

(d) Have AWG or kcmil designation.

(e) Have coverings or insulation suitable for installation in the vertical position without injury to the covering or deformation of the insulation when supported in accordance with NEC article 300-19.

(f) Have stranded conductors.

(2) Color coding for 3-phase power cable. - (Phase A - Brown, Phase B - Orange, Phase C - Yellow).

(3) Color coding for control and instrumentation cable. - The color coding shall be in accordance with table K-2 of NEMA WC 7. The base colors shall be colored insulation or jacket compound. The use of color coatings applied to the insulation or the jacket surface will not be acceptable.

(4) Indoor power cable. - This cable shall:

(a) Be single-conductor or multiconductor, nonshielded type.

(b) Be suitable for installation in cable trays and in conduits, and for general use.

(c) Have insulation or individual conductors that is cross-linked-polyethylene, NEC-type XHHW or THWN.

(d) Be UL listed and shall bear the UL-type label on the outer surface per the NEC.

(e) Be provided with a PVC-type flame-retardant jacket covering, if it is a multiconductor cable.

(5) Multiconductor control cable. - This cable shall:

(a) Be suitable for installation in cable trays and conduit, for direct burial, and for general use.

(b) Have insulation on the individual conductors that is in accordance with NEC-type XHHW insulation and that meets the following:

(aa) For No. 12 AWG, the insulation shall be nominally 30 mils (0.76 millimeter) thick.

(c) Have a binder tape or jacket covering.

(d) Have shielding that conforms to NEMA WC 7 (ICEA S-66-524), part 4, except the type shall be limited to the following:

(aa) Copper tape with a thickness of at least 5 mils, and a minimum overlap of 10 percent.

(bb) Copper braid consisting of 24 groups of 6 or 7 No. 30 AWG wires per group, or the equivalent in total circular mil area, providing a minimum coverage of 85 percent. (Example: No. 30 AWG wire has an

area of 100.5 circular mils; 6 strands of the wire in 24 groups gives a total area of 14,472 circular mils.)

(e) Have an overall flame-retardant covering (jacket) of thermoplastic or neoprene that meets the following:

(aa) For cable with No. 12 AWG individual conductors, the jacket shall be at least 60 mils thick, except 12-conductor cable shall be at least 80 mils thick.

(6) Instrumentation cable. - This cable shall:

(a) Be twisted pair for transducer output circuits and be twisted triad for RTD circuits.

(b) Be suitable for installation in cable trays and conduit, for direct burial, and for general use.

(c) Have No. 18 AWG conductors.

(d) Have a conductor insulation that is rated 600 volts and be suitable for operation at an ambient temperature of 105 °C.

(e) Have copper or aluminum tape shielding which completely covers the pair or triad assembly. The shielding shall also be provided with a tinned, stranded copper drain wire.

(f) Have a flame-retardant jacket rated for 600 volts.

d. Installation. - The Contractor shall install the cables in accordance with the requirements of these specifications, the requirements of the NEC and NESC, where applicable, and the following:

(1) No combination of alternating- and direct-current circuits, or current transformer and potential transformer circuits shall be included in the same multiconductor cable.

(2) The Contractor shall install cable without exceeding the allowable pulling tensions and sidewall pressures recommended by the cable manufacturer. Where a lubricant is needed as an aid to the pulling, only soapstone or other suitable material not injurious to the cable sheath shall be used. Cable damaged during installation shall be removed and shall be replaced by and at the expense of the Contractor.

(3) No splices will be allowed in multiconductor control cables. Splices in other types of cable shall only be made when approved by the Contracting Officer's Representative.

(4) Cable installed in a vertical or inclined plane shall be supported by cable grips (including hooks) and shall be installed with slack spans between the supports.

Cable entering equipment shall be securely clamped by commercial type cable clamps. Where cables are installed in sleeves under equipment or pass through blockouts, the openings shall be blocked with a silicone-foam, fire-retardant type material in accordance with the NEC.

(5) Sufficient length shall be left at the cable ends to make connections conveniently to equipment, fixtures, and devices. Spare single conductors at each end of a multiconductor cable shall be retained in a length equal to the longest single conductor of the multiconductor cable.

(6) Cable shall not be pulled into conduits until the conduit runs have been cleaned and are free from obstructions and sharp corners. A clean, dry, tight-fitting rag shall be drawn through the conduit immediately before installing the cable. The cable shall be installed so as to prevent cuts or abrasions in the insulation or the protective covering, or kinks in the cable.

(7) At the termination point of multiconductor cable, the conductors shall be formed into neat packs and the conductors shall be laced or tied with self-locking cable ties.

(8) Terminations of control and instrumentation wire shall be made with heavy-duty, preinsulated, pressure-crimp-type terminal connectors with ring tongues. The connectors shall be tin-plated copper; shall have a serrated inner barrel; shall have 600-volt-rated nylon insulation, with an insulation support sleeve for vibration resistance; and shall be UL listed. Each connector shall be compatible with the conductor size and type on which it is used.

(9) Multiconductor cables shall be tagged at each end. The tags shall be suitable for outdoor use, shall be rectangular in shape, and shall be white in color. The tags shall be attached to the cable by self-locking cable ties and shall be marked with the cable designation. The cable designations shall be as shown on the approved wiring diagram drawings. The lettering shall be computer generated.

(10) All conductors, whether single-conductor cables or individual conductors of multiconductor control, instrumentation, and power cables, shall be marked at each end with the conductor designation on the first line followed by the cable designation on the second line as shown on the approved wiring diagram drawings. The markers shall be white and shall be marked with the conductor designation. The spare conductors of multiconductor cables shall be marked with the cable designation and the word "SPARE", and shall be numerically sequenced (e.g., 2CSA-CSB-SPARE1). The markers shall have lettering that has been computed generated. The markers shall be white in color and shall be of the self-laminating-vinyl type or of the heat-shrink type.

(11) The insulated conductors shall be subjected to the tests specified paragraph 2.06 (Wiring Checkout and Tests) before the conductors are energized.

e. Cost. - The cost of furnishing and installing insulated conductors and of making electrical connections to the new governor control systems and associated equipment shall

be included in the respective applicable lump-sum price bid in the schedule for installing and field testing digital governor control system(s) and appurtenant parts, which lump-sum prices shall include the cost of all labor and materials required by this paragraph.

PART 8 - SHAFT VIBRATION MONITORING SYSTEM

8.01 GENERAL

A new shaft vibration monitoring system complete with probes, drivers, cables, monitor, and all miscellaneous mounting devices, hardware, and conduit required for a complete and operational system shall be furnished and installed by the Contractor to replace the existing system for monitoring generator shaft vibration and displacement.

The new probes shall be mounted near the generator bearings at the locations of the existing pickups where indicated on the drawings and identified from the field examination.

The new control panel or monitor and associated enclosure shall be furnished by the Contractor for mounting in the same space where the existing control panel was installed in the unit control board where shown on the drawings and identified from the field examination.

The vibration monitoring equipment shall provide indication of shaft runout in addition to alarm and shutdown of the generating unit in the event of sustained and excessive shaft vibration.

8.02 REFERENCES

The publications with approval or revision date listed below form a part of this specification to the extent referenced.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

Standard	Date	Title
ISO 9001	1994	Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing (ISO)

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION (NEMA)

Standard	Date	Title
NEMA ICS-1	Jan. 1, 1993	Industrial Control and Systems General Requirements

8.03 CHARACTERISTICS

The sensors shall be proximity probes measuring shaft runout in both the x and y directions. The Contractor may either reuse the existing or install new mounting brackets for the proximity probes at the specific locations as directed by the Contractor's erecting engineer so the probes can be easily adjusted and properly aligned with the generator shaft axis. The probe mounting brackets shall be designed and constructed to avoid resonant frequency problems.

The brackets, proximity probes, and conduit to route the probe cables to the unit control board shall be shown on the required contractor arrangement drawings. The Contractor shall also provide a sufficient length of the proper cable type to interconnect the probes to the probe drivers located in the unit control board. All cable connectors and other hardware necessary

for interconnection of this cable shall be provided. Proper grounds shall be provided at all instrumentation to avoid 60-hertz and 120-hertz ground-loop problems.

The shaft vibration monitoring system shall be furnished with the following features:

a. The calibrated output of the probes shall be 200 mV per mil.

b. The probe tip shall be 8 mm diameter for use with existing mounting brackets.

c. Adjustable settings for activation upon abnormal vibrations, including a setpoint multiplication feature. The range and sensitivity shall be determined by the Contractor.

d. Be furnished with a separate starting timing relay that has an adjustable time setting range of approximately 5 to 40 seconds. This relay shall be used to enable the device which will multiply the normal operation setpoint when starting. For alarm, shutdown, and remote indication of abnormal vibration during starting, three electrically separate contacts shall be furnished.

e. Be furnished with an integral running timing relay that has an adjustable time setting range of approximately 1 to 6 seconds. This relay shall be used to prevent alarm and shutdown due to short periods of abnormal vibration/displacement when running at synchronous speed. For alarm, shutdown, and remote indication of sustained abnormal vibration during running, three electrically separate contacts shall be furnished.

f. Be rated for operation on 120 volts, 60 hertz, alternating current.

g. Have output contacts rated 10 amps at 125 volts direct current.

h. Have mounted on the front of the control panel or monitor:

1. An indicating lamp to indicate that the monitoring unit is being energized or power is being applied.

2. An indicating lamp to indicate when excessive shaft vibration/displacement is occurring.

3. An indicating lamp to indicate when sustained excessive shaft vibration/displacement is occurring.

4. An “On-Off-Test” selector switch that will open the tripping and alarm circuits during testing.

5. Be provided with sufficient inputs/outputs (I/O) for interfacing directly with the existing generator shutdown and lockout circuitry and SCADA (Supervisory Control and Data Acquisition) system without modification to existing system hardware and programs.

i. Operation. - The indicating lamp for excessive vibration/deflection shall be on and the timing relay shall begin timing out during large momentary vibrations/deflections. The lamp shall go out and the timing relay shall reset when the vibration/deflection stops. If a sustained large shaft vibration/deflection occurs, the timing relay shall time out, seal in, initiate alarm and unit shutdown, and light the indicating lamp for sustained excessive vibration/deflection. A reset pushbutton shall be provided to reset the timing relay and indicating lamp.

8.04 INSTALLATION

The Contractor shall install the shaft vibration monitoring system complete with proximity probes, drivers, cables, monitor, and all miscellaneous mounting devices, hardware, and conduit required for a complete and operational system at the approximate locations of the respective existing system components.

The Contractor shall furnish and install all required electrical conduit required for the wiring between the individual system components in accordance with NEMA ICS-1. As far as practicable embedded and exposed conduit installed for the existing monitoring system components may be reused.

8.05 PAYMENT

Payment for furnishing, delivering, installing, and field testing the shaft vibration monitoring systems will be made at the applicable lump-sum price bid therefor in the schedule.

PART 9 - COATINGS

9.01 COATINGS, GENERAL

a. General. - The Contractor shall submit all purchase orders, certifications, and samples; furnish all materials; clean surfaces; and apply the approved protective coatings in accordance with this paragraph and paragraphs 9.02 (Coating Tabulations and Categories) and 9.03 (Color Schedule for Coatings).

Coating materials required by these specifications, but not covered or listed in the coating tabulations, shall be subject to certification, sampling, and testing in accordance with subparagraph 9.01.c (Coating materials approval) and methods of surface preparation and application shall be in accordance with the manufacturer's instructions and the general requirements of these specifications.

(1) Protection of newly coated and adjacent surfaces, and equipment. - Items or surfaces not to be coated, but which are adjacent to surfaces to be cleaned and coated, shall be protected against contamination and damage during the cleaning and coating operations. This includes surfaces and equipment which are subject to contact by airborne contaminants as well as those which are in physical contact with the areas being cleaned or coated. Examples include: mechanical and electrical equipment (open or enclosed), instruction and similar plates, and wet and newly coated surfaces.

Newly coated items shall not be moved until the coating is dry through. A coating film shall be considered dry through when it cannot be distorted or removed by exerting substantial, but less than maximum, pressure with the thumb and turning the thumb through 90 degrees in the plane of the coating film.

(2) Interior coating of machinery and equipment. - Unless otherwise specified, the Contractor will not be required to disassemble machinery, equipment, or other metalwork for the purpose of coating the interiors.

(3) All components of individual coating systems shall be obtained from the same manufacturer.

(4) Damage caused by the Contractor. - Any items or surfaces which are, in the Contracting Officer's opinion, damaged or contaminated by the Contractor's operations shall be returned to their original condition by and at the expense of the Contractor. Before top coating any coated surfaces, the Contractor shall reclean any exposed surfaces and apply coating materials as necessary to restore damaged or defective surfaces to the specified condition. Manufacturer-coated equipment shall be restored to the original appearance of the equipment by appropriate methods.

Temporary or permanent welding for the convenience of the Contractor shall not be done on areas where the welding will damage other protective coatings, unless the areas of coatings which would be damaged thereby are accessible for repairing and inspection.

b. References. - The publications listed below form a part of this specification to the extent referenced.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

Standard	Title
D 522-93a	Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
D 870-92	Standard Practice for Testing Water Resistance of Coatings Using Water Immersion
D 1141-90 Reapproved-92	Standard Specification for Substitute Ocean Water
D 1475-96	Standard Test Method for Density of Liquid Coatings, Inks, and Related Products
D 2244-93	Standard Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates
D 2697-86 Reapproved -91	Standard Test Method for Volume Nonvolatile Matter in Clear or Pigmented Coatings
D 2794-93	Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
D 3359-95a	Standard Test Methods for Measuring Adhesion by Tape Test
D 3363-92a	Standard Test Method for Film Hardness by Pencil Test
D 4060-95	Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
D 4214-97	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
D 4417-93	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
D 4541-95	Standard Test Method for Pull-Off Strength of Coating Using Portable Adhesion Testers
D 4587-91	Standard Practice for Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water-Exposure Apparatus
D 5162-91	Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating Metallic Substrates

Standard	Title
D 5532-94	Standard Specification for Micaceous Iron Oxide Pigments Paint
G 8-96	Standard Test Methods for Cathodic Disbonding of Pipeline Coatings
G 14-88 Reapproved-96	Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
G 42-96	Standard Test Method for Cathodic Disbonding of Pipeline Coatings Subject to Elevated Temperatures
G 53-96	Standard Practice for Operating Light- and Water-Exposed Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials
G 95-87 Reapproved -92	Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method)

CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS)

Standard	Date Mo-Yr	Title
PB-201B	10-95	Red Primer, High Solids Phenolic Type (Formula PB-201B)
PB-202B	10-95	Pink Primer, High Solids Phenolic Type (Formula PB-202B)

FEDERAL SPECIFICATIONS, STANDARDS, and QUALITY PRODUCTS LIST (QPL)

Standard	Date Mo-Day-Yr	Title
TT-E-1593B Notice 1	02-10-87	Enamel, Silicone Alkyd Copolymer, Gloss (for Exterior and Interior Use)
TT-P-664D Notice 1	08-28-92	Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Compliant
QPL-TT-P-644D-20	02-09-94	Federal Qualified Products List of Products Qualified under Federal Specification TT-P-664D, Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Compliant
595B	12-15-89	Colors Used in Government Procurement

MILITARY SPECIFICATIONS (MIL) and QUALITY PRODUCTS LIST (QPL)

Standard	Date Mo-Day-Yr	Title
E-24635B	06-30-94	Enamel, Silicone Alkyd Copolymer (Metric)
QPL-24635-12	09-16-97	Qualified Products List of Products Qualified under Military Specification MIL-E-24635, Enamel, Silicone Alkyd Copolymer (Metric)

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

Standard	Date Mo-Day-Yr	Title
AB 1	06-01-91	Abrasive Specification No. 1 - Mineral and Slag Abrasives
PA2	06-01-96	Measurement of Dry Coating Thickness with Magnetic Gauges
SP 1	11-01-82	Surface Preparation Specification No. 1 - Solvent Cleaning
SP 3	07-01-95	Surface Preparation Specification No. 3 - Power Tool Cleaning
SP 11	07-01-95	Surface Preparation Specification No. 11 - Power Tool Cleaning to Bare Metal
VIS 3	07-01-95	GUIDE TO SSPC-VIS3, Visual Standard for Power- and Hand-Tool Cleaned Steel (Standard Reference Photographs)

JOINT STANDARD
SOCIETY FOR PROTECTIVE COATINGS (SSPC)/NACE INTERNATIONAL (NACE)

Standard	Date Mo-Day-Yr	Title
SP 6/No. 3	09-15-94	Joint Surface Preparation Standard - SSPC-SP6/NACE No. 3 - Commercial Blast Cleaning
SP 7/No. 4	09-15-94	Joint Surface Preparation Standard - SSPC-SP7/NACE No. 4 - Brush-Off Blast Cleaning
SP 10/No. 2	09-15-94	Joint Surface Preparation Standard - SSPC-SP10/NACE No. 1 - Near-White Blast Cleaning

c. Coating materials approval. -

(1) General. - The Contractor shall submit to the Government, for approval, complete and legible copies of purchase orders, material certifications, samples of all coatings and related materials and qualification of coating applicators, as specified herein. Submittals shall be in accordance with paragraphs 1.03 (Submittal Requirements) and 1.06 (Submission of Material Safety Data Sheets for Hazardous Materials).

(2) Submittals. -

(a) Transmittal letter. - In addition to the requirements of paragraph 1.03 (Submittal Requirements), the Contractor's transmittal letter shall identify each item to be coated for each submittal and resubmittal and shall include the following information:

(aa) Coating tabulation number.

(bb) Sub-letter and sub-number or item name of the specific item being coated.

(cc) Tabulation option number of the material being applied.

(b) Product data and application sheets. - Manufacturer’s product data and application sheets of coating material being applied.

(c) Purchase orders. - Purchase orders shall contain the following documentation for the represented material:

(aa) Supplier’s name, address, and phone number, purchase order number, and purchase order date.

(bb) Manufacturer’s name, address, and phone number.

(cc) Batch number(s) for each material, except thinners.

(dd) Quantities ordered for each material, except thinners.

(ee) Color and gloss referenced for each material, listing either the manufacturer’s standard color or as specified in Color Schedule 3., paragraph 9.03 (Color Schedule for Coatings).

(d) Manufacturer’s certification of compliance. -

(aa) Composition and formulation. - The certification shall state that the material is of the same composition and formulation as:

1. Material which previously has been found to comply with these specifications when tested completely; or that

2. The material complies with these specifications based on complete performance tests which the manufacturer has conducted on the particular batch of material; or that

3. The material complies with these specifications based on complete performance tests which the manufacturer has conducted previously and has conducted manufacturer's quality control(QC), quality assurance (QA) on the particular batch of material, assuring the Government that this batch is unchanged from previously tested batches, or that

4. The submitted product meets all the coating manufacturer's quality control (QC), quality assurance (QA) requirements, which signifies that the material complies with the manufacturer's published product data sheets and long-term product performance testing.

(bb) Required documentation. - The manufacturer’s certification of compliance for the represented material shall contain the following documentation:

1. Manufacturer’s name, address, and phone number for each material.

2. Batch number(s) for each material, except thinners.

3. Quantities ordered for each material, except thinners. Quantity of entire batch manufactured is not acceptable, unless entire batch is greater than or equal to the quantity delivered to the project site.

4. Color and gloss referenced for each material, listing either the manufacturer’s standard color or as specified in the Color Schedule 3, paragraph 9.03 (Color Schedule for Coatings).

5. Signed and dated by the manufacturer’s technical representative.

(e) Specific material certification of compliance and documentation. - In addition to the requirements of subparagraph (c), the Contractor shall submit the following specific manufacturer/supplier certification of compliance or other specific documentation for the following materials:

(aa) Abrasive materials. - Abrasive materials used in surface preparation shall be certified in accordance with subparagraph (d).

(bb) Micaceous iron oxide (MIO). - Materials containing MIO products shall be certified in accordance with subparagraph (c).

(cc) Qualified Products List (QPL). - Certification of compliance is required for materials certified by a QPL for use of materials listed in the tabulations.

(f) Samples. -

(aa) Sample material types and quantities. - Upon the request of the Government, the Contractor shall furnish the following samples and quantities for liquid and mastic materials from the batches to be used, except thinners.

1. 1-quart sample for single-component coating materials.

2. 1-quart sample for two-component coating materials with the constituents supplied in separate containers.

(bb) Labeling of material samples. - Each material sample shall include the following information:

1. The Contractor's name, address, telephone number, and date of transmittal.

2. The appropriate coating RSN number listed in paragraph 1.03 (Submittal Requirements).

3. Manufacturer's name, address and phone number for the material.

4. Batch number(s) for each material represented.

(cc) Return of unused sample material. - At the option of the Government, samples which have been submitted may be returned to the Contractor or manufacturer after the testing period has been completed.

(g) "Or Equal" material substitution for immersion or burial service. - The Contractor may propose to use an "or equal" material for a "brand name or equal" product specified and described by a coating category. The Contractor shall submit data and documentation for "or equal" material substitution in accordance with subparagraph c. The "or equal" material will be evaluated on material composition, surface preparation, and plan of application.

In addition to the above submittal requirements, the "or equal" material submittal shall include:

(aa) Product data and application sheets.

(bb) Manufacturer's certifications.

(cc) Performance capabilities to meet or exceed the requirements as summarized in the associated coating category.

(dd) List of projects (not less than three) where the material has been successfully used in applications similar to the specified applications, including project name and location, type of structure, owner's name, address, and telephone number, and application date.

(ee) Manufacturer’s certified test reports for coating or coating system substitution to equal or exceed the appropriate category performance requirements.

(ff) Material samples and certified testing reports from an independent laboratory, if requested by the Government.

(h) “Or equivalent commercial” material substitution for atmospheric service. - Some coatings or coatings systems are specified using a Government specifications number followed by "or commercial equivalent." A commercial equivalent is a coating or coating system which will perform equal to or better than the Government specifications coating on the specified feature and under the specified conditions both at the time of coating application and the expected life cycle environment that the coating will be exposed to.

To obtain approval of a proposed substitution of commercial coatings for certain specified coatings in quantities of 20 gallons or less, the Contractor shall submit the material and the items to be coated in accordance with subparagraph 9.01.c.(2)(a) (transmittal letter). A manufacturer's certification compliance shall be submitted in accordance with subparagraph 9.01.c. (2)(d) (manufacturer’s certification of compliance) and shall state the coating will perform equal to or better than the specified coating listed in the tabulation. A 1-quart sample of the coating shall be submitted upon the request of the Government.

Upon approval of the proposed substitute commercial coating, the Contractor shall submit the remaining submittal requirements in accordance with subparagraph 9.01.c.(2) (Submittals).

(i) Qualification of coating applicators. - Each coating applicator shall be skilled and experienced in the application of each coating material which they will apply under this contract. The Contractor shall submit written evidence that each coating applicator meets the special standards of responsibility listed below for each coating material they will apply.

The Contractor shall furnish for approval for each applicator for each coating material either (aa) or (bb) as follows:

(aa) Data showing that the applicator has successfully completed training in the use of the coating material (including surface preparation; mixing; and application) on applications similar to those specified in these

specifications and has obtained certification as a qualified applicator of the coating material from the coating material manufacturer; or

(bb) Data showing that the applicator is skilled and experienced in the application of the coating material under conditions and with materials similar to those specified in these specifications. Data shall include a list of projects (not less than three) where the applicator has successfully applied the coating material, including project name and location; type of structure; owner's name, address, and phone number; application date; and a certification from the manufacturer of the coating material indicating that the coating material was correctly applied.

d. Materials. - Materials shall be in accordance with these specifications and shall meet the salient characteristics for composition, physical, and performance requirements listed in the coating categories in paragraph 9.02 (Coating Tabulations and Categories).

(1) Containers. - All pigmented coatings and primers shall be purchased in containers not larger than 5 gallons as packaged by the manufacturer unless the Contractor is equipped at the coating site to handle and thoroughly mix coatings which are delivered in larger containers. All materials shall be delivered to the jobsite in their original unopened containers bearing the manufacturer’s name, brand, batch number, date of manufacture, and any special instructions.

(2) Colors and tinting. - Colors of finish coatings shall be in accordance with paragraph 9.03 (Color Schedule for Coatings). All colors and tints shall be prepared by the manufacturer. No tinting shall be allowed at the jobsite.

(3) Shelf life of coating material. - Coating material shall not be used that exceeds the manufacturer’s minimum specified storage stability period.

(4) Volatile organic compounds (VOC). - The volatile organic compound (VOC) content of all specified coatings systems shall not exceed the maximum VOC content permitted by Federal, State, and local air pollution control regulations. VOC content shall be determined by ASTM D 2697 or other recognized standards. VOC content for the individual coatings or coating systems are listed in the coating categories and are identified as either "as supplied" or "reduced for spray”. The addition of thinners to the coating material, if required, shall determine the maximum VOC allowable, not the "as supplied" VOC content. Thinning of coating material shall not exceed the allowable maximum VOC limit.

(5) Abrasives. - The abrasives used to prepare the specified surfaces shall meet the requirements of SSPC-AB 1. The abrasives shall be either Type I or Type II, Class A material. The abrasive’s grade shall be the grade needed to produce the surface profiles specified per these specifications.

(6) Micaceous Iron Oxide (MIO) products. - Coating materials containing MIO products shall conform to ASTM D 5532, Type 1, at 80 percent minimum lamellarity, 85 percent minimum iron (III) oxide (Fe_2O_3) content, with the non-MIO crystalline

content comprised of quartz, mica, feldspathics, barytine, and shall be free of sulfates, carbonates and chlorine with soluble salts below 0.04 percent.

e. Preparation of surfaces. - Prior to or between subsequent coating applications, the Contractor shall re-clean or perform additional surface preparation for corroding or flash rusting of metal substrate surfaces and contaminated coated surfaces or improperly cured coatings.

(1) Surface profile. -

(a) Specified surface profile. - Where abrasive blasting is specified for a given service environment, the profile shall be as recommended by either the coating's manufacturer(s) or as given in the coating category or tabulation.

(b) Non-specified surface profile. - Where the surface profile is not specified, the blasted surface shall have the following profile for the listed service environments:

(aa) Atmospheric. - 1 mil or greater angular profile and shall be less than the specified millage of the first applied coat.

(bb) Burial and immersion. - angular profile between 1.5 to 3 mils.

(c) Testing of Surface Profile. - The surface profile of abrasive blasted steel surfaces shall be measured for compliance to manufacturer's instructions or specification herein, prior to coating application, in accordance with ASTM D 4417; except that, only Method C is allowed and Precision and Basis is not required.

(2) Metalwork and equipment. - Surface preparation shall be in accordance with the methods herein and as indicated in the coating tabulation. Any coatings not required by and not shown in the coating tabulation shall be removed from the surfaces by suitable and effective means, unless otherwise directed. All surfaces not specifically covered herein shall be prepared by methods common to good practice for the particular surface.

(a) Surface irregularities. - Weld spatter, slag burrs, porosity, sharp edges, pits, laminations, crevices, or other objectionable surface irregularity shall be removed or repaired before cleaning.

(b) Specific surface preparation. - Following removal or repair of surface irregularities, specific surface preparation shall be by one of the following methods, as specified for each item in the coating tabulation:

Method A. - Initial surface preparation shall be in accordance with SSPC-SP1; except that, the solvent chosen shall not leave a residue on the surface, such as xylene.

Method B. - Surface preparation shall be in accordance with SSPC-SP6/NACE No. 3. In situations where abrasive blasting is undesirable or impractical, SSPC-SP11 may be used.

Method B-1, Repair of defective or damaged coated areas. - Following the removal or repair of surface irregularities and Method A, the surfaces shall be cleaned of all defective or damaged coated areas and prepared in accordance with SSPC-SP6/NACE No. 3.

Edges of existing sound coating surrounding the repaired areas shall be feathered to remove any abrupt edges. Feathered areas being overcoated shall be roughened to achieve a matted or lusterless finish to equal or exceed SSPC-SP7/NACE No. 4.

In situations where abrasive blasting is undesirable or impractical, repair shall be in accordance with SSPC-SP11; except that, the tools and media used to prepare the surfaces shall retain or produce a surface profile and use of SSPC-VIS 3 standard, SP3/PWB is prohibited.

Method C. - Surface preparation shall be in accordance with SSPC-SP10/NACE No. 2.

Method D. - Following the initial solvent cleaning, loose corrosion products or other foreign substances, if any, shall be removed by chipping, scraping, wire brushing, light etch blasting, or other equally effective means and the surface shall be cleaned again with solvent. After the second solvent cleaning, the surfaces shall be treated with metal conditioner which has been diluted in acid-resistant containers with three parts (by volume) of clear water to one part (by volume) of metal conditioner. The solution shall be applied by spray, dip, or brush, allowed to remain on the metal surface for 2 to 10 minutes, then vigorously rinsed off with water (preferably hot), and the surface allowed to dry thoroughly. (Note: Solution is strongly acidic, and proper safety precautions shall be exercised in handling and use.)

Method I. - Surface preparation shall be in accordance with SSPC-SP7/NACE No. 4. In circumstances where abrasive blasting is not possible or feasible, surface preparation shall be in accordance with SSPC-SP3 or special treatments approved by the coatings manufacturer may be used.

f. Application. -

(1) General material preparation and application. - Materials shall be thoroughly mixed at the time of application, and shall be clean and free from moisture.

All Contractor-applied coatings exposed to public view shall present a uniform texture and color-matched appearance.

Thinning of coatings to facilitate satisfactory application shall be kept to a minimum, but in no event shall it exceed 1 pint per gallon of coating, except as otherwise specified; only thinner approved for the type of coating shall be used. Thinning with VOC regulated compounds shall be in accordance with this paragraph and subparagraph 9.01.c.(4) (volatile organic compounds.)

Openings of registers and grilles shall not be clogged and the surfaces shall not be excessively coated.

(2) Suspension of coating operations due to weather. - Coating application shall be suspended when weather conditions are unfavorable for coating application and proper cure. The coating application shall be suspended until conditions are favorable. These restrictions shall be based on the more restrictive requirement of either the manufacturer's recommendations or these specifications.

(3) Environmental temperatures and humidities. - The application of individual coating systems shall be applied within the maximum and minimum specified curing temperatures and between the maximum and minimum relative humidity applicable to that coating system. The temperature and humidity limits shall be as defined on the coating category sheets or the manufacturer’s product data sheets, whichever is more restrictive. Temperature and humidity restrictions are listed in the table below. These restrictions shall apply and are referenced by the corresponding number for specific materials listed in subparagraph 9.01.f.(9) (Application of specific materials).

Table 2 - Temperature and Humidity Restrictions

Restriction No.	Description
1	For surfaces that are not thoroughly dry at application time, the substrate shall be heated to 80°F, to drive off any moisture present before application.
2	The surfaces shall be a minimum of 5°F above the dewpoint temperature at time of coating application and during the full curing period.
3	Application shall not proceed unless the humidity of the atmospheric and of the surface to be coated are such that evaporation rather than condensation will result.
4	Coatings shall not be applied when either the air or surface temperature is below 45°F.
5	Surfaces shall be free of "black ice".
6	Application shall not be allowed on surfaces with free moisture.
7	Air and substrate temperatures shall be above 50°F during application and the curing period.

(4) Control of adverse environmental conditions. - For areas of adverse environmental conditions that are detrimental to coating application and cure, the Contractor shall control the environment by suitable means.

(5) Recoating times at a reference temperature. - Coated surfaces that are to receive subsequent coats shall be recoated within a time frame window. Recoat windows at specified temperatures are provided in paragraph 9.02 (Coatings Tabulations and Categories) and the manufacturer's recommendations. For recoating at temperatures other than listed, the Contractor shall consult the coating manufacturer for adjusted recoat limits. At fluctuating temperatures, the cure time shall be accounted for. Where the recoat limit has been exceeded, the Contractor shall prepare the coated surface in accordance with the manufacturer's instructions.

(6) Heating of cold-applied coatings. - Heating of cold-applied coatings may be allowed, if necessary, to improve application properties. Methods of heating shall be by hot-water bath or other OSHA-approved methods to temperatures not exceeding 100°F.

(7) Spray application. - Effective means shall be provided for removing free oil and moisture from the air-supply lines of all spraying equipment. Spray equipment shall be equipped with pressure gauges and pressure regulators. Nozzle pressure consistent with acceptable finish results shall be employed when spray coating. Spray equipment shall also be equipped with mechanical agitators; except that, mechanical agitators shall not be used for single component, moisture cure, urethanes. Care shall be exercised during spray application to hold the nozzle sufficiently close to the surfaces being coated to produce a continuous wet coat, and to avoid excessive evaporation of the volatile constituents and loss of material into the air, or bridging over crevices and corners.

(8) Coating application. - Each coat shall be applied in such a manner as to produce an even film of uniform thickness which will completely cover irregularities, fill crevices, and be tightly bonded to the substrate or previous coat. Each coat shall be free from runs, pinholes, sags, laps, brush marks, voids, and other defects. Each coat shall be allowed to dry or to harden before the succeeding coat is applied.

(a) Primer coats. - The primer coats shall cover the peaks of the surface profile by the specified dry film thickness. Unless otherwise specified, primer coats shall be applied as follows:

(aa) Edge Coat. - The first primer coat shall be an edge coat applied to edges, boltheads, welds, corners, and similar surfaces by brushing to thoroughly and effectively coat these areas. The coating material may be delivered to the surface by spraying and then "scrubbed in" by brushing.

(bb) General primer coats. - After the edge has have been applied, primer coats may be applied by conventional brush, roller, or spray equipment to all surfaces, including edge coated surfaces, to achieve a smooth, uniform coating.

(b) Intermediate coats and topcoats. - After the primer coat has been applied and is dry, intermediate and topcoats, if specified, shall be applied in accordance to the applicable tabulation number for number of coats and

thickness. The manufacturer's application instructions and recoating times for maximum and minimum curing temperatures and between maximum and minimum relative humidity shall be followed.

The coating color for intermediate coats shall be tinted with manufacturer's standard color to differentiate between coats to aid the coating applicator in the uniformity, thickness, and complete application of the material.

(9) Application of specific materials:

(a) Priming coats for atmospheric exposure only. - Priming coats shall be applied, unless otherwise specified in the coating tabulations or category sheets, at a DFT of not less than 1.0 mil for the first coat. Following the first coat of priming, an additional "edge" coat shall be applied over all rivets, welds, bolts, seams, sharp corners, and edges before subsequent painting. The first coat shall be applied by brush or roller, and subsequent coats shall be applied by either brush, roller, or spray, except that priming coats may be applied by spraying when method B surface preparation is specified.

Temperature and humidity restrictions: 1, 2, 3, 4, 5 and 6

(b) Enamels. - For ferrous surfaces, unless otherwise specified, enamels shall be spray applied to produce a minimum DFT of 1.5 mils per coat, and the total minimum DFT of the coating system shall be 4.0 mils.

Temperature and humidity restrictions: 1, 2, 3, 4, 5 and 6

(c) Single-component, moisture curing, urethane. - Application shall be in accordance with the manufacturer's instructions. The maximum DFT or wet film thickness per coat shall not be exceeded. Application of zinc-rich urethane primers at temperatures greater than 90°F or at humidities greater than 90 percent, shall be applied at the minimum DFT rather than the maximum DFT.

Application is allowed when the surface is saturated-surface-dry, i.e., where the ferrous surface is damp but retains no free moisture.

The coating shall not be opened and agitated or box mixed when atmospheric or material temperatures are less than 5°F degrees Fahrenheit above the dewpoint temperature. New containers shall be opened immediately prior to application to restrict reaction with atmospheric moisture. Full or partially filled containers shall not be opened and exposed to the atmosphere for more than one hour, maximum, before resealing. For partially filled opened or resealed containers that will not be applied within one hour, four ounces of the manufacturer's approved "float" thinner per five gallon container shall be "floated" on the surface of the remaining coating.

Temperature and humidity restrictions: 5 and 6

(d) Epoxy coating for oil exposure. - The epoxy coating shall be mixed and applied according to the manufacturer's instructions, except as otherwise specified. The first coat shall be applied by brush or roller (over the areas listed below) and succeeding coats by spray. Prior to applying the first coat, all welds and rough or irregular surfaces, including edges, shall be given a vigorously brushed coat to ensure complete coverage free of pinholes; the first general coat may then be spray applied over the wet brush coat. All coats shall be applied in rigid adherence to the manufacturer's time-temperature limits on time between coats. The minimum curing times before immersion shall be according to these specifications and the manufacturer's instructions.

Damaged areas or other areas requiring touch up coating shall be sanded to roughen the surface, and thereafter the manufacturer's special instructions regarding special solvent wiping or other preparation for touch up repair shall apply; areas in which the specified drying time between coats is exceeded shall be treated and prepared by the same method.

Temperature and humidity restrictions: 1, 2, 3, 5, 6 and 7

(e) Weathering aliphatic polyurethane topcoats over epoxy coatings. - Weathering aliphatic polyurethane topcoats shall be mixed and applied according to the manufacturer’s recommendations and to the manufacturer’s compatible epoxy base coating, except as otherwise specified. Application should be applied within the epoxy base coating recoat "window". For application exceeding the epoxy base coating recoat "window", the base coat shall be abraded to the manufacturer’s recommendations.

Temperature and humidity restrictions: 1, 2, 3, 5, 6 and 7

(f) Waterborne acrylic coating. - Waterborne acrylic coating shall be spray applied to produce a minimum DFT of 3 mils per coat. In interior areas where spray coating is impracticable, as determined by the Contracting Officer, application by brush or roller is permissible. Air, surface, and material temperature shall be between 55 and 120°F during coating application and for 2 hours or more thereafter as necessary under ambient conditions to produce a firm film. Surface temperatures shall be a minimum of 5°F above the dewpoint before coating application, and the relative humidity shall be less than 85 percent. If rainfall or moisture condensation produces a visible effect on the coating, an additional coat shall be applied at no additional cost to the Government.

The coating develops its cohesive strength before developing its full adhesive strength. Application of additional coats before the previous coat has cured beyond its minimum time to recoat is not allowed. The coating shall be throughly cured before taking DFT measurements or handling coated metalwork and equipment. Any coating that has lost its adhesion prior to full cure shall have the coating removed and recoated.

Application of oil or alkyd topcoats over a waterborne acrylic primer applied to galvanized surfaces exposed to severe moisture or humidity is not allowed.

Temperature and humidity restrictions: 1, 2, 3, 4, 5 and 6

g. Testing. - The hardened coating shall be tested for acceptance by the applicable standard(s) listed below for the following coating system exposure:

(1) All coating exposures (atmospheric, burial, and partial or complete immersion). - The dry film thickness (DFT) shall be measured on hardened completed coating systems, but before the recoating interval has been exceeded, on steel surfaces in accordance with SSPC-PA2, “Measurement of Dry Coating Thickness with Magnetic Gages"; except that, the third sentence of section 3.1 shall read " No single spot measurement in any 100 square foot area shall be less than 90 percent of the specified thickness." The least value readings on the bare substrate shall be used to specify the DFT measurement is taken from the peaks and not the valleys of surface profile. In accordance with section 3.2 of SSPC-PA2, irregular or complex shapes of less than 50 square feet area per face, a minimum of three spot measurements shall be taken.

The average of the five spot measurements and the average of the three spot measurements for irregular or complex shapes shall not be less than the specified thickness for DFT acceptance.

(2) Burial and partial or complete immersion exposure. - Nonconductive coating applied to conductive base metals which will be buried or completely or partially submerged in water shall be tested for pinholes and holidays in accordance to ASTM D 5162; except that, high voltage testing shall be conducted on 16 mils and greater DFT. The use of detergent wetting solution shall not be allowed.

The Contractor shall consult with the manufacturer to determine maximum voltage for the applied coating for testing to prevent coating damage. The Contractor shall notify the Contracting Officer's Representative 72 hours in advance of holiday testing so that the Contracting Officer's Representative may witness the pinhole and holiday testing.

h. Repair of construction related defects. - Damaged areas, pinholes, holidays, laps, voids, or other defects shall be repaired within the minimum and maximum recoat window times in accordance with the coating manufacturer's recommendations and the applicable tabulation by which the coating was applied. Repaired areas shall be retested. The cost of furnishing all materials and performing all work required in repair of defective coatings shall be borne by the Contractor.

i. Cost. - The cost of furnishing and applying coating materials shall be included in the applicable prices bid in the schedule for the items to be coated.

9.02 COATING TABULATIONS AND CATEGORIES

a. General. - Contractor-furnished items shall be surface prepared and coated in accordance with the tabulations.

b. Coating tabulations. - The tabulation specifies the items to be coated, the substrate surface, the coating or coating material options by an alphanumeric label, Federal or Military specification number, or "Brand" name, the number and thickness of coats to be applied, the surface preparation method, and the surface profile if different from general conditions. Within some coating options, there may be more than one coating category listed. The Contractor shall apply only one coating category per option. Individual system coats shall be compatible with the other applied coats, either primer, intermediate, or topcoat.

c. Coating categories. - Specific coating categories referenced in the coating tabulations identify product name and manufacturer or Federal or Military specification and list the generic chemical composition, physical characteristics, and performance requirements.

Tabulation No. TAB06. -

The exposed surfaces of equipment and metalwork* items listed below shall be painted or coated in accordance with this tabulation.

Items to be painted or coated:

a. Miscellaneous exterior surfaces of governor actuator cabinet components and piping not subject to oil.

Paint or coating material, option 1	Number and thickness of coats	Surface preparation method
Shop painting: Manufacturer's standard surface preparation and shop-applied permanent paint system that meets the requirements of the second footnote below.** The equipment and metalwork shall also be field painted with two finish coats as specified below. Field painting: Before applying finish coats, all damaged areas of shop-applied paint system shall be repaired with priming paint.		
Finish field coat: Category: AE-C1 (Colors and glosses as shown in the color schedule.)	2 or more coats 3-mil DFT, minimum, per coat 8-mil DFT, minimum, for total system, excluding edge coats	A For undamaged coated surfaces to receive additional coatings B For uncoated ferrous surfaces, except galvanized B-1 For damaged areas of coated surfaces

Paint or coating materials, option 2	Number and thickness of coats	Surface preparation method
Shop painting: Manufacturer's standard surface preparation and shop-applied permanent paint system that meets the requirements of the second footnote below.** The equipment and metalwork shall also be field painted with two finish coats as specified below. Field painting: Before applying finish coats, all damaged areas of shop-applied paint system shall be repaired with priming paint.		
Finish coats: Category: AE-E2(w) (Colors and glosses as shown in the color schedule.)	2 or more coats 3-mil DFT, minimum, per coat 9-mil DFT, minimum, for total system, excluding edge coats	A For undamaged coated surfaces to receive additional coatings B For uncoated ferrous surfaces, except galvanized B-1 For damaged areas of coated surfaces

Tabulation No. TAB06. -		
Paint or coating material, option 3	Number and thickness of coats	Surface preparation method
Shop painting:		
Prime coat for ferrous metal surfaces: Category: AE-A2 AE-A3 AE-A4 AE-A5 AE-A6	1 or more coats for uncoated surfaces 1 or more coats as required for repair of damaged coated surfaces 2-mil DFT, minimum, plus edge coats	A For undamaged coated surfaces to receive additional coatings B For uncoated ferrous surfaces, except galvanized B-1 For damaged areas of coated surfaces
Finish coat: Category: AE-C1 (Colors and glosses as shown in the color schedule.)	2 or more coats 3-mil DFT, minimum, per coat 8-mil DFT, minimum, for total system, excluding edge coats	A For undamaged coated surfaces to receive additional coatings within recoat window
Paint or coating material, option 4	Number and thickness of coats	Surface preparation method
Shop painting:		
Prime coat for ferrous metal surfaces: Category: AE-A7 AE-E1(w)	1 or more coats 3-mil DFT, minimum, plus edge coats	A For undamaged coated surfaces to receive additional coatings B For uncoated ferrous surfaces, except galvanized B-1 For damaged areas of coated surfaces
Finish coats: Category: AE-E2(w) (Colors and glosses as shown in the color schedule.)	2 or more coats 3-mil DFT, minimum, per coat 9-mil DFT, minimum, for total system, excluding edge coats	A For undamaged coated surfaces to receive additional coatings within recoat window
Paint or coating materials, option 5	Number and thickness of coats	Surface preparation method

Tabulation No. TAB06. -		
Prime coat for galvanized ferrous metal surfaces: Category: AE-W2	1 or more coats for uncoated surfaces 1 or more coats as required for repair of damaged coated surfaces 3-mil DFT, minimum, plus edge coats	A For undamaged coated surfaces to receive additional coatings B-1 For damaged areas of coated surfaces I For galvanized surfaces***
Finish coats: Category: AE-W7 (For a metallic aluminum color) AE-W6 (For a specific color)	2 or more coats 2-mil DFT, minimum, per coat 7-mil DFT, minimum, for total system, excluding edge coats	A For undamaged coated surfaces to receive additional coatings within recoat window
Paint or coating materials, option 6	Number and thickness of coats	Surface preparation method
Prime coat for galvanized ferrous metal surfaces: Category: AE-E1(w)	1 or more coats for uncoated surfaces 1 or more coats as required for repair of damaged coated surfaces 3-mil DFT, minimum, plus edge coats	A For undamaged coated surfaces to receive additional coatings B-1 For damaged areas of coated surfaces I For galvanized surfaces***
Finish coats: Category: AE-E2(w) (Colors and glosses as shown in the color schedule.)	2 or more coats 3-mil DFT, minimum, per coat 9-mil DFT, minimum, for total system, excluding edge coats	A For undamaged coated surfaces to receive additional coatings within recoat window

Tabulation No. TAB06. -

Paint or coating materials, option 7	Number and thickness of coats	Surface preparation method
Prime coat for aluminum, copper, brass, or bronze metal surfaces: Category: AE-A2 AE-A3 AE-A4	1 or more coats for uncoated surfaces 1 or more coats as required for repair of damaged coated surfaces 2-mil DFT, minimum, plus edge coats	A For undamaged coated surfaces to receive additional coatings B-1 For damaged areas of coated surfaces D For aluminum, copper, brass, or bronze surfaces
Finish coat: Category: AE-C1 (Colors and glosses as shown in the color schedule.)	2 or more coats 3-mil DFT, minimum, per coat 8-mil DFT, minimum, for total system, excluding edge coats	A For undamaged coated surfaces to receive additional coatings within recoat window

Paint or coating materials, option 8	Number and thickness of coats	Surface preparation method
Prime coat for aluminum, copper, brass, or bronze metal surfaces: Category: AE-E1(w)	1 or more coats for uncoated surfaces 1 or more coats as required for repair of damaged coated surfaces 3-mil DFT, minimum, plus edge coats	A For undamaged coated surfaces to receive additional coatings B-1 For damaged areas of coated surfaces D For aluminum, copper, brass, or bronze surfaces
Finish coats: Category: AE-E2(w) (Colors and glosses as shown in the color schedule.)	2 or more coats 3-mil DFT, minimum, per coat 9-mil DFT, minimum, for total system, excluding edge coats	A For undamaged coated surfaces to receive additional coatings within recoat window

Tabulation No. TAB06. -

* Unless otherwise specified, unexposed surfaces that require coating, such as interiors of enclosures and equipment, shall be given the manufacturer's standard permanent coated finish. After installation, repair damaged areas of these unexposed coated surfaces to equal and color match undamaged surfaces.

** Coat items at the manufacturer's plant with the manufacturer's standard shop-applied permanent coatings system that meets the following requirements:

a. Coatings system shall consist of the manufacturer's standard surface preparation and two or more coats that will produce a dry-film thickness of not less than 2 mils. The color shall be the manufacturer's standard.

b. Coatings system shall provide a minimum of 2 years' corrosion-free protection without significant coating defects while stored in outdoor atmospheric exposure.

c. Coating shall be compatible with category AE-C1 or AE-E2(w) finish coats, and the surface of the manufacturer's coating shall require only cleaning and sanding to develop a tight and permanent bond between the category AE-C1 or AE-E2(w) enamel and the manufacturer's coating.

*** Stabilizing or storage treatments, if present on galvanized surfaces, shall be removed by light sandblasting.

T-TAB06F.398

Tabulation No. T-TAB19. -

The interior and exterior* ferrous surfaces of the items listed below shall be painted or coated in accordance with this tabulation.

Items to be painted or coated:

a. Governor oil piping, exterior surfaces of governor actuator cabinet components and proportional valve housing of actuator cabinet exposed to oil.

* If these items will be exposed to Ultra Violet (UV) light, the base coatings shall be topcoated with the corresponding topcoat listed below. No topcoat required if the surfaces will not have outdoor exposure.

Paint or coating materials, option 1	Number and thickness of coats	Surface preparation method
Base coats: Categories: IE-1A1 IE-1C IE-1F IE-1J	2 or more coats 6-mil DFT, minimum, per coat 12-mil DFT, minimum, for base coat, plus edge coats	C
Finish coat(s): Category: IE-1AT over IE-1A1 IE-1CT over IE-1C IE-1DT over IE-1F IE-1DT over IE-1J Match the compatible category “T” aliphatic polyurethane to the base coat used. (Colors and glosses as shown in the color schedule.)	1 or coats of compatible “T” aliphatic polyurethane 2 to 4 mils DFT, minimum, for finish coat, per coat 14-mil DFT, minimum, for total system, excluding edge coats	Follow the Manufacturer’s specific application instructions and/or specifications for surface preparation before applying next coat.

Paint or coating materials, option 2	Number and thickness of coats	Surface preparation method
Category: IES-7A	1 prime coat, to produce a DFT between 3 to 4 mils per coat, plus edge coats	C Follow the Manufacturer’s specific application instructions and/or specifications for surface preparation before applying next coat.
	1 or more intermediate coats, to produce a minimum DFT of 3 mils per coat	
(Colors and glosses as shown in the color schedule)	1 or more topcoats, to produce a minimum DFT of 3 mils per coat 9-mil DFT, minimum, for total system, excluding edge coats	

Tabulation No. T-TAB19. -

Paint or coating materials, option 3	Number and thickness of coats	Surface preparation method
Category: IES-7C	1 prime coat, to produce a DFT between 3 to 4 mils per coat, plus edge coats	C Follow the Manufacturer's specific application instructions and/or specifications for surface preparation before applying next coat.
	1 or more intermediate coats, to produce a minimum DFT of 3 mils per coat	
(Colors and glosses as shown in the color schedule)	1 or more topcoats, to produce a minimum DFT of 3 mils per coat 9-mil DFT, minimum, for total system, excluding edge coats	

Paint or coating materials, option 4	Number and thickness of coats	Surface preparation method
Category: IES-7E	1 prime coat, to produce a DFT between 3 to 4 mils per coat, plus edge coats	C Follow the Manufacturer's specific application instructions and/or specifications for surface preparation before applying next coat.
	1 or more intermediate coats, to produce a minimum DFT of 3 mils per coat	
(Colors and glosses as shown in the color schedule)	1 or more topcoats, to produce a minimum DFT of 3 mils per coat 9-mil DFT, minimum, for total system, excluding edge coats	

Paint or coating materials, option 5	Number and thickness of coats	Surface preparation method
Category: IES-8G	1 prime coat, to produce a DFT between 3 to 4 mils per coat, plus edge coats	C Follow the Manufacturer's specific application instructions and/or specifications for surface preparation before applying next coat.
	1 or more intermediate coats, to produce a minimum DFT of 3 mils per coat	
(Colors and glosses as shown in the color schedule)	1 or more topcoats, to produce a minimum DFT of 1.5 to 2 mils per coat 8-mil DFT, minimum, for total system, excluding edge coats	

T-TAB19F.498

Category AE-A2

Category AE-A2 coatings shall be:

Chromox primer, V13-F-28 or V13-R-28; as manufactured by:

Valspar Corporation
1401 Seven Street
Baltimore, Maryland 21230
410-625-7200
800-638-7756

or equal, having the following salient characteristics:

COMPOSITION:

V13-F-28, Phenolic-alkyd resin, with Zinc phosphate, titanium dioxide, and inerts as pigments
V13-R-28, Phenolic-alkyd resin, with Zinc phosphate, iron oxide, and inerts as pigments

Lead and Chromate free

PHYSICAL CHARACTERISTICS:

Volume solids:	52%, minimum
VOC (as supplied):	3.3 pounds per gallon (394 grams per liter), maximum
Minimum application temperature:	50°F
Recoating time at 75°F	Dry to touch, 15 minutes Recoat time 2 hours, minimum
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Direct impact resistance: (ASTM G 14)	greater than 140 inch pounds
Direct impact resistance: (ASTM D 2794)	greater than 150 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/4-inch mandrel)	passes
Abrasion resistance: (ASTM D 4060, CS-17 wheel, 1,000 cycles, 1 kg, Taber Abrasion)	100 mg loss
Pencil hardness: (ASTM D 3363)	2H, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A or 4B

C-AE-A2.398

Category AE-A3

Category AE-A3 coatings shall be a:

Federal Specifications, TT-P-664D, Alkyd, Corrosion-inhibiting, Lead and Chromate free, VOC-Compliant (420 grams/liter, maximum), Primer. Only materials listed in the Qualified Product List (QPL) shall be used.* The Products listed in QPL-TT-P-664-20 (February 9, 1994) are:

Manufacturer	Manufacturer's Product Designation, and Test or Qualification Reference
Daniel Boone Paints, Inc. 15701 Nelsen Place South Tukwila WA 98188 (425) 228-7767	Proprime 43 93H136
J. Landau Co., Inc. 665 Washington Avenue Carlstadt NJ 07072	45-18044 Q1152
Sherwin Williams 549 E. 115th Street Chicago IL 60628 (312) 821-3434	Custom Product E90RC0038 Q1127
Spraylat Corporation 1701 East 122nd Street Chicago IL 60633 (773) 846-5900	EXAAROO7S 93H141

Products have the following salient characteristics:

COMPOSITION:

Alkyd, Corrosion-inhibiting, primer as allowed by TT-P-664D

Lead and Chromate free

PHYSICAL CHARACTERISTICS:

Per TT-P-664D

VOC (as supplied):	3.5 pounds per gallon (420 grams per liter), maximum
Recoating time at 70°F and 50% relative humidity	2 hours, minimum
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Per TT-P-664D

* Federal Specification TT-P-664 and its QPL are now prepared by the General Services Administration, Federal Supply Services, Paints and Chemicals Commodity Center, Engineering and Commodity Management Division, 9FTE-10, 400 15th St. Auburn, WA 98001-6599. Notice: August 28, 1992

C-AE-A3.298

Category AE-A4

Category AE-A4 coatings shall be a:

California Department of Transportation's (CALTRANS) Formulation No. PB-201B (Red) or PB-202B (Pink) primer (Issue October 1995). These formulations have been successfully produced by the following Manufacturers:

Triangle Coatings, Inc.
1930 Fairway Drive
San Leandro CA 94577
(510) 895-8000

Davlin Coatings, Inc.
700 Allston Way
Berkeley CA 94710 The
(510) 848-2863

CALTRANS* provides a list of other manufacturers who have formulations that have been accepted by CALTRANS and will be considered for approval.

The products have the following salient characteristics:

COMPOSITION:

Red Phenolic/Tung Oil

Lead and Chromate free

PHYSICAL CHARACTERISTICS:

Per PB-201B or PB-202B

Weight/gallon:	Between 11.6 and 11.8 pounds per gallon
VOC (as supplied):	2.2 pounds per gallon (260 grams per liter), maximum
Recoating time at 77°F and 50% relative humidity:	8 hours, minimum
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Per PB-201B or PB-202B

* California Department of Transportation, Engineering Service Center, Chemistry Laboratory, 5900 Folsom Boulevard, Sacramento CA 95819-0128; (916) 227-7289.

C-AE-A4.298

Category AE-A5

Category AE-A5 coatings shall be:

Rustarmor 29; as manufactured by:

Carboline
350 Hanley Industrial Court
St. Louis MO 63144
(314) 644-1000

or equal, having the following salient characteristics:

COMPOSITION:

A soya modified alkyd, with multi-inhibitive pigments,

Lead and Chromate free

PHYSICAL CHARACTERISTICS:

Volume solids:	57%, minimum
VOC (as supplied):	2.65 pounds per gallon (318 grams per liter), maximum
Minimum application temperature:	50°F (40°F with written approval)
Recoating time at 75°F, 50% relative humidity, and 2 mils DFT:	Dry to touch, 1 hour
	Recoat time 12 hours, minimum, if topcoated with either an Alkyds or Acrylics.
	Recoat time 48 hours, minimum, if topcoated with either an Epoxy or Polyurethanes
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Direct impact resistance: (ASTM G 14)	greater than 140 in pounds
Direct impact resistance: (ASTM D 2794)	greater than 150 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/4-inch mandrel)	passes
Abrasion resistance: (ASTM D 4060, CS-17 wheel, 1,000 cycles, 1 kg, Taber Abrasion)	250 mg loss
Pencil hardness: (ASTM D 3363)	2H, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A or 4B

C-AE-A5.398

Category AE-A6

Category AE-A6 coatings shall be:

GP 818 primer; as manufactured by:

Carboline
350 Hanley Industrial Court
St. Louis MO 63144
(314) 644-1000

or equal, having the following salient characteristics:

COMPOSITION:

A modified alkyd

Lead and Chromate free

PHYSICAL CHARACTERISTICS:

Volume solids:	60%, minimum
VOC (as supplied):	2.75 pounds per gallon (330 grams per liter), maximum
Minimum application temperature:	50°F (40°F with written approval)
Recoating time at 75°F, 50% relative humidity, and 2 mils DFT:	Recoat time 1 hour, minimum
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Direct impact resistance: (ASTM G 14)	greater than 140 in pounds
Direct impact resistance: (ASTM D 2794)	greater than 150 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/4-inch mandrel)	passes
Abrasion resistance: (ASTM D 4060, CS-17 wheel, 1,000 cycles, 1 kg, Taber Abrasion)	250 mg loss
Pencil hardness: (ASTM D 3363)	2H, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A

C-AE-A6.398

Category AE-A7

Category AE-A7 coatings shall be:

Kem-Kromik, Universal Metal Primer, either B50NZ6 (Brown), B50WZ1 (Off-White), or B50HZ1 (Buff); as manufactured by:

Sherwin-Williams
101 Prospect Avenue NW
Cleveland OH 44115-1075
(800) 752-8468

or equal, having the following salient characteristics:

COMPOSITION:

A phenolic modified, alkyd resin

Lead, Barium, and Chromate free

PHYSICAL CHARACTERISTICS:

Volume solids:	70%, minimum
Weight/gallon:	Between 12.15 and 12.85 pounds per gallon, varies by color
VOC (as supplied):	3.45 pounds per gallon (415 grams per liter), maximum
Minimum application temperature:	50°F (40°F with written approval)
Recoating time at 75°F, 50% relative humidity, and 6 mils WFT:	Dry to touch, 30 minutes
	Recoat time 1 hour, minimum, if topcoated with itself or alkyds.
	Recoat time 16 hours, minimum, if topcoated with high performance coatings
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Direct impact resistance: (ASTM D 2794)	greater than 70 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/4-inch mandrel)	passes
Abrasion resistance: (ASTM D 4060, CS-17 wheel, 1,000 cycles, 1 kg, Taber Abrasion)	250 mg loss
Pencil hardness: (ASTM D 3363)	H, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 260 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A or 4B

C-AE-A7.398

Category AE-C1

Category AE-C1 coatings shall be a:

Military Specifications, MIL-E-24635*, Silicon Alkyd, Copolymer, Semigloss, VOC-Compliant (420 grams/liter, maximum), Enamel, or TT-E-1593B**, Silicon Alkyd, Copolymer, Gloss, VOC-Compliant (420 grams/liter, maximum), Enamel. The Color Schedule listed in the Paint and Coating Division of the specifications will specify the gloss and color which is required.

These coatings*** are available from multiple suppliers and have been reformulated to meet VOC limitations. Recoating times and other requirements, shall be according to manufacturer's instructions, unless otherwise specified.

Manufacturer	Manufacturer's Product Designation
Sherwin Williams 549 E. 115th Street Chicago IL 60628 (312) 821-3434	Silicon Alkyd (Low VOC), B56 Z Series
Carboline 350 Hanley Industrial Court St. Louis MO 63144 (314) 644-1000	Subsil® 30 HS
Ameron PO Box 1020 Brea CA 92622-1020 (714) 529-1951	Amercoat 3203

or equal, having the following salient characteristics:

COMPOSITION:

Silicone Alkyd, enamel as allowed by MIL-E-24635B or TT-E-1593B

Lead and Chromate free

PHYSICAL CHARACTERISTICS:

Per MIL-E-24635B or TT-E-1593B

VOC (as supplied):	3.5 pounds per gallon (420 grams per liter), maximum
Recoating time at 70°F and 50 percent relative humidity	Varies. Do not apply when the surface temperature is less than 5°F above the dew point.
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Per MIL-E-24635B or TT-E-1593B

* Military Specification MIL-E-24635B (Issue: June 30, 1994) and Qualified Product List (QPL), QPL-24635-12 (Issue: September 16, 1997), are prepared by the Naval Sea System Command, SEA 03R42, 2531 Jefferson Davis Highway, Arlington, VA 22242-5160; (703) 602-6020.

** Federal Specification TT-E-1593B, Notice 1 (Issue: February 10, 1987), are prepared by the General Services Administration, Federal Supply Services, Paints and Chemicals Commodity Center, Engineering and Commodity Management Division, 9FTE-10, 400 15th St. Auburn, WA 98001-6599.

*** These coatings have been used as substitute coatings for those coatings specifically formulated to meet Military Specification MIL-E-24635B or Federal Specification TT-E-1593B.

C-AE-C1.298

Category AE-E1(w)

Category AE-E1(w) coatings shall be:

DTM Waterborne Acrylic Primer/Finish Coating, Series B66W1; as manufactured by:

Sherwin-Williams
101 Prospect Avenue NW
Cleveland OH 44115-1075
(800) 752-8468

or equal, having the following salient characteristics:

COMPOSITION:

100% acrylic emulsion corrosion-resistant coating (flat)

Lead and Chromate free

PHYSICAL CHARACTERISTICS:

Volume solids:	37%, minimum
VOC (as supplied):	2.01 pounds per gallon (240 grams per liter), maximum
Minimum application temperature:	50°F
Recoating time at 77°F and 50% RH:	4 hours, minimum
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Abrasion resistance: (ASTM D 4060, CS-17 wheel, 1,000 cycles, 1 kg, Taber Abrasion)	225 mg loss
Direct impact resistance: (ASTM G 14)	greater than 160 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/8-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A or 4B

C-AE-E1W.398

Category AE-E2(w)

Category AE-E2(w) coatings shall be:

DTM Waterborne Gloss Acrylic Coating*, B66 Series; as manufactured by:

Sherwin-Williams
101 Prospect Avenue NW
Cleveland OH 44115-1075
(800) 752-8468

or equal, having the following salient characteristics:

COMPOSITION:

100% acrylic emulsion corrosion-resistant coating (gloss)

Lead and chromate free

Physical Characteristics:

Volume solids:	37%, minimum
VOC (as supplied):	2.01 pounds per gallon (240 grams per liter), maximum
Minimum application temperature:	50°F
Recoating time at 77°F and 50% RH:	4 hours, minimum
Application method:	brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Abrasion resistance: (ASTM D 4060, CS-17 wheel, 1,000 cycles, 1 kg, Taber Abrasion)	107 mg loss
Direct impact resistance: (ASTM G 14)	greater than 160 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/8-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A or 4B

* If the color is a safety color, black, pastel, or if medium, deep, and ultra deep tinting bases are used, Category AE-E1(w), (DTM primer-finish, B66W1 series), shall be used as a primer for this topcoat.

C-AE-E2W.398

Category AE-W2

Category AE-W2 primer coatings shall be:

MC-Miozinc; as manufactured by:

Wasser High-Tech Coatings
8401 S. 228th, Building. 103
Kent WA 98032
(206) 850-2967

or equal, having the following salient characteristics:

COMPOSITION:

Aromatic, single-component, moisture cure urethane - zinc and micaceous iron oxide pigmented

Lead and chromate free

PHYSICAL CHARACTERISTICS:

Volume solids:	59%, minimum
Weight per gallon:	20.2 ± 0.6 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	4 mils
Curing time at 75°F:	Touch - 20 minutes; Handle - 8 hours; Stack - 12 hours
Recoating time at 50 to 90°F and 60% RH*:	4 hours, minimum; no maximum
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Direct impact resistance: (ASTM G 14)	greater than 160 inch pounds
Direct impact resistance: (ASTM D 2794)	greater than 150 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/4-inch mandrel)	passes
Abrasion resistance: (ASTM D 4060, CS-17 wheel, 1,000 cycles, 1 kg, Taber Abrasion)	45 mg loss
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A or 4B

* Additional recoat time is required at temperatures of 20 to 40°F and humidities of 10 to 30%.

C-AE-W2.398

Category AE-W6

Category AE-W6 topcoat shall be:

MC-Shieldcoat; as manufactured by:

Wasser High-Tech Coatings
8401 S. 228th, Building. 103
Kent WA 98032
(206) 850-2967

or equal, having the following salient characteristics:

COMPOSITION:

Aliphatic, single-component, moisture-cure urethane

Lead and chromate free

PHYSICAL CHARACTERISTICS:

Volume solids:	60%, minimum
Weight per gallon:	Colors - 11.6 ± 1.0 pounds per gallon Clear - 8.5 ± 0.2 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	2 mils
Curing time at 75°F:	Touch - 30 minutes; Handle - 16 hours
Recoating time at 60 to 90°F and 60% RH*:	6 hours, minimum; 72 hours, maximum; after 72 hours abrade surfaces
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Direct impact resistance: (ASTM D 2794)	greater than 150 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/2-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A or 4B

* Additional recoat time is required at temperatures of 20 to 40°F and humidities of 10 to 30%.

C-AE-W6.298

Category AE-W7

The Category AE-W7 primer/topcoat shall be:

MC-Aluminum; as manufactured by:

Wasser High-Tech Coatings
8401 S. 228th, Building. 103
Kent WA 98032
(206) 850-2967

or equal, having the following salient characteristics:

COMPOSITION:

Aliphatic, single-component, moisture cure urethane

Lead and chromate free

PHYSICAL CHARACTERISTICS:

Volume solids:	60 percent, minimum
Weight per gallon:	9.3 ± 0.2 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	2 mils
Curing time at 75°F:	Touch - 30 minutes; Handle - 16 hours
Recoating time at 50 to 90°F and 60 percent relative humidity*:	4 hours, minimum; 72 hours, maximum; after 72 hours abrade surfaces
Application method:	Brush, roller, conventional or airless spray

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Abrasion resistance: (ASTM D 4060, CS-17 wheel, 1,000 cycles, 1 kg, Taber Abrasion)	35 mg loss
Direct impact resistance: (ASTM G 14)	greater than 160 inch pounds
Flexibility: (ASTM D 522, 180 degree bend over 1/8-inch mandrel)	passes
Pencil hardness: (ASTM D 3363):	4H, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A or 4B

* Additional recoat time is required at temperatures of 20 to 40°F and humidities of 10 to 30 percent.

C-AE-W7.898

Category IE-1A1

Category IE-1A1 coating system shall be:

Amerlock 400/400 cure; as manufactured by:

Ameron
PO Box 1020
Brea CA 92622-1020
(714) 529-1951

or equal, having the following salient characteristics:

COMPOSITION:

Self-priming, two-component, polyamide epoxy coating

PHYSICAL CHARACTERISTICS:

Volume solids:	80%, minimum
VOC (as supplied):	1.4 pounds per gallon (168 grams per liter), maximum
Minimum curing temperature:	50°F
Surface application temperature above dew point:	5°F, minimum
Mixed usable pot life at 70 °F:	2.5 hours, minimum
Maximum applied DFT per coat:	8 mils
Curing time at 70°F:	Touch - 9 hours; Through - 20 hours
Recoating time at 70°F:	16 hours, minimum; 2 months, maximum; after 2 months abrade surfaces
Mixing ratio:	1 to 1, by volume
Application method:	Brush, roller, conventional, or airless spray
Time before immersion after the final coat has been applied at 70°F:	7 days, minimum

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or color difference (ASTM D 2244).
Flexibility: (ASTM D 522, 180° bend over 1-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A
Cathodic disbondment: (Applicable tests includes but are not limited to: ASTM G 8, ASTM G 42, ASTM G 95)	Has passed a recognized standard cathodic disbondment test.
Potable water:	National Sanitation Foundation (NSF) 61 approved

C-IE-1A1.398

Category IE-1AT

Category IE-1AT coating system shall be:

Amerlock 450/450HS cure; as manufactured by:

Ameron
PO Box 1020
Brea CA 92622-1020
(714) 529-1951

or equal, having the following salient characteristics:

COMPOSITION:

Two-component, aliphatic polyurethane topcoat

PHYSICAL CHARACTERISTICS:

Volume solids:	63%, minimum
VOC (as supplied):	2.4 pounds per gallon (287.5 grams per liter), maximum
Minimum curing temperature:	40°F
Surface application temperature above dew point:	5°F, minimum
Mixed usable pot life at 70 °F:	4 hours, minimum
Maximum applied DFT per coat:	2 mils
Curing time at 70°F:	Touch - 30 minutes; Through - 8 hours
Recoating time at 70°F:	4 hours, minimum; 14 days, maximum
Mixing ratio:	4 to 1, by volume
Application method:	Brush, roller, conventional, or airless spray
Time before immersion after the final coat has been applied at 70°F:	6 days, minimum

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or colordifference (ASTM D 2244).
Flexibility: (ASTM D 522, 180° bend over 1-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A
Cathodic disbondment: (Applicable tests includes but are not limited to: ASTM G 8, ASTM G 42, ASTM G 95)	Has passed a recognized standard cathodic disbondment test.

This is the weathering topcoat for Category IE-1A1, if one is specified.

C-IE-1AT.298

Category IE-1C

Category IE-1C coating system shall be:

Tnemec, Series 69, Hi-Build Epoxoline II; as manufactured by:

Tnemec Company, Inc.
PO Box 411749
Kansas City MO 64141
(816) 483-3400

or equal, having the following salient characteristics:

COMPOSITION:

Self-priming, two-component, polyamidoamine epoxy

PHYSICAL CHARACTERISTICS:

Volume solids:	67%, minimum
VOC (as supplied):	2.29 pounds per gallon (275 grams per liter), maximum
Minimum curing temperature:	50°F
Surface application temperature above dew point:	5°F, minimum
Mixed usable pot life at 77 °F:	4 hours, minimum
Maximum applied DFT per coat:	5 mils
Curing time at 75°F:	Touch - 2 hours; Handle - 6 hours
Recoating time at 75°F:	8 hours, minimum; 14 days, maximum; after 14 days abrade surfaces
Mixing ratio:	1 to 1, by volume
Application method:	Brush or roller (small areas only); conventional, or airless spray
Time before immersion after the final coat has been applied at 70°F:	7 days, minimum

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or color difference (ASTM D 2244).
Flexibility: (ASTM D 522, 180° bend over 1-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A
Cathodic disbondment: (Applicable tests includes but are not limited to: ASTM G 8, ASTM G 42, ASTM G 95)	Has passed a recognized standard cathodic disbondment test.

Category IE-1CT is the weathering topcoat for this epoxy system, if one is specified.

C-IE-1C.298

Category IE-1CT

Category IE-1CT coating system shall be:

Tnemec, Series 75, Enduro-Shield; as manufactured by:

Tnemec Company, Inc.
PO Box 411749
Kansas City MO 64141
(816) 483-3400

or equal, having the following salient characteristics:

COMPOSITION:

Two-component, high-build, aliphatic, acrylic polyurethane enamel, topcoat

PHYSICAL CHARACTERISTICS:

Volume solids:	70%, minimum
VOC (as supplied):	2.11 pounds per gallon (253 grams per liter), maximum
Minimum curing temperature:	40°F
Surface application temperature above dew point:	5°F, minimum
Mixed usable pot life at 77 °F:	2 hours, minimum
Maximum applied DFT per coat:	5 mils
Curing time at 75°F:	Touch - 1 hour; Handle - 6 hours
Recoating time at 75°F:	8 hours, minimum; 14 days maximum
Mixing ratio:	4 to 1, by volume
Application method:	Brush, roller, conventional, or airless spray
Time before immersion after the final coat has been applied at 70°F:	7 days, minimum

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or color difference (ASTM D 2244).
Flexibility: (ASTM D 522, 180° bend over 1-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A
Cathodic disbondment: (Applicable tests includes but are not limited to: ASTM G 8, ASTM G 42, ASTM G 95)	Has passed a recognized standard cathodic disbondment test, when applied over the specified epoxy base coat.

This is the weathering topcoat for Category IE-1C, if one is specified.

C-IE-1CT.298

Category IE-1DT

Category IE-1DT coating system shall be:

Devthane 379, Aliphatic Urethane Gloss Enamel; as manufactured by:

Devoe Coatings
4000 Dupont Circle
Louisville KY 40207
(502) 897-9861

or equal, having the following salient characteristics:

COMPOSITION:

Two-component, aliphatic, polyurethane, topcoat

PHYSICAL CHARACTERISTICS:

Volume solids:	63%, minimum
VOC (as supplied):	2.6 pounds per gallon (311 grams per liter), maximum
Minimum curing temperature:	40°F
Surface application temperature above dew point:	5°F, minimum
Mixed usable pot life at 77°F:	4 hours, minimum
Maximum applied DFT per coat:	3 mils
Recoating time at 80°F and 50% RH:	3 hours, minimum; 24 hours, maximum
Mixing ratio:	4 to 1, by volume
Application method:	Brush, roller, conventional, or airless spray
Time before immersion after the final coat has been applied at 70°F:	6 days, minimum

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or color difference (ASTM D 2244).
Flexibility: (ASTM D 522, 180° bend over 1-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A
Cathodic disbondment: (Applicable tests includes but are not limited to: ASTM G 8, ASTM G 42, ASTM G 95)	Has passed a recognized standard cathodic disbondment test, when applied over the specified epoxy base coat.

This is the weathering topcoat for Category IE-1D, IE-1E, and IE-1F, if one is specified.

C-IE--1DT.298

Category IE-1F

Category IE-1F coating system shall be:

Bar-Rust 233H; as manufactured by:

Devoe Coatings
4000 Dupont Circle
Louisville KY 40207
(502) 897-9861

or equal, having the following salient characteristics:

COMPOSITION:

Self-priming, two-component, modified polyamide amine epoxy

PHYSICAL CHARACTERISTICS:

Volume solids:	80%, minimum
VOC (as supplied):	1.41 pounds per gallon (170 grams per liter), maximum
Minimum curing temperature:	40°F
Surface application temperature above dew point:	5°F, minimum
Mixed usable pot life at 77°F and 50% RH:	3.5 hours, minimum
Maximum applied DFT per coat:	6 mils
Recoating time at 77°F and 50% RH:	4 hours, minimum; 1 month, maximum
Mixing ratio:	4 to 1, by volume
Application method:	Brush or roller (small areas only); conventional or heavy-duty airless spray (preferred)
Time before immersion after the final coat has been applied at 70°F:	7 days, minimum

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or color difference (ASTM D 2244).
Flexibility: (ASTM D 522, 180° bend over 1-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	3H, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A
Cathodic disbondment: (Applicable tests includes but are not limited to: ASTM G 8, ASTM G 42, ASTM G 95)	Has passed a recognized standard cathodic disbondment test.
Potable water:	National Sanitation Foundation (NSF) 61 approved

Category IE-1DT is the weathering topcoat for this epoxy system, if one is specified.

C-IE-1F.398

Category IE-1J

Category IE-1J coating system shall be:

Bar-Rust 235, Multi-Purpose Epoxy; as manufactured by:

Devoe Coatings
4000 Dupont Circle
Louisville KY 40207
(502) 897-9861

or equal, having the following salient characteristics:

COMPOSITION:

Self-priming, two-component, modified polyamide amine epoxy

PHYSICAL CHARACTERISTICS:

Volume solids:	68%, minimum
VOC (as supplied):	2.4 pounds per gallon (292 grams per liter), maximum
Minimum curing temperature:	40°F
Surface application temperature above dew point:	5°F, minimum
Mixed usable pot life at 77°F and 50% RH:	3.5 hours, minimum
Maximum applied DFT per coat:	8 mils
Recoating time at 77°F and 50% RH:	5 hours, minimum; 1 month, maximum
Mixing ratio:	4 to 1, by volume
Application method:	Brush or roller (small areas only); conventional or heavy-duty airless spray (preferred)
Time before immersion after the final coat has been applied at 70°F:	7 days, minimum

COATING SYSTEM PERFORMANCE REQUIREMENTS:

Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or color difference (ASTM D 2244).
Flexibility: (ASTM D 522, 180° bend over 1-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	3H, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A
Cathodic disbondment: (Applicable tests includes but are not limited to: ASTM G 8, ASTM G 42, ASTM G 95)	Has passed a recognized standard cathodic disbondment test.

Category IE-1DT is the weathering topcoat for this epoxy system, if one is specified.

C-IE-1J.398

Category IES-7A

Category IES-7A coating system shall be:

MC-Zinc, primer; MC-Ferrox B, intermediate coat; MC-Ferrox A, topcoat; as manufactured by:

Wasser High-Tech Coatings
8401 S. 228th, Building. 103
Kent WA 98032
(206) 850-2967

or equal, having the following salient characteristics:

COMPOSITION:

Primer - Aromatic, single-component, moisture-cure, urethane - zinc pigmented, containing a minimum of 83%, by weight, of zinc in dry film.

Intermediate coat - Aromatic, single-component, moisture-cure, urethane, pigmented portion shall contain micaceous iron oxide at a minimum loading of 4 pounds per gallon

Topcoat - Aliphatic, single-component, moisture-cure urethane - pigmented portion must contain micaceous iron oxide at a minimum loading of 3.5 pounds per gallon.

Lead and chromate free

PHYSICAL CHARACTERISTICS, PRIMER:

Volume solids:	60%, minimum
Weight per gallon:	23.7 ± 0.8 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	3.5 mils
Curing time at 75°F:	Touch - 20 minutes; Handle - 8 hours; Stack - 10 hours
Recoating time at 50 to 90°F and 60% RH*:	4 hours, minimum; no maximum
Application method:	Brush, roller, conventional or airless spray

PHYSICAL CHARACTERISTICS, INTERMEDIATE COAT:

Volume solids:	59%, minimum
Weight per gallon:	13.5 ± 0.6 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	5 mils
Curing time at 75°F:	Touch - 30 minutes; Handle - 18 hours; Stack - 24 hours
Recoating time at 50 to 70°F and 60% RH*:	6 hours, minimum; no maximum
Application method:	Brush, roller, conventional, or airless spray
Time before immersion after final coat has been applied at 40 to 90 °F and 30 percent RH:	8 hours, minimum (special immersion situations may be permitted after 1 hour)

PHYSICAL CHARACTERISTICS, TOPCOAT:

Volume solids:	60%, minimum
Weight per gallon:	13.0 ± 1.0 pounds per gallon

Category IES-7A

VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	3.5 mils
Curing time at 75°F:	Touch - 30 minutes; Handle - 18 hours; Stack - 24 hours
Recoating time at 60 to 90°F and 60% RH*:	6 hours, minimum; no maximum
Application method:	Brush, roller, conventional, or airless spray
Time before immersion after final coat has been applied at 40 to 90 °F and 30% RH:	8 hours, minimum (special immersion situations may be permitted after 1 hour)
COATING SYSTEM PERFORMANCE REQUIREMENTS:	
Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or color difference (ASTM D 2244).
Direct impact resistance: (ASTM D 2794)	greater than 150 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/2-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A

* Additional recoat time is required at temperatures of 20 to 40°F and humidities of 10 to 30%.

C-IES-7A.198

Category IES-7C

Category IES-7C coating system shall be:

MC-Miozinc, primer; MC-Ferrox B, intermediate; MC-Ferrox A, topcoat; as manufactured by:

Wasser High-Tech Coatings
8401 S. 228th, Building. 103
Kent WA 98032
(206) 850-2967

or equal, having the following salient characteristics:

COMPOSITION:

Primer - Aromatic, single-component, moisture cure urethane - zinc and micaceous iron oxide pigmented

Intermediate - Aromatic, single-component, moisture-cure, urethane, pigmented portion shall contain micaceous iron oxide at a minimum loading of 4 pounds per gallon

Topcoat - Aliphatic, single-component, moisture-cure urethane - pigmented portion must contain micaceous iron oxide at a minimum loading of 3.5 pounds per gallon.

Lead and chromate free

PHYSICAL CHARACTERISTICS, PRIMER:

Volume solids:	59%, minimum
Weight per gallon:	20.2 ± 0.6 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	4 mils
Curing timing at 75°F:	Touch - 20 minutes; Handle - 8 hours; stack - 12 hours
Recoating time at 50 to 90°F and 60% RH*:	4 hours, minimum; no maximum
Application method:	Brush, roller, conventional or airless spray

PHYSICAL CHARACTERISTICS, INTERMEDIATE COAT:

Volume solids:	59%, minimum
Weight per gallon:	13.5 ± 0.6 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	5 mils
Curing timing at 75°F:	Touch - 30 minutes; Handle - 18 hours; stack - 24 hours
Recoating time at 50 to 70°F and 60% RH*:	6 hours, minimum; no maximum
Application method:	Brush, roller, conventional or airless spray

PHYSICAL CHARACTERISTICS, TOPCOAT:

Volume solids:	60%, minimum
Weight per gallon:	13.0 ± 1.0 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	3.5 mils

Category IES-7C

Curing timing at 75°F:	Touch - 30 minutes; Handle - 18 hours; stack - 24 hours
Recoating time at 60 to 90°F and 60% RH*:	6 hours, minimum; no maximum
Application method:	Brush, roller, conventional or airless spray
COATING SYSTEM PERFORMANCE REQUIREMENTS:	
Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or color difference (ASTM D 2244).
Direct impact resistance: (ASTM D 2794)	greater than 150 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/2-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A

* Additional recoat time is required at temperatures of 20 to 40°F and humidities of 10 to 30%.

C-IES-7C.298

Category IES-7E

Category IES-7E coating system shall be:

MC-Miozinc, spot primer; MC-Ferrox B, primer/intermediate; MC-Ferrox A, topcoat; as manufactured by:

Wasser High-Tech Coatings
8401 S. 228th, Building. 103
Kent WA 98032
(206) 850-2967

or equal, having the following salient characteristics:

COMPOSITION:

Spot Primer - Aromatic, single-component, moisture cure urethane - zinc and micaceous iron oxide pigmented

Primer/Intermediate - Aromatic, single-component, moisture-cure, urethane, pigmented portion shall contain micaceous iron oxide at a minimum loading of 4 pounds per gallon

Topcoat - Aliphatic, single-component, moisture-cure urethane - pigmented portion must contain micaceous iron oxide at a minimum loading of 3.5 pounds per gallon.

Lead and chromate free

PHYSICAL CHARACTERISTICS, SPOT PRIMER:

Volume solids:	59%, minimum
Weight per gallon:	20.2 ± 0.6 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	4 mils
Curing time at 75°F:	Touch - 20 minutes; Handle - 8 hours; Stack - 12 hours
Recoating time at 50 to 90°F and 60% RH*:	4 hours, minimum
Application method:	Brush, roller, conventional or airless spray

PHYSICAL CHARACTERISTICS, PRIMER/INTERMEDIATE:

Volume solids:	59%, minimum
Weight per gallon:	13.5 ± 0.6 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	5 mils
Curing time at 75°F:	Touch - 30 minutes; Handle - 18 hours; Stack - 24 hours
Recoating time at 50 to 70°F and 60% RH*:	6 hours, minimum; no maximum
Application method:	Brush, roller, conventional or airless spray
Time before immersion after final coat has been applied at 40 to 90 °F and 30 percent RH:	8 hours, minimum (special immersion situations may be permitted after 1 hour)

PHYSICAL CHARACTERISTICS, TOPCOAT:

Volume solids:	60%, minimum
Weight per gallon:	13.0 ± 1.0 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum

Category IES-7E

Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	3.5 mils
Curing time at 75°F:	Touch - 30 minutes; Handle - 18 hours; Stack - 24 hours
Recoating time at 60 to 90°F and 60% RH*:	6 hours, minimum; no maximum
Application method:	Brush, roller, conventional or airless spray
Time before immersion after final coat has been applied at 40 to 90°F and 30% RH:	8 hours, minimum (special immersion situations may be permitted after 1 hour)
COATING SYSTEM PERFORMANCE REQUIREMENTS:	
Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or color difference (ASTM D 2244).
Direct impact resistance: (ASTM D 2794)	greater than 150 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/2-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A

* Additional recoat time is required at temperatures of 20 to 40°F and humidities of 10 to 30%.

C-IES-7E.298

Category IES-8G

Category IES-8G coating system shall be:

MC-Zinc, primer; MC-Miomastic, intermediate; MC-Aluminum, topcoat; as manufactured by:

Wasser High-Tech Coatings
8401 S. 228th, Building. 103
Kent WA 98032
(206) 850-2967

or equal, having the following salient characteristics:

COMPOSITION:

Primer - Aromatic, single component, moisture-cure, urethane - zinc pigmented containing a minimum of 83%, by weight, of zinc in dry film.

Intermediate - Aromatic, single-component, moisture cure urethane - micaceous iron oxide pigmented, at a minimum loading of 6 pounds per gallon

Topcoat - Aliphatic, aluminum filled, single-component, moisture cure urethane

Lead and chromate free

PHYSICAL CHARACTERISTICS, PRIMER:

Volume solids:	60%, minimum
Weight per gallon:	23.7 ± 0.8 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	3.5 mils
Curing time at 75°F:	Touch - 20 minutes; Handle - 8 hours; Stack - 10 hours
Recoating time at 50 to 90°F and 60% RH:	4 hours, minimum; no maximum
Application method:	Brush, roller, conventional or airless spray

PHYSICAL CHARACTERISTICS, INTERMEDIATE COAT:

Volume solids:	59%, minimum
Weight per gallon:	17.0 ± 1.0 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	3 mils
Curing time at 75°F:	Touch - 30 minutes; Handle - 18 hours; Stack - 24 hours
Recoating time at 40 to 70°F and 60% RH*:	6 hours, minimum; no maximum
Application method:	Brush, roller, conventional or airless spray

PHYSICAL CHARACTERISTICS, TOPCOAT:

Volume solids:	60%, minimum
Weight per gallon:	9.3 ± 0.2 pounds per gallon
VOC (as supplied):	2.8 pounds per gallon (335 grams per liter), maximum
Minimum application temperature:	20°F (Inspector must approve application below 33°F)
Maximum applied DFT per coat:	2 mils

Category IES-8G

Curing time at 75°F:	Touch - 30 minutes; Handle - 16 hours
Recoating time at 50 to 90°F and 60% RH*:	4 hours, minimum; 72 hours, maximum; after 72 hours abrade surfaces
Application method:	Brush, roller, conventional or airless spray
Time before immersion after final coat has been applied at 40 to 90°F and 30% RH:	8 hours, minimum (special immersion situations may be permitted after 1 hour)
COATING SYSTEM PERFORMANCE REQUIREMENTS:	
Fresh/Deionized water immersion test: (ASTM D 870)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
Salt water immersion test: (ASTM D 870, ASTM D 1141 formula A with no heavy metals)	passes 3,000 hour test with aerated water held at ambient temperatures with no blisters evident on either the scribed or unscribed sides.
QUV Accelerated weathering test: (ASTM D 4587, ASTM G 53)	passes 3,000 hour test with no blisters evident on either the scribed or unscribed sides, minimal chalking (ASTM D 4214) or color difference (ASTM D 2244).
Direct impact resistance: (ASTM D 2794)	greater than 150 inch pounds
Flexibility: (ASTM D 522, 180° bend over 1/2-inch mandrel)	passes
Pencil hardness: (ASTM D 3363)	2B, minimum
Pulloff Adhesion: (ASTM D 4541) (Elcometer)	greater than 500 psi
Tape adhesion: (ASTM D 3359)	equal to or better than 4A

* Additional recoat time is required at temperatures of 20 to 40°F and humidities of 10 to 30%.

C-IES-8G.298

9.03 COLOR SCHEDULE FOR COATINGS

The colors and gloss of finish coats shall be in accordance with schedule 3 (Color Schedule). The Contractor shall obtain a true match of color and gloss for all coated surfaces.

For items required to be coated but not listed in the color schedule, the color or colors to be used will be selected by the Contracting Officer from the colors listed in the color schedule.

The 5-digit numbers in the "Color Number" column refer to Federal Standard No. 595B for identifying color that is designated by last four digits and gloss is designated by first digit. Where the gloss in Federal Standard No. 595B differs from gloss specified in the "Gloss" column, the gloss specified in the "Gloss" column shall govern.

Gloss abbreviations:

G - Full Gloss
SG - Semigloss
ES - Eggshell
L - Lusterless
F - Flat

Numbers listed in the "Tabulation No." column of the color schedule refer to corresponding item numbers to be coated in the tabulations.

Schedule 3 - Color Schedule

Tabulation No.	Item Surface	Color	Color No.	Gloss
TAB06	Miscellaneous exterior surfaces of governor actuator components and piping not subject to oil. Refer to note below.	medium gray		gloss
TAB19	Governor oil piping, exterior surfaces of governor actuator components and proportional valve housing of actuator cabinet exposed to oil	medium gray		gloss

Note: Majority of paint is subject to oil. Those items under TAB06 shall have approval from the Contracting Officer's Representative prior to painting.

PART IV
CONTRACT DOCUMENTS, EXHIBITS AND OTHER ATTACHMENTS

(A) LIST OF ATTACHMENTS

1. DRAWINGS, GENERAL

The drawings of Headgate Rock Powerplants show the general arrangement of the plant and equipment. Except as otherwise provided, the drawings are not to be considered as defining the design of the equipment to be furnished, but are merely illustrative of the technical requirements. The Contractor shall determine whether his proposed equipment/components are fully compatible with the illustrative design shown on the drawings. If he finds that his proposed equipment/components are not compatible with the design shown on the drawings, the Contractor shall elect to furnish either equipment/components that are compatible with the design shown on the drawings or propose a new design which will be compatible with his proposed equipment/components. If the Contractor elects to propose a new design, he will be required to receive approval from the Government prior to using his proposed design. In case of difference between the drawings and technical requirements, technical requirements shall govern.

The drawings included as part of the solicitation are intended only to show scope of work.

2. LIST OF DRAWINGS

The following attached drawings are made a part of these specifications:

Bureau of Indian Affairs
Hydroelectric Power Project
Headgate Rock Powerplant

Site Location -

1. 1117-D-2 - General Map
2. 1117-D-3 - General Plan
3. 1117-D-4 - General Plan

Informational Drawings -

Mechanical Installation:

4. 1117-D-8 - General Arrangement - Floors - El. 352.00 and El. 360.75
5. 1117-D-9 - General Arrangement - Floors - El. 327.50 and El. 3343.25
6. 1117-D-10 - General Arrangement - Plan - Centerline Draft Tube
7. 1117-D-11 - General Arrangement - Transverse Section - Centerline Unit 2
8. 1117-D-12 - General Arrangement - Section - 4-Line Wall
9. 1117-D-13 - General Arrangement - Longitudinal Sections
10. 1117-D-216 - Piping Details - Material Schedule

Electrical Installation:

11. 1117-D- 491 - Unit #1 Control schematic diagram
12. 1117-D- 492 - Unit #1 Protection schematic diagram
13. 1117-D- 493 - Unit #1 Breaker control schematic diagram
14. 1117-D- 495 - Generating Unit #1 Three line diagram
15. 1117-D- 496 - Unit #1 Annunciator schematic diagram
16. 1117-D- 497 - Unit #1 Programmable controller schematic diagram
17. 1117-D- 498 - Unit #1 Programmable controller schematic diagram
18. 1117-D- 499 - Unit #1 Programmable controller schematic diagram
19. 1117-D- 640 - Governor A1A device list
20. 1117-D- 642 - Governor A1A schematic diagram
21. 1117-D- 643 - Governor A1A schematic diagram
22. 1117-D- 644 - Governor A1A schematic diagram
23. 1117-D- 645 - Governor A1A schematic diagram
24. 1117-D- 646 - Governor A1A schematic diagram
25. 1117-D- 647 - Governor A1A schematic diagram
26. 1117-D- 648 - Governor A1A wiring diagram
27. 1117-D- 711 - Governor A1A wiring diagram
28. 1117-D- 713 - Governor A1A wiring diagram
29. 1117-D- 714 - Governor A1A wiring diagram
30. 1117-D- 716 - Governor A1A wiring diagram
31. 1117-D- 717 - Governor A1A wiring diagram

(*Drawing Sheet Nos. 32 through 75 are deleted*)

76. 1117-D-1911 - Interconnection Terminal Cabinet C2D - Wiring Diagram (sheet 1 of 2)
77. 1117-D-1912 - Interconnection Terminal Cabinet C2D - Wiring Diagram (sheet 2 of 2)
78. 1117-D-1913 - Interconnection Terminal Cabinet C2E - Wiring Diagram (sheet 1 of 2)
79. 1117-D-1914 - Interconnection Terminal Cabinet C2E - Wiring Diagram (sheet 2 of 2)
80. 1117-D- 654 - Generator G1A Terminal Cabinet - Wiring Diagram
81. 1117-D- 658 - Generator G2A Terminal Cabinet - Wiring Diagram
82. 1117-D- 662 - Generator G3A Terminal Cabinet - Wiring Diagram
83. 1117-D-1935 - Wiring Schematic Diagram
84. 1117-D-1936 - Wiring Schematic Diagram
85. 1117-D-1938 - Generator - List of Instruments and Leads (sheet 1 of 3)
86. 1117-D-1939 - Generator - List of Instruments and Leads (sheet 2 of 3)

Standard Drawings -

87. 40-D-5324 - Electrical Standards - Control and Instrument Switch Escutcheons and Indicating Lamps
88. 40-D-6187 - Unit Control Board - Controls, Instruments and Relaying - Standard Nameplates

89. 40-D-7013 - Standard Design - Governor System - Configuration 5
90. 40-D-7014 - Standard Design - Governor System - Turbine Gate Servomotor and Runner Blade Servomotor Control Systems
91. 104-D-1150 - Device Designations and Symbols to be used on Single-Line and Schematic Diagrams
92. 104-D-1152 - Bureau Of Reclamation's Drawing Format
93. 104-D-1165 - Main Control Board CSA - Panel 7R - Wiring Diagram

Manufacturer's Drawings - Woodward Governor Company -

94. 9973-740 - Governor - Diagram-Wiring (sheet 3 of 8)
95. 9973-740 - Governor - Diagram-Wiring (sheet 6 of 8)
96. 9981-875 - Governor - Arrangement-Horizontal PMG
97. 9981-876 - Governor - Diagram-Hydraulic Schematic (sheet 1 of 2)
98. 9981-876 - Governor - Diagram-Hydraulic Schematic (sheet 2 of 2)
99. 9981-952 - Governor - Arrangement-Actuator (sheet 1 of 3)
100. 9981-952 - Governor - Arrangement-Actuator (sheet 2 of 3)
101. 9981-952 - Governor - Arrangement-Actuator (sheet 3 of 3)

Manufacturer's Drawings - Voith Hydro, Inc. -

102. 6099-MM-2 - Actuator Schematic
103. 4840-ACY-1 - Piping Elevation
104. 4840-ACZ-1 - Piping Details
105. 4840-ADA-1 - Powerhouse Piping
106. 4840-ADB-1 - Piping Details
107. 4840-ADC-1 - Piping Details
108. 4840-ADD-1 - Piping Sections
109. 5128-JI-1 - Gate Mechanism Assembly (Allis-Chalmers Corp.)
110. 5180-OH-1 - Servomotor Arrangement
111. 117-6562-FE-1 Oil Head-Restoring Mechanism Assembly

Manufacturer's Drawings - Villares (Vibration Monitoring System) -

112. 26E113173 - Wiring, Instruments and Accessories
113. 26E113173 - Wiring, Instruments and Accessories - Parts List (sheets 1 and 2)
114. 26E113173 - Wiring, Instruments and Accessories - Parts List (sheets 3 and 4)
115. 26E113173 - Wiring, Instruments and Accessories - Parts List (sheets 5 and 6)
116. 26E113173 - Wiring, Instruments and Accessories - Parts List (sheets 7)
117. 26E113264 - Point to Point Internal Wiring of the Terminal Cabinet (sheet 2 of 2)