

TECHNICAL SPECIFICATIONS – SCOPE OF WORK

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SECTION 1 SCOPE OF WORK

1.01 GENERAL

- A. The Washington Metropolitan Area Transit Authority (WMATA) also referenced herein as “the Authority”, plans to replace existing obsolete Switch Machine power supplies, also referred to as “WHB”. The majority of existing WHB power supplies throughout the rail system have exceeded reasonable expectation of maintainability. The equipment is difficult to maintain due to age, discontinued components and the dissolution of the Original Equipment Manufacturers (OEM); this makes obtaining repair parts difficult or impossible. Additionally, the original linear design is inefficient compared to current technologies. The original power supplies need to be replaced to bring the Automatic Train Control (ATC) system into compliance with the Federal Transit Administration (FTA) mandated State of Good Repair (SOGR). *NOTE: All requirements listed within this document are applicable if the delivered Power Supplies are COTS or Design-Build.*
1. The Contractor shall provide replacement Switch Machine (WHB) Power Supplies for the WMATA ATC system. The supplies shall feed the non-grounded WHB DC bus (WHB-WHC) for switch-and-lock movement and snowmelter control circuits (HB-HC) at TCRs controlling interlockings. Two types of Power Supplies shall be provided;
 - a. Single-Phase (70 each)
 - b. Three-Phase (120 each)
 2. The contractor shall:
 - a. Install, adjust and test the delivered power supplies in quantities and at locations specified in VOL. I (A)
 - b. Deliver spare supplies
 - c. Provide technical manuals
 - d. Provide Test Platform
 - e. Provide Field Maintenance Training
 - f. Provide Shop Level (bench) training
 - g. Provide updated Book of Plan (BOP) drawings
 - h. Provide spreadsheet of delivered Assets (Location, Manufacture, Model, Serial Number, Install Date) *Note – spares should have a location of 400*
 3. The Authority is seeking a proposal to upgrade Automatic Train Control (ATC) Switch Machine (WHB) power supplies as specified herein. The upgrade process will include the following: supplying single and three phase power supplies in the specified quantities; installation of the power supplies; adjustment and testing of newly installed supplies; provide Test Platform, documentation and Shop level training for power supplies delivered under this contract.
 4. The Contractor is responsible for gathering the necessary data for the performance of the work under this contract order. The Contractor shall promptly notify WMATA of any additional work and of any reduced work in order to adjust the final negotiated amount of the Contract.
 5. The Authority will furnish the Contractor with its Design Criteria including the ATC CAD Manual (ATC-5000), Design Criteria, Standard Drawings, and other design-related information for the Contractor's use in developing their design and installation planning.
 6. By providing the WMATA Design Criteria, WMATA does not relieve the Contractor of its responsibility for the adequacy of the design
 7. All proposed work and any equipment, materials, including, but not limited to design, procurement, and furnishing shall be submitted to the Project Engineer for approval. The Project Engineer is hereby defined as the WMATA Contracting Officer's Technical Representative or his designee.
- B. The design shall be carried out in accordance with the latest version of applicable codes,

regulations and standards that apply to the project work. In the event that WMATA's Design Criteria exceed applicable standards, the Contractor shall provide a design consistent with the Authority's Design Criteria.

- C. All drawings and data generated by the Contractor (including hard copy and electronic copy) shall become WMATA property. All information collected by the Contractor is WMATA Proprietary Information. The Contractor may not use any data it gains access to for any purpose other than to perform work in furtherance of this Scope.
- D. The Contractor shall submit to the Project Engineer for approval a detailed Safety Analysis and component level Failure Mode, Effects and Criticality Analysis (FMECA) performed in accordance with the latest AREMA Communication and Signals Manual for all hardware, and certify that it is of "Fail Safe" design and functionality. Existing FMECAs for previous equipment used at WMATA may be resubmitted if the analysis pertains to the exact part number and revision level of the equipment to be provided for this contract. The document must clearly identify the part number and revision level.
- E. The Contractor shall develop a preliminary design schedule and submit with the proposal. After the task is awarded, the Contractor shall develop a detailed baseline schedule with budgeted cost assigned to each deliverable for WMATA task manager's approval.
- F. The Contractor shall develop and submit for the approval of the Project Engineer a detailed schedule for the design/procurement and Installation of the new Power Supplies and be based on the following Contract milestones (all dates are based on calendar days);

MILESTONE	DELIVERABLE	DUE DATE
MS-1	Preliminary Actions - Submit Qualifications - Submit Project Schedule - Presentation	NTP+20
MS-2	Design / Specs	NTP+40
MS-3	Test Plan - Factory Test Procedure - Acceptance Test Procedure - Field test & Adjustment Procedure	NTP+60
MS-4	Acceptance of Factory Test Results	NTP+70
MS-5	Manuals - O&M Manual Approval - Shop Manual Approval - Programming Manual (if applicable)	NTP+80
MS-6	Delivery & Acceptance of Test Platform	NTP+110
MS-7	Training	NTP+120
MS-8	25% Delivery & Installation of Supplies	NTP+255
MS-9	50% Delivery & Installation of Supplies	NTP+440
MS-10	75% Delivery & Installation of Supplies	NTP+620
MS-11	100% Delivery & Installation of Supplies	NTP+800
MS-12	Delivery of Spare Supplies	NTP+980
MS-13	BOP Updates & Salvage Delivery	NTP+990

- G. Design Delivery and Milestone Schedule – schedule developed and updated monthly by Contractor and agreed with WMATA Project Manager.
- H. All Work shall be completed by **NTP + 1100 calendar days**.

1.02 MINIMUM TECHNICAL AND PROPOSAL REQUIREMENTS

- A. WMATA will provide;

Applicable WMATA System Specifications. The Contractor should consult the following specifications for technical requirements not covered within this Contract. Any questions should be directed to the Project Engineer:

- a. 34 42 52 ATC DC Power Supplies
 - b. 34 42 49 ATC Signal Wire and Cable
 - c. 34 42 41 Basic ATC Electrical and Electronic Components Requirements
 - d. 34 42 92 ATC Instruction Manuals
- B. The materials specified in the WMATA Standard Specifications represent the minimum standards to be used.
- C. Designing to meet Buy America guidelines shall be required for federal funded project.
- D. The Contractor's design, and furnishing work shall be in accordance with the applicable WMATA ATC Standard Specifications (Rev. 9), unless explicitly stated otherwise within these Contract Documents
- E. The Contractor shall include in their proposal descriptions of the overall product operation, hardware specifications, software methodology, system and product history by location (to include property name and contact information) and previous experiences on in-service transit system rehabilitation projects. The contractor shall have a minimum of 15 years' experience in manufacturing power supplies.
- F. WMATA Standards and Specifications, available upon request, are overall general specifications, applicable to equipment, materials, selections, other services, and all other Contractor work, except as otherwise stated in these Specifications.

1.03 BASIC DESCRIPTION OF EXISTING SYSTEM

- A. The existing power supplies are either mounted on the wall or installed in a standard 19-inch rack with EIA spacing. The existing supplies vary in size and input requirements based on manufacture. The replacement power supplies will be physically equal to or smaller in size (width and height) than the existing power supply of its kind (Single-Phase or Three-Phase). The size requirement will ensure minimal or no modification to the 19-inch racks for the GRS and Electro Chloride replacements. However, the associated cabling may need to be modified or replaced. The existing Goodall power supplies will require the installation of new 19-inch racks with EIA spacing for the replacement supplies. Cabling may need to be modified or replaced.
- B. The existing supplies to be replaced by the **Single-Phase** version have the following electrical characteristics and were manufactured by;
1. Manufactured by GRS (General Rail Way Signal Co.)
 - a. Input voltage = 120 VAC
 - b. Output = 110-140 VDC at 40AMP.
 - c. Dimensions = W 19" x H 10 ½ "x D 9"
 - d. Current Mounting = Rack

Replacement supplies will be mounted in the same location
- C. The existing supplies to be replaced by the **Three-Phase** version have the following electrical characteristics and were manufactured by;
1. Electro Chloride (GRS Chloride Electro Networks Co.)
 - a. Input voltage = 208-Y 3-Phase, 4-wire grounded neutral, 60 Hz
 - b. Output = 110 – 140 VDC at 50 AMP
 - c. Dimensions = W 19" x H 21"x D 13"
 - d. Current Mounting = Rack

Replacement supplies will be mounted in the same location

 - e. Count = 70 units [see VOL. I (A) for count per location]
 - f. Locations = 27
 2. Goodall – 60 AMP Version (Goodall Mfg. Co.)
 - a. Input voltage = 208-Y 3-Phase, 4-wire grounded neutral, 60 Hz
 - b. Output = 110 – 140 VDC at 60 AMP
 - c. Dimensions = W 24" x H 36"x D 24"
 - d. Current Mounting = Wall

Replacement supplies may be mounted in a new rack if there are space issues.

 - e. Count = 28 units [see VOL. I (A) for count per location]
 - f. Locations = 14

3. Goodall – 100 AMP Version (Goodall Mfg. Co.): Each 100 AMP Power supply will be replaced by two units supplied under this contract wired in parallel.
 - a. Input Voltage = 208-Y 3-Phase, 4 wire grounded neutral, 60 Hz
 - b. Output = 110 – 140 VDC at 100 AMP
 - c. Dimensions = W 21” x H 49” x D 18”
 - d. Current Mounting = Wall
Replacement supplies will be mounted in a new rack
 - e. Count = 4 units [see VOL. I (A) for count per location]
 - f. Locations = 2

1.04 PRIMARY TASKS

- A. **PROJECT MANAGEMENT:** The Contractor shall provide a dedicated Project Manager who will be the primary point of contact with WMATA's Project Manager. The Contractor shall also assign other such technical and administrative personnel appropriate for the scope and general level of effort required to meet the performance commitments, e.g. System Engineer, Electrical/Electronic Engineer, Technical Writer, CAD Operator, and QC Inspector. The contractor shall be responsible for managing the project team to complete this task within the project budget and schedule. Monthly Project Management Team Meetings will be required throughout the duration of the task.

The Contractor's Project Manager shall coordinate the work with all sub-contractors (if any). The Contractor shall be responsible for all project deliverables and coordination of quality reviews of materials prior to delivery to WMATA and acceptance testing prior to installation.

Specific Contractor responsibilities include:

- Preparation and distribution of correspondence, memoranda, action lists, and related material;
- Submission of a project schedule to the WMATA Project Manager that meets all due dates cited herein;
- Coordination between the Contractor's in-house disciplines and sub-contractors to ensure consistency in the deliverables;
- Ensure key project personnel have extensive experience and demonstrated ability in performing equivalent tasks on similar projects. At minimum proof of qualifications shall be provided for the following project personnel:
 - a. Senior Project Engineer;
 - b. Electrical Engineer;
 - c. Field Engineer;
 - d. Technical Writer;
 - e. Software Engineer (if applicable)
- Compliance with the Contractor's Quality Program. Responsible for all project deliverables and coordination of quality reviews of materials prior to delivery to WMATA.
- Contractor manpower and budget control to complete project tasks within the agreed upon budget and schedule.
- Preparation and submission of Monthly progress reports as required supporting Contractor's invoices. Monthly Progress Report shall include major highlights and deliverables, scope, schedule, and budget progress within the month and shall be approved by WMATA's reviewer of the Progress Report.
- Responses to WMATA questions and requests to the work of this task;
- Resolution and formal responses to review comments; and
- Scheduling Monthly Project Meetings;

B. SITE SURVEY: The Contractor shall conduct site surveys to confirm the number and type of power supplies to be replaced, power supply placement, installation requirements (such as power supply placement, modifications to wiring or addition of racks), and associated factors at each location.

C. PROVIDE REPLACEMENT SWITCH MACHINE (WHB) POWER SUPPLIES:

1. **120 VAC Single-Phase Input**

Replacement (new) Power Supplies shall be mountable in a standard EIA 19 inch rack.

- Dimensions (Max): W 19" x H 10 ½" (6U) x D 22"
- Specifications: See Section 4.4
- Quantity:
 - For Installation = 60 units (*see VOL. I (A)*)
 - Locations = 24
 - Delivery (no install) to Training and SAMS = 4 units
 - Spares = 6 units
 - Total = 70 units

2. **208-Y VAC Three-Phase Input**

Replacement (new) Power Supplies shall be mountable in a standard EIA 19 inch rack.

- Dimensions (Max): W 19" x H 21" (12U) x D 22"
- Specifications: See Section 4.4
- Quantity:
 - For Installation = 106 units (*See Note and VOL. I (A)*)
 - Locations = 43
 - Delivery (no install) to Training and SAMS = 4 units
 - Spares = 10 units
 - Total = 120 units

NOTE: At two locations large power supplies are being replaced with two paralleled smaller units.

- *98 units to be installed one for one*
- *8 units to be installed two for one*
- *106 total units for install*

Deliverables:

- Single-Phase Power Supplies
- Three-Phase Power Supplies

- D. PROVIDE A TEST PLATFORM: Suitable for Shop acceptance testing of each type of power supply provided under this contract. The Test Platform, documentation and training shall be delivered prior to the start of WMATA acceptance testing. See Section 1.17.

Deliverables:

- Test Platform
- Manual and Schematics for Test Platform (may be included within the Shop Manual)
- Training on Test Platform (may be included within the Shop Training)

E. PROVIDE TECHNICAL DOCUMENTATION

1. O&M Manual for field personnel: Quantity = 84 (may include both types of supplies in one manual)
2. Shop Manual for bench technicians: Quantity = 20 (includes manuals distributed during training)
3. Test Platform Manual: Quantity = 5 (may be included within Shop Manual)
4. Programming Manual (if applicable) (may be included in Shop Manual): Quantity = 3

Deliverables:

- O&M Manual
- Shop Manual
- Test Platform and Programming Manuals (if separate from Shop Manual)

F. POWER SUPPLY INSTALLATION:

1. The Contractor shall review the associated TCR Book of Plan (BOP) drawings and take into consideration any ongoing or planned projects that may impact the scope elements defined herein as provided by WMATA. A detailed installation plan shall be provided that includes: Acceptance testing, Replacement of existing power supplies, Adjustment and testing of installed supplies, and delivery of removed equipment and wiring to a location specified by WMATA for salvage.
2. The front and back of the newly installed power supplies shall be accessible.
3. The replacement units for the GRS Single-Phase and Electro Chloride Three-phase supplies shall be installed in the same location and mounting method (rack mount) as the original power supplies.
4. The replacement units for the wall mounted Goodall supplies shall be installed in racks near the original wall mount location (if possible). The installation will require new EIA racks to be provided. The racks may need to be installed perpendicular to the wall to provide both front and back access to the supplies
5. A full complement of non-corroding hardware shall be used to mount each DC power supply in the manner previously submitted and approved. Mounting panels or brackets shall be rigidly designed so that they do not sag under the weight of the power supply.

6. Replacement of existing Single-Phase GRS power supplies with the Single-Phase version supplied under this Contract. 60 Power Supplies at 24 locations as detailed in Appendix-A.
 - a. Remove the supplies designated for replacement and deliver to WMATA collection site for salvage.
 - b. Install replacement supplies in the same rack location as the removed supplies.
 - c. Adjust and test newly installed power supplies for proper voltage and load sharing as specified in the Test Plan, Section 1.17.
7. Replacement of specified existing Three-Phase Electro Chloride power supplies with the Three-Phase version supplied under this Contract. 70 Power Supplies at 27 locations specified in VOL. I (A).
 - a. Remove the supplies designated for replacement and deliver to WMATA collection site for salvage.
 - b. Install replacement supplies in the same rack location as the removed supplies.
 - c. Adjust and test newly installed power supplies for proper voltage and load sharing as specified in Test Plan, Section 1.17.
8. Replacement of specified existing Three-Phase Goodall power supplies with the Three-Phase version supplied under this Contract. 32 Power Supplies at 16 locations specified in VOL. I (A).
 - a. Remove the supplies designated for replacement and deliver to WMATA collection site for salvage.
 - b. Install replacement supplies in new 19 inch EIA racks (near the original wall mounted location if possible). The new racks may need to be installed perpendicular to the wall to provide both front and back access to the supplies. Each three-phase Goodall 100-AMP supply will be replaced with two (2) each three-phase 50-AMP supplies connected in parallel.

NOTE – Since all ATC power supplies are connected in parallel for redundancy – this will result in four (4) 50-AMP supplies connected in parallel to replace the currently installed parallel 100-AMP supplies.
 - c. Adjust and test newly installed power supplies for proper voltage and load sharing as specified in Test Plan, Section 1.17.
9. Additional Information
 - a. The existing power supplies are connected in pairs (parallel) thru internal isolation diodes for redundancy and load sharing. The isolation prevents a failure of a single supply from disabling the parallel unit, as well as preventing a paralleled unit from back feeding the other supply. Each power supply is connected via dry contacts to a power circuit failure alarm within the TCR.

Deliverables:

- Removal of current supplies
- Installation of new supplies
- Adjustment and testing of new supplies
- Delivery of removed items to collection site

G. TRAINING: Provide training to WMATA Shop personnel.

1. Power Supply Training: Circuit explanation, component level repair, and calibration. One day class – 15 students.
2. Test Platform Training: Circuit explanation and operation- 5 students

Deliverables:

- Power Supply Training
- Test Platform Training

1.05 GENERAL REQUIREMENTS

A. Drawing Requirements

1. The Contractor shall provide updated Book of Plans (BOP) drawings to show changes to equipment and wiring within the Train Control Rooms (TCRs); As-In-Service drawings. Documents shall be provided with sufficient detail to provide adequate instructions to installers for the removal and installation of power supplies, and all changes to wiring.
2. All drawings and sketches shall be provided in hard copy and AutoCAD format. Full (24"x36") and half (11"x17") sized drawings shall be developed and shall utilize the WMATA Standard title block and comply with the ATC CAD Manual, ATC-5000.

B. The work to be performed in accordance with these specifications includes engineering manufacturing, testing, delivering, documenting, providing training, providing operation and maintenance manuals, and warranting quantities of AC to DC Power Supplies described herein.

C. The Contractor shall bear total system responsibility for all specified additions and changes to Authority systems of any type. The Contractor's total system responsibility includes engineering services, factory testing, documentation, training, warranting and all other areas described herein, which are subject to periodic review and acceptance by the Authority (as specified in this document).

D. Authority support will be limited to those items of work that are expressly stated to be "Authority Furnished" or "Authority Provided" in these Specifications. All other items of work are the responsibility of the Contractor.

E. All Contractor provided systems, equipment and services shall perform and be suitable for their intended purpose. Where not specifically stated in these Specifications, the equipment, system, subsystems, installation and operation shall meet or exceed all applicable standards of the latest editions of the following:

1. The Department of Transportation Federal Railroad Administration Technical Manual for Signal and Train Control Rules, Standards and Instructions (FRA).
2. Signal and Communications Manual of Recommended Practices by American Railway Engineering and Maintenance of Way Association (AREMA)
3. American National Standard Institute (ANSI).
4. National Electrical Manufacturers Association (NEMA).
5. Institute of Electrical and Electronic Engineers (IEEE).
6. Insulated Cable Engineers Association (ICEA).
7. American Society for Testing and Materials (ASTM).

F. The Contractor shall furnish AC to DC Power Supplies that meets all applicable performance and availability specification requirements; notwithstanding any errors or omissions in these Technical Specifications or the Contract Drawings that would otherwise prevent such delivery. In the event the Contractor discovers an error(s), omission(s) or conflict in the Technical Specifications or the Contract Drawings, the Contractor shall notify the Project Engineer in writing within ten (10) calendar days.

- E. The Contractor shall identify and make known to WMATA as soon as practicable, but in no case more than five (5) calendar days after the Contractor discovers the potential conflict among the requirements and criteria either in WMATA documents or industry standards that affect the scope, cost or quality of the designed work. The notification shall include a clear statement of the conflict, the source of the requirement and/or criteria, a recommended solution to the potential conflict, and identification of any cost/schedule impacts.

The Authority will solely determine the solution to the conflict based on either the Contractor's recommendation or its own evaluation. The Contractor shall incorporate the Authority's decision into the design/plan with a minimal impact to the scope, cost or quality of the final design product. Changes that result in re-design or scope change will be addressed through a task order modification.

- F. Equipment provided by the Contractor that does not meet the performance or functionality requirements of these Specifications shall be redesigned, resubmitted and, upon approval by the Project Engineer, be modified at the Contractors expense. Any modifications to approved designs shall be subject to the prior approval of the Project Engineer.
- G. Although the Authority retains rights to review the Contractor's system and component configuration and products selected and to accept or not accept for reasons of specification compliance or noncompliance, the Contractor retains sufficient latitude to ensure compliance with all specified performance and availability requirements. The Contractor shall submit engineering data, technical documentation, test program and quality assurance program data, and product selections that will ensure compliance with the system technical specifications. In the event these submissions are not accepted by the Authority, the Contractor shall resubmit with corrections or resubmit completely revised documentation. The Contractor shall remain responsible for bearing any additional costs associated with changes necessary to affect compliance with all specified performance and availability standards.
- H. In the event the Contractor claims relief from specified performance standards or availability because of the application of "Brand Name" or equal proprietary or detailed specifications, Authority directed changes, Authority reviews, or any other Authority actions claimed to be in conflict with such performance standards; the Contractor shall furnish written notice to the Project Engineer within 10 days after the discovery of such action attributed to the Authority (under no circumstances, later than 60 calendar days after the date specified for the Preliminary Design Review and design Engineering submittals). The Project Engineer will then review the Authority action cited and Contractor problem(s) involved, in an attempt to resolve these difficulties. In the absence of such timely notice, no such specification relief will be granted. The burden of proof for such claim(s) shall rest with the Contractor. The submission of timely Contractor claim(s) for specification relief as described, shall be required as a prerequisite to the acceptance of resulting claims(s) for increased Contract cost or performance time extensions.
- I. In the event of three failures of any system, subsystem, module or component, in the period between the onset of factory testing and the end of the Warranty period, the Contractor shall immediately re-engineer the failed item(s). The Contractor shall obtain WMATA's approval of the revision and perform all tasks (including the provision of new replacement parts, for all current, subsequent and earlier versions installed under this contract) at no additional cost to the Authority. The warranty period will be one year for total product replacement for failed units.
- J. If subcontractors are used, the PRIME is responsible for work completion and quality by subcontractor and/or vendors.

- K. Price Schedule: The Contractor shall complete the project bid Price Schedule that includes all required payment items.
- L. WMATA Review: WMATA will review all submittals identified under this contract. Formal comments generated during the review will be provided to the Contractor via Procore, and the Contractor shall respond to the comments via the same system; Procore.
- M. WMATA has implemented Procore, a web-based project management application for individual capital projects through all phases: planning, preliminary engineering, design, procurement and construction, and configuration management. The Contractor PM shall be responsible for coordinating the work of all sub-contractors, and shall maintain a central project folder in Procore. Reference Documents related to this Contract will be provided in the Procore website. WMATA Task Manager will maintain these documents. The Contractor shall coordinate with WMATA Task Manager for any accessibility issues to these documents.
- N. Site Visits
 - 1. Conferences
 - (a) Initial – Kick Off Meeting
 - (b) At each Milestone if needed
 - (c) As needed
 - 2. Track and Non-Track Site Visits: The Contractor shall inspect each installation site to determine installation requirements including: wiring, mounting locations, and other site specific information.
 - (a) Initial Site Inspection and inventory
 - (b) Additional inspections if needed
 - 3. Site Specific Work Plan (SSWP) is required from the Contractor in order to access the work sites. The Contractor shall submit as a deliverable and propose design schedule accordingly.
- O. Other Requirements
 - 1. Provide Installation Schedule.
 - 2. The Contractor should be aware that operational and emergency situations may interfere with wayside access. The Contractor should assume that 20% of access requests may be denied due to competing priorities.
- P. Document Control Requirements – Submit all electronic media and documents in Procore including Manuals, Design Analysis, Drawings, required Certifications, etc.

1.06 SAFETY AND SECURITY

- A. Badge Requirements: All Visitors, and Contactors requiring access to WMATA’s Facilities are required to follow the procedure in Section 01116 of Division 1 to be eligible for WMATA issued identification and access badge.
- B. WMATA Policies: The Contractor (and sub-contractors) must adhere to all WMATA security, safety and wayside policies.
- C. The Contractor shall adhere to the rules and guidelines of the latest revisions of the Authority’s

“Metrorail Safety Rules and Procedures (MSRP) Handbook”, Roadway Worker Protection Manual (RWPM), “Automatic Train Control System Integrity Maintenance Practices” and Construction Safety and Environmental Manual (CSEM).

- D. The Contractor shall request from WMATA to gain access to the areas for inspection that are not readily accessible.
- E. Failure Mode, Effects and Criticality Analysis (FMECA)
 - 1. The contractor shall perform a Failure Modes, Effects, and Criticality Analysis (FMECA) to the level of the electronic components for all vital hardware.
 - 2. The FMECA is a traditional qualitative analysis used to identify and analyze single-point failure modes, and their combinations, in vital hardware circuits to the level of the electronic components. The purpose is to verify safe operation under conditions of hardware failure and power supply anomalies.
 - 3. Each FMECA shall, at a minimum, address the following:
 - (a) Single point hardware failures for all circuit components, their effects on the hardware circuit, their effects on the overall system, and the means by which the failure is detected. The FMEA shall address all failure modes relevant to the component, as identified in AREMA Section 17.3.3 and shall include analysis of wiring/connectors.
 - (b) The effects of all failure modes shall be classified as self-revealing or non-self-revealing. Failures that are not self-revealing shall be analyzed in all combinations with all other failures. In the instance of a non-self-revealing failure, a subsequent failure cannot be considered as independent.
 - (c) If the Contractor determines that analysis of a non-self-revealing failure in combination with all other failures not required, the Contractor shall document the reasons justifying this decision in the FMEA.
 - (d) The FMEA shall describe the approach taken and justifications where needed. It shall present results in a tabular format.
 - 4. Existing FMECAs for previous equipment used at WMATA may be resubmitted if the analysis pertains to the exact part number and revision level of the equipment to be provided for this contract and fulfills the requirements. The document must clearly identify the part number and revision level of the printed circuit board under analysis.
 - 5. If the safe operation of the vital equipment requires the correct operation of supporting equipment (e.g. power supplies), the contractor shall demonstrate the fail-safety of this supporting equipment.

1.07 STORAGE AND DELIVERY INSTRUCTIONS

- A. The Contractor shall ship spare equipment to a location designated by the Project Engineer.
- B. All spare equipment and material shall be packed for warehouse storage. Like items (only) shall be grouped together and boxed as lots, as designated by the Project Engineer. Lots shall be marked as to item nomenclature, manufacture part or drawing number, WMATA part number, contract number, specification reference (if applicable), and end use (WMATA project identification data) , as directed by the Project Engineer. Each individual item shall also be tagged with a WMATA part number, if a number is assigned by the Engineer.

- C. The Contractor shall deliver spare equipment and materials to any of the various locations designated by the Project Engineer. All locations will be within a 25-mile radius of Washington, D.C. (Maryland, Virginia, or the District of Columbia).

1.08 SITE VISITS & ROOM LOGBOOK DOCUMENTATION

- A. The Contractor shall without exception record an entry into the Room Log Book anytime they enter a train control room. The entry shall include name(s), company, date, time, activity performed and reasons for entry.

1.09 QUALITY ASSURANCE

- A. The Contractor shall submit within forty-five (45) days of NTP, a Quality Assurance program plan. This submittal shall identify how the Quality Assurance will be monitored, upheld, and/or certified (such as an ISO Certification) throughout the manufacturing, procurement, delivery and warranty period and include all reference documents.
- B. The Contractor shall provide, as a part of the proposal, a Quality Assurance Plan in accordance with the requirements of the Special Conditions section of this contract and maintain ISO 9001 Certification.
- C. Refer to Section 01470 of Division 1 specification

1.10 SUBMITTALS/DELIVERABLES

- A. The Contractor shall submit other submittals listed elsewhere in these specifications or as required by the Project Engineer including, but not limited to the list of deliverables below.
- B. All submittals shall be made via Procore. All relevant documents and revisions shall be placed in the Procore document folder for the project.
- C. The Contractor shall submit the following no later than twenty (20) days after receiving Notice to Proceed:
 - 1. Project Schedules
 - 2. Project Engineers' Qualifications
 - 3. Manual Writer Qualifications
- D. The Contractor shall submit a Preliminary Engineers Presentation Outline no later than thirty (30) calendar days after receiving Notice to Proceed.
- E. Prior to the Preliminary Design Review, the Contractor shall have successfully delivered the Preliminary Engineers Presentation.
- F. The Contractor shall submit a Test Plan no later than ninety (90) calendar days after receiving Notice to Proceed. The Test Plan shall be based on the requirements of Section 1.17.
- G. The contractor shall submit an O&M Manual Outline no later than one hundred eighty (180)

calendar days after receiving Notice to Proceed.

- H. If applicable, the contractor shall submit a Programming Manual Outline no later than one hundred fifty (150) calendar days after receiving Notice to Proceed.
- I. The contractor must submit the following as a minimum to the Project Engineer for approval, prior to purchase or fabrication of any equipment to be used on this contract:
 - 1. Complete internal circuits and wiring diagrams
 - 2. Drawings showing the physical dimensions and characteristics of each piece of equipment
 - 3. Complete performance data including environmental operating characteristics of each piece of equipment and electronic circuit
 - 4. Complete parts listing
 - 5. List of any specialized test equipment or software for testing or configuration
 - 6. Manufacturers Certified Test Procedure
- J. The contractor shall submit the applicable test procedure, a minimum of thirty (30) days prior to each of the following tests:
 - 1. Factory Test
 - 2. Type Acceptance
 - 3. Field Test & Adjustment (including load balancing)
 - 4. Shop Acceptance Test Procedure
- K. Prior to the onset of Factory Testing the Contractor shall gain approval of the following:
 - 1. All Products
 - 2. First draft O&M and Shop Manuals
- L. Site specific Work Plan (SSWP) shall be submitted 60 days prior to start of work
- M. Failure Mode and Effect Analysis (FMEA) shall be submitted no later than NTP+ one hundred twenty (120) calendar days
- N. Switch Machine (WHB) Power Supply Survey and Report shall be submitted no later than NTP+ ninety (90) calendar days
- O. Quality assurance Plan shall be submitted no later than NTP+ one hundred (120) calendar days, as per Section 1.09.
- P. Other submittals listed elsewhere in these Specifications or as required by the Project Engineer.

1.11 ENGINEERING REVIEWS

- A. The Authority will establish and maintain a close and continuing review process to monitor the Contractor's total effort during the life of the Contract. Each system and subsystem will be

reviewed for compliance with the design, testing, functional and operational requirements of the technical specifications contained herein. The Authority's determination of compliance and noncompliance with the technical specifications is final and binding. However, the Authority reserves the right to rescind approval, if an item is later found to be noncompliant with the Contract Specifications, unless previously identified, during this contract, by the Contractor as a variance and approved as such by the Authority. In instances where the Contractor is aware of a noncompliance, it is in the best interest of all parties to discuss the noncompliance issue at the earliest opportunity. Failure to do so may result in expensive redesign upon discovery, at no additional cost to the Authority.

- B. The Authority retains the right of final interpretation of these Specifications, based on the intent and requirements at the time of writing. Review findings shall be conveyed to the Contractor through the Engineer.
- C. The Contractor may request, and the Authority will consider requests for, minor technical deviations to these Specifications that the Contractor considers beneficial in keeping with Specification performance and system availability standards. The Authority will evaluate such requests while taking into account the following factors:
 - 1. Overall benefit to the Authority and safety of the WMATA system.
 - 2. Improvement in system performance.
 - 3. Existing specification inconsistencies.
 - 4. Benefits of new technology.
 - 5. Standardization with existing equipment and spare parts in stock.
 - 6. System compatibility.
 - 7. Contract cost reduction.
- D. Submittals will be returned with one of three (3) approval codes as follows:
 - 1. **Approved** - submittal is acceptable and appears to be Specification Compliant.
 - 2. **Approved as Noted** - submittal is acceptable however, minor items (such as typos) need to be corrected. The Contractor makes the minor edits then proceeds with no need for resubmittal.
 - 3. **Revise and Resubmit** – there are one or more issues with the submittal. Comments and marked items must be corrected and resubmitted for review.
- E. The Authority reserves the right to allow for no less than thirty (30) calendar days for checking and appropriate action on the submittals.
- F. Specific details and formats for each review point shall be established at a joint Authority/Contractor project planning conference no more than thirty (30) days after Notice to Proceed. The following basic requirements for each review point shall serve as the basis of agreement, subject to adjustments to reflect system complexity and the amount of technical data required for each review
- G. Major review points shall be established by the Engineer on the basis of engineering progress and shall follow the general outline set forth below for the systems defined herein:
 - 1. Product Submittals – The Contractor shall submit for each item to be installed on the WMATA property, the intended use of said item, all drawings (physical construction,

schematic, etc.), applicable catalog cuts, certified test reports, engineering data and other related items (including samples) Which the Project Engineer considers necessary to evaluate the submittals, prior to procurement of such equipment. Exception: Product approval shall not be required prior to purchase and installation when the Contractor furnishes "Brand Name" or "Trade Name" products, as specified herein (without substitutions, option changes, major revisions, deviations from specifications, etc.), for the purpose specified herein. Record copies of such product data shall be furnished in lieu of product approval submittals.

2. Preliminary Design Review - Maximum of ninety (90) days after notice to proceed.
3. Final Engineering Progress/Design Review - Minimum of thirty (30) days prior to Factory Testing.

1.12 SPARE PARTS

- A. 30 days prior to the onset of the initial delivery, the Contractor shall submit and obtain approval of a "Contract Spare Parts List".

1.13 TEST EQUIPMENT

- A. The Contractor shall furnish 1 unit of any specialized test equipment needed to test and/or set up their equipment that has not been provided as part of past WMATA contracts and is required to test the track circuit equipment to be supplied. This equipment shall include all software installed into the equipment and accessories to be delivered complete and ready for operation. Detailed information pertaining to each piece of test equipment shall be submitted to the Engineer for approval prior to procurement. The submittal shall demonstrate that the functionality of the proposed equipment is directly applicable to the new WMATA ATC System.

1.14 DESIGN REQUIREMENTS

A. Physical Environment

1. All equipment supplied under this contract shall meet all environmental standards in the latest AREMA Signaling and Communications Handbook, including shock, vibration, temperature and humidity for the applicable class of equipment.

B. General Design

1. System shall be designed in accordance with established FRA and AREMA recommended guidelines.
2. Power supplies shall be fully compatible with the existing signal (Train Control) equipment. No modifications to the present signal system shall be made to accommodate the new power supplies without the Project Engineers approval.
3. The existing DC Power Supplies are installed in a standard 19-inch rack with EIA spacing. The replacement products shall fit into the existing equipment racks with only minor modifications to the equipment racks as approved by the Authority Engineer (relocation to another rack of existing equipment or components not being replaced is prohibited).
4. All external connections from the modules to existing control wiring shall be wired out to proper AAR Terminal Blocks, as described in Section 1.15.

5. Electrical Installation

1. Install all basic electrical components of the correct type, size and rating required to provide the specified operation of the DC Power Supply equipment. This shall include replacement of basic electrical components damaged or burned out in the course of manufacturing and testing.
2. Install fuses or circuit breakers of the correct type, size and rating to:
 - i. Protect the electrical equipment and circuits from short-term and long-term overloads,
 - ii. Function properly as part of the ATC power distribution system protection, and,
 - iii. Function properly as part of the ATC Power Failure Alarm system
3. Attach lugs to the ends of conductors in such a manner that the flexibility of the conductor will not be destroyed and the possibility, of wire breakage at the terminal will be reduced to a minimum. Lugs shall be attached to the conductor with a tool made by the same manufacturer as the lug and/or terminal being used. The tool shall be equipped with a ratchet (or hydraulic) device which ensures proper application of the lug and which will not release until proper compression is attained. The crimp tool shall be calibrated according to manufacturer's specifications. Tools which are excessively worn, damaged, abused, or show evidence of missing parts shall not be used

6. Electronic Components

Install all basic electronic components of the correct type, size and rating necessary to provide the specified operation of ATC electronic equipment. This shall include replacement of basic electronic parts damaged or burned out in the course of manufacturing and testing.

C. Environment

1. All equipment supplied under this contract shall meet all environmental standards in the latest AREMA Signaling and Communications Handbook, including shock, vibration, temperature and humidity for the applicable class of equipment.
2. The Contractor shall provide all products and materials necessary for the protection of the DC Power Supply against interference by the physical or electrical environment. The products and materials so used shall not themselves constitute a threat to human health or Safety, or interfere with the operation of existing equipment or systems.
3. The Contractor shall include in the design and fabrication, all required equipment and/or procedures to prevent external or internal physical interference with the operation of the Power Supplies.

1.15 TECHNICAL SPECIFICATIONS AND REQUIREMENTS

A. The finished product must comply with but is not limited to the requirements in this section.

B. WMATA Design Criteria

The Contractor shall utilize the WMATA Design Criteria, WMATA Standard Specifications, which are the set of master guide specifications reflecting WMATA

technical policy. These guide specifications will be provided by WMATA.

C. Power Supply Requirements

1. Input Voltage

- I. The power supplies shall be designed and rated to operate on the following source voltage:
 - a. For Single Phase Units: 120 VAC, 60 Hz
 - b. For Three Phase Units: 208 VAC-Y, 4 wire grounded neutral, 60 Hz
 - c. The input voltage may vary as much as ± 15 percent and the frequency may vary ± 0.5 Hz.
- II. The power supplies shall not be damaged by a sustained input voltage varying from 0 to 150 percent of the rated input voltage.
- III. The unit will shut down in over or under voltage conditions. The supply should auto-recover if the input voltage returns to an acceptable level.
 - a. Input Range for 120 VAC = 102 – 138
 - b. Input Range for 208 VAC = 177 – 239

2. Rated Output Voltage

- I. The output voltage shall be adjustable from 110 – 140VDC at maximum current.
- II. These power supplies shall deliver to the switch-and-lock movements, at any load, or temperature between -40 degrees Celsius and +70 degrees Celsius, their rated voltage at rated input voltage. The output voltage may vary somewhat from its rating during warm-up, but it shall not exceed 120 percent of rated voltage and the warm-up period shall not be greater than 20 minutes.

3. Regulation : 1% Maximum

4. Rated Output Current: The Power Supplies shall be capable of delivering 50 AMPs at the rated voltage

5. Efficiency: Minimum of 80%

6. Environmental

- I. The Power Supply shall be designed to operate between -40 degrees Celsius and +70 degrees Celsius.
- II. All circuit boards shall have conformal coating applied to protect from dust and moisture

7. Overvoltage Protection

- I. The power supply will disable the output at 150VDC.
- II. The power supply shall auto-recover from over voltage shutdown. In the event the power supply is designed to discontinue auto-recovery after several attempts then a manual reset shall be provided to restart the supply.

8. Overload Protection: The unit shall limit current to 120% of rating or less. Temporary voltage fold back with auto-restart is acceptable under severe load conditions.

9. Parallel Operation

- I. The power supplies shall be installed in pairs (connected in parallel) with each supply equally sharing the load. A Sense or Control Wire may be used to control load balancing.
 - II. Isolation diodes shall be internally used to prevent back feeding of the supplies due to parallel operation.
10. Ripple and Noise
 - I. The ripple and noise shall be less than 2%
 - II. The electrical noise from these power supplies shall not interfere with any electrical, electronic system, or with the communications systems.
11. Reliability: Power supply units shall have a minimum individual MTBF of 150,000 hours. MTBF shall be calculated at fifty percent (50%) load. The maximum MTTR for any individual local power supply unit shall be one hour.
12. Output Voltage Transients: Output voltage transients may appear on these power supplies for internal or external reasons; however, the circuitry of the power supply shall contain devices to protect the rectifiers utilized in the supply.
13. Electrical Noise Immunity: Immune from external RF energy from portable 2-way radios (495 MHz at 6 Watts at 2 feet) and personal communications devices such as cellular telephones.
14. Transformers: Transformers used in DC Power Supplies shall not emit audible noise in excess of 50 dB (referenced to 0.00002 dynes per square cm.) at a distance of three feet when operated anywhere within the range of specified input and output voltages and currents specified.
15. Electrical Insulation

The power supplies shall be electrically insulated so that they will be capable of withstanding, for one minute, 600 volts, 60 Hz applied between:

 - (a) The input leads (connected together) and the chassis.
 - (b) The output leads (connected together) and the chassis.
 - (c) The input leads (connected together) and output leads (connected together).
16. Cooling
 - a. The power supplies shall be designed for natural convection cooling. No supplementary fans or other cooling devices will be allowed.
 - b. A power supply may be mounted on a rack with other power supplies and shall accordingly be certain that convection area and other components are sized and have dissipation ratings, for such installations.
 - c.
17. Duty Cycle

The power supplies shall be designed for an intermittent duty cycle.
18. Failure Alarm

Each DC power supply shall be equipped with a failure alarm device which shall detect any internal failure which would impair the ability of the power supply to deliver its full rated load. This device shall be normally energized by a small percentage of the rated load current of the power supply and shall cause two separately wired internal contacts to open when a failure is detected. One of these contacts shall be independently wired to binding posts for an external alarm indication circuit. The

second contact shall be used to light an indication lamp or LED indicator mounted on the power supply. (See Section 34 42 39.55, ATC - Track and Alarm Indication Panels) This circuit shall function even if the output voltage is maintained by a tandem power supply.

The current drawn by internal monitoring circuitry (such as the failure alarm) shall not be displayed by the output current meter.

19. Identification

Each power supply shall be clearly and permanently labeled with the following:

- I. Manufacture's name
- II. Part or model number
- III. Serial number
- IV. Input rating
- V. Output rating (Continuous)

20. Components and Wiring

Electrical and electronic components used in DC power supplies shall be as specified in Section 34 42 39.41. Internal wire shall meet the requirements of Section 34 42 39.49. Power supplies which are designed to be repaired in the rack shall have all components in modular assemblies which do not require soldering to replace.

21. Housing

Each power supply shall be housed in a metal panel-chassis combination with no exposed electrical connections or wires. A perforated protective cover shall be used to provide for convective heat transfer. Metal used in this housing and cover that is subject to corrosion shall be protected by zinc plating or an approved equivalent finish applied after forming.

22. Mounting

The power supplies shall be mountable in a standard 19-inch rack with EIA spacing.

23. Physical Dimensions

- I. The Single Phase version shall be capable of fitting into an 19-inch rack with EIA spacing, and shall measure no more than: W 19" x H 10 ½" (6U) x D 22"
- II. The Three Phase version shall be capable of fitting into an 19-inch rack with EIA spacing, and shall measure no more than: W 19" x H 21" (12U) x D 22"

24. Front Panel

The front panel shall be designed for use in mounting the power supply in a standard 19-inch rack with EIA hole spacing. All panel mounted indicating, adjusting or protective devices, or openings for such devices, shall be legibly and permanently labeled.

25. Panel Mounted Indicators

Each power supply shall have an output voltmeter, an output ammeter and a normally illuminated power failure light (lamp or LED) mounted on its front panel. As an option, the Contractor may provide this metering on a separate panel in the same rack

as the power supplies. Meter accuracy shall be ± 2 percent with nominal readings at center scale.

26. Terminals

- a. The power supplies shall be equipped with standard AAR type binding posts (No. 14-24 studs) within the chassis, for the connection of all external input and output power leads. Terminals for external connections to the internal failure alarm contacts shall be of the 8-32 barrier strip type or standard AAR type binding posts. Each terminal shall be permanently labeled.
- b. Where input or output terminals are in close proximity to the failure indication terminals, a grounded metal barrier shall be provided to prevent accidental application of high voltage to the other terminals.

27. Protection

Circuit breakers or fuses shall be easily reset or replaced.

D. Nature of the Technical Specifications

1. These Technical Specifications shall be considered by the Contractor to be based primarily on System Performance Requirements. Minimum acceptable technical characteristics have also been specified for power supplies and certain materials and services, in order to maintain desired standards of quality, and ensure that interchangeability, maintainability, and reliability goals of the Authority are achieved.
2. WMATA Standards and Specifications are overall general specifications applicable to equipment, materials, selections, installation workmanship other services, and all other Contractor work except as otherwise stated in these Specifications.

1.16 INSTALLATION METHOD AND SUPPORT

- A. The Contractor shall install the power supplies delivered under this Contract. All supplies shall be subject to acceptance testing prior to installation. Coordination between Contractor and WMATA will be required to facilitate installation. All WMATA safety and wayside rules must be followed.
- B. The Contractor shall coordinate acceptance testing with WMATA-SAMS: All power supplies shall be delivered to SAMS for acceptance testing prior to installation. At minimum, SAMS will test a random 10% sample out of each shipment.
- C. The Contractor shall present an installation plan and schedule for review and approval to the Project Engineer and ATCM for TCR installation.
- D. Single-Phase Switch Machine Power Supplies:
 - 1. The Contractor shall replace the current Single Phase Power Supplies (GRS) within the specified TCR locations with the Single-Phase Supplies delivered under this contract.
 - 2. The replacement of the Power Supplies will performed in such a manner as not to impact revenue operations.
 - 3. The Contractor will remove the current power supplies and deliver them for disposition as specified by the Project Engineer.
 - 4. The replacement supplies shall be installed in the same physical location as the removed supplies with only minor modifications (if any) to the equipment racks.
 - 5. Wiring to the power supplies shall be installed neatly and sized appropriately. All wiring must comply with AREMA Section 10 and WMATA System Spec 34 42 49 ATC Signal Wire and Cable:
 - (i) Wire and cables shall be sized according to the National Electrical Code or of the same size as currently installed, whichever is larger.
 - (ii) Wire/Cable insulation shall be black in color and wire tags applied at both ends of the cable.
 - (iii) Wires and cables shall be installed in a neat workmanlike manner. Cables in trays or troughs shall be laid therein. Cables within trays or troughs shall be installed with a minimum of crossover. Wires and cables shall be installed according to manufacturer's recommendation for bend radii. Wires and cables attached to racks shall be dressed vertically and horizontally; shall not be run diagonally.
 - (iv) Wire and cable shall be tied down with black nylon straps.
 - (v) Wire or cable splicing is not allowed.
 - 6. See VOL. I (A) for list of locations and counts.
Note – the Contractor is responsible for performing a site survey to confirm detailed work at each location, counts and types of power supplies to be replaced.

E. Three-Phase Power Supplies

1. The Contractor shall replace the current Three-Phase Power Supplies (Goodall and Chloride Electric) within the specified TCR locations with the Three-Phase Supplies delivered under this contract.
2. The replacement of the Power Supplies will be performed in such a manner as not to impact revenue operations.
3. The Contractor will remove the current power supplies and deliver them for disposition as specified by the Project Engineer.
4. The replacement supplies shall be installed in the same physical location as the removed supplies with only minor modifications to the equipment racks.
5. Wiring to the power supplies shall be installed neatly and sized appropriately. All wiring must comply with AREMA Section 10 and WMATA System Spec 34 42 49 ATC Signal Wire and Cable:
 - a. Wire and cables shall be sized according to the National Electrical Code or of the same size as currently installed, whichever is larger.
 - b. Wire/Cable insulation shall be black in color and wire tags applied at both ends of the cable.
 - c. Wires and cables shall be installed in a neat workmanlike manner. Cables in trays or troughs shall be laid therein. Cables within trays or troughs shall be installed with a minimum of crossover. Wires and cables shall be installed according to manufacturer's recommendation for bend radii. Wires and cables attached to racks shall be dressed vertically and horizontally; shall not be run diagonally.
 - d. Wire and cable shall be tied down with black nylon straps.
 - e. Wire or cable splicing is not allowed.
6. See VOL. I (A) for list of locations and counts.

Note – the Contractor is responsible for performing a site survey to confirm detailed work at each location, counts and types of power supplies to be replaced.

- F. All removed power supplies and cable (if any) shall be delivered to WMATA as specified by the Project Manager for salvage.
- G. The Contractor shall update the BOM with serial number and location as specified in Section 1.20. Power Supplies delivered as spares shall have the location noted as 400 (main storeroom).
- H. The Contractor shall update TCR Drawings to reflect the changes in Power Supplies.
1. The drawing updates shall be done in AutoCAD and according to WMATA CAD Specifications. Reference ATC-5000.
 2. All Drawings edits must be reviewed and approved by the Project Engineer.
 3. Replacement pages for drawing changes shall be provided for placement in the TCR Book of Plans (BOP).
- I. Power Supply Failures

All Power Supply failures discovered during acceptance testing or installation shall be replaced or repaired by the Contractor.

1.17 TESTING

A. The Contractor shall develop a Test Plan that covers factory testing, WMATA acceptance testing by Electronic Shop, field adjustment and final operational testing after installation.

B. General

1. The Contractor shall establish and implement a Comprehensive Test Program that will ensure the DC Power Supplies and associated equipment furnished during the performance of this Contract, meet the technical requirements and standards specified, as well as all performance criteria. The Contractor's Test Program shall include type acceptance and factory, reliability testing.
2. The Contractor shall furnish qualified test personnel, calibrated test equipment, and tools as necessary to perform all setup procedures, tests and retests until acceptance by the Authority.
3. The Contractor shall furnish to the Authority one unit or one complete set of any specialized test equipment used during Factory Testing.
4. The Authority reserves the right to perform additional nondestructive tests and inspections at any time during the course of the contract work. Results indicating deficiencies involving noncompliance with Specification requirements will be reported to the Contractor for corrective action.
5. The Authority and the Project Engineer (or designee) reserve the right to witness any or all tests and inspections in the Contractor's plants. The Contractor shall advise the Project Engineer a minimum of two (2) weeks in advance of each test. When tests are to be conducted continuously as a production line routine, the Contractor shall advise the Project Engineer two (2) weeks in advance of the start of such tests and shall indicate the duration of the period over which such tests will be conducted.
6. The Contractor shall submit the factory and reliability reports (for the actual equipment being provided under this contract) to the Project Engineer prior to shipment of the actual equipment and as specified elsewhere in these Contract Specifications.
7. The Contractor shall be responsible for the costs of its personnel and any special equipment and assistance required to conduct all required tests and complete the required documentation. When a device or system does not meet the specification requirements initially, the Contractor shall make the necessary corrections and shall be responsible for the total cost of additional tests and/or inspections required to prove compliance.
8. No test which requires that a potentiometer, adjustable resistor or other adjustable component be adjusted to within twenty-five percent (25%) of its maximum or minimum value in order to achieve the required test results will be considered satisfactorily completed. When a component adjustment is within twenty-five percent (25%) of its limits, the Contractor shall notify the Project Engineer, commence corrective action and schedule a retest to take place after the condition is corrected.

C. Test Procedures

1. Complete test procedures must be submitted and approved prior to the onset of any given test being performed and in accordance with other sections of these Specifications. Negative testing shall be applied, whenever applicable, to a given test.
2. Procedures shall be written in detailed steps with acceptable values listed whenever measurements are to be taken; in no case shall a single check mark be used to verify multiple readings or test steps.
3. All test inspection procedures shall be subject to the approval of the Project Engineer.
4. Procedure Format:
 1. Title Sheet - containing the test procedure title, contract number, test number, issue date and revision date. This sheet shall also present a concise, but complete, statement of the purpose of the test described. Finally, blanks shall be provided for the signatures and signature dates of the Contractors responsible personnel and the Engineer.
 2. Table of Contents
 3. List of test prerequisites
 4. List of abbreviations used in test
 5. List of test equipment required
 6. Preliminary information (background information further clarifying the purpose of the test).
 7. Data sheets for recording results. These sheets shall include:
 - i. The permissible maximum and minimum values
 - ii. The measured value
 - iii. Check boxes for each adjustable circuit component to indicate the adjustment is within the acceptable range

D. Test Completion Forms must be submitted and approved by the WMATA Project Engineer prior to the onset of Factory testing. These forms shall include but are not limited to the following:

1. Test Completion
2. Description
3. Start and Completion date and time
4. Test Technician/Engineer(s)
5. Signature blocks for Engineer and Authority Witness

E. Discrepancy/Action Record

1. All discrepancies identified during testing
2. All corrective actions taken
3. Initials of individual clearing each item
4. Signature blocks for Engineer and Authority Witness

F. Test Equipment Used for Factory Testing

1. Type, model and serial number of all equipment used
2. Calibration date
3. Signature blocks for Engineer and Authority Witness

G. Type Acceptance Testing

1. Any and all equipment items that are not presently being used on the WMATA Transit System and previously type acceptance approved by WMATA shall be subject to First Article Type Acceptance Testing, at the Project Engineer's discretion.
2. Items used previously and modified by substantial revision, as determined by the Project Engineer, are also subject to testing.
3. The Contractor must submit for approval a Type Acceptance Procedure, specific to each item subject to first article type acceptance testing.
4. The test shall prove that the equipment/device will reliably operate as designed, within the physical, electrical and environmental parameters of these Contract Specifications.
5. In the place of testing, certified test results may be deemed as an acceptable alternative, at the Project Engineers discretion, for equipment in use on other properties.

H. Factory Testing

1. The Contractor and/or his subcontractors shall perform all necessary factory tests and inspections of systems, subsystems, assemblies, subassemblies and components supplied under this Contract to ensure compliance with these Contract Specifications. These tests shall verify design and nameplate ratings and shall ensure adequate and proper performance, safety and reliability.
2. All systems, subsystems and all electronic devices shall be one hundred percent (100%) inspected and tested. The test shall be as comprehensive as possible.
3. The DC Power Supplies shall be connected and tested in a manner to allow for a complete functional verification of the system hardware and software operation.
4. Each component and unit shall be inspected at its point of manufacture and evidence of this inspection and acceptability shall be indicated on the item where practicable.
5. When test results are not recorded on a test-data plate affixed to the component or unit, the Contractor shall furnish certified test reports for each item at the time of delivery.
6. The Contractor shall submit and have approved pre-printed data sheets for each test to be performed, complete with all information pertinent to the specific location or device under test that can be entered prior to actual testing.
7. The Contractor shall submit completed test results within two weeks of test completion.
8. All new cables and plug coupler cables to be provided shall be tested end to end to verify proper termination, configuration (pin to pin), and if applicable keying.
9. All discrepancies found in Factory testing shall be resolved, prior to shipment of a given unit or component.

I. Acceptance Testing

1. Each Power Supply shipment shall be delivered to SAMS (195 Telegraph Road, Alexandria, VA 22314) for acceptance testing. SAMS will perform a random 10% test of each shipment. If two (2) or more failures per fifty units (or 4%) are defective during the sample test then the entire shipment shall be returned to the manufacture.
2. The Contractor shall coordinate with SAMS the delivery and pickup of shipments.
3. A copy of the completed Factory Test Results shall be included with each unit.
4. No more than fifty (50) units may be delivered at a time for testing, exceptions may be agreed to by the SAMS Superintendent and Project Manager. Sample testing shall be performed on each shipment.
5. Shipments shall not remain warehoused at SAMS after testing without approval from the SAMS' Superintendent. Completed units should be picked up by Contractor within five (5) calendar days.

J. Test Platform for Acceptance Testing

1. The Contractor shall provide a Test Platform suitable for Shop acceptance testing of each type of power supply provided under this contract. All components and test equipment required for acceptance and repair testing shall be included. The tester shall use the same connections as will be utilized during installation (no jumps or clips). The tester shall be delivered prior to acceptance testing by the Shop. Operator training shall be provided for the tester prior to delivery of Power Supplies.
2. The platform shall test, but is not limited to the following:
 1. High-pot (input to chassis, output to chassis, input to output)
 2. Power Failure Alarm (panel and remote)
 3. Output Voltage and Current (no load, medium load, full load)
 4. Voltage Adjustment Range
 5. Ripple and noise (under light, medium and heavy load)
 6. Output: Over Current
 7. Output: Over Voltage
 8. Input: Under Voltage
 9. Input: Over Voltage
 10. Load Regulation
 11. Load Sharing

3. Platform construction and documentation shall conform to:
 1. All components shall be mounted in an enclosure or rack.
 2. All connections to the power supply under test shall be of the same type used during installation (no jumpers or clips).
 3. All connections shall be clearly labeled.
 4. Safety precautions shall be integrated to protect users from high voltage and high temperature surfaces.
 5. A single AC connection shall power the platform.
 6. A master power switch shall be available to power down the Test Platform.
 7. If the unit is microprocessor controlled then reinstall media shall be provided.
 8. If PC based then the software shall be compiled for currently available and supported OS.
 9. If PLCs are used then copies of firmware shall be provided.
 10. An Operation & Maintenance Manual shall be provided with a schematic for the Test Platform.
 11. Test Procedure and Test Results Forms shall be provided.

1.18 TRAINING

- A. The Contractor shall provide a recommended and approved program of Shop Maintenance Training for WMATA shop maintenance personnel on the power supplies provided under this Contract. This program is to be presented to a core group of WMATA Training and Maintenance personnel, in a WMATA facility. The class shall take place, prior to the initial delivery of power supplies, during a minimum of one (1) daytime shift of eight (8) hours. The training course shall include but is not limited to the following:
- B. Training shall be provided to Shop personnel that includes all information necessary for the maintenance, calibration and component level repair of the power supplies. A bound copy of the Shop maintenance Manual shall be provided to each student. The training and material shall include but not be limited to:
 - 1. Theory of Operation
 - 2. Review of Block Diagram
 - 3. Review of schematics
 - 4. Operational testing
 - 5. Troubleshooting to component level
 - 6. Adjustment and calibration
 - 7. Students will be given the opportunity to practice procedures on a power supply
 - 8. Use of any specialty tools or software
 - 9. If microprocessors are used, all instructions necessary for adjustment and testing of processor based circuitry.
 - i. Pseudo Code – explanation of software function
 - ii. Copies of firmware
 - iii. Instructions and tools for adjusting software functions, if applicable; e.g., meter settings, delays, current limits or trip points, etcetera.
 - 10. Course topics:
 - a. Theory of operation (including explanation of switch mode regulation)
 - b. Software descriptions (if applicable)
 - c. Preventative maintenance instructions (PMI)
 - d. Troubleshooting and fault isolation to the board level or major component
 - e. Contractor's set-up procedure used in this contract
 - f. Use of any required test or diagnostic equipment
 - 11. Methods of Instruction:
 - a. Detailed descriptions
 - b. Diagrams and Flowcharts
 - c. Practical "hands-on" exercises
 - 12. The Contractor shall provide Thirty (30) Student Guides, one in its own binder and one unbound, containing copies of manufacturers equipment manuals for each item of equipment furnished by the Contractor and all necessary lessons required to perform the course objectives. In addition, one hundred-twenty (30) sets of electronic media, either CD or DVD, are to be submitted to the Authority complete with all visual aids and text contained in the student guides. The Operations and Maintenance Manuals (O&M

Manual), included in the student guide, shall be in accordance with specifications contained herein.

13. The Contractor shall provide 2 Instructor Guides, one in its own binder and one unbound, containing all necessary lessons, notes, references, etc. required to present the course in an efficient, thorough manner. In addition, two (2) sets of electronic media, either CD or DVD, are to be submitted to the Authority complete with all visual aids and text contained in the instructor guides.
- C. The quality of the training program shall be such to ensure competence in the maintenance of the track modules and wayside equipment. As part of the training program, the supplier will involve the Authority's Signal instructors in all phases of the training program. The course contents will be developed with the WMATA Signal Instructors to assure that there is a continuation in future training needs.
 - D. Following the last day of a training session, the Contractor shall submit a training report to the Authority.
 - E. The personnel teaching the training course shall possess teaching experience in similar technical courses and a thorough knowledge of the equipment that is being provided under this contract. Proof of the above requirements shall be provided by one or more of the following:
 1. A resume
 2. A certificate or diploma
 3. A curriculum vitae
 4. Documentary evidence of qualifications

1.19 MAINTAINABILITY

- A. All information and tools necessary for the continued maintenance and repair of the power supplies shall be provided.
- B. All information, specialty tools and software necessary for the testing, adjustment and repair of the power supplies shall be provided free of license keys. WMATA shall have rights to copy documentation, maintenance firmware/software as required to maintain the equipment.
 - 1. Software tools, if any, shall be current and supported at time of commissioning.
 - 2. Any software that is PC Based shall operate on currently available and supported OS.
- C. Source information for all components shall be provided:
 - 1. The manufacture and manufacture part number shall be identified for all components.
 - 2. Firmware images shall be provided for all programmable devices.
 - 3. Full specifications shall be provided for all custom components.
- D. The Contractor shall compile a list of recommended spare components (including custom parts) and quantities. The contractor shall provide the spare components under this contract.
- E. Custom parts or firmware/software. WMATA shall have the right to purchase all components directly from the manufacture without using the contractor or subcontractor as an intermediary or being charged an additional service fee/commission.
- F. The Contractor shall provide a list of obsolete parts, if any, at the time of delivery/install and assist with identifying alternatives.
- G. Provide a complete repair history of all failures and corrective actions during the installation and warranty period.
- H. BOM in WMATA specified format suitable for upload into the WMATA Maintenance Management System. This list will be used to preload the power supplies into the WMATA 3MS system. The BOM shall include:
 - 1. Description
 - 2. Manufacture
 - 3. Model Number
 - 4. Serial Number
 - 5. Date of Manufacture
 - 6. Location (install location, e.g., A01, A02, or 400 for spares)
 - 7. Warranty period (start date and length)
 - 8. Hardware and software revisions
 - 9. Other information as requested by WMATA
- I. Warranty

A two (2) year warranty covering parts, labor and workmanship shall be provided commencing from date of install for units installed by Contractor. All shipping costs shall be the responsibility of the Contractor.

- J. The contractor shall be responsible for furnishing the engineering services required to select material and equipment, and translate these specifications into finished AC to DC Power Supplies. The contractor is required to provide any Interface Requirements, Maintenance Manuals, Instruction, and Drawings.

Documents shall be provided in MS Office format and searchable PDF. Drawings shall be provided in AutoCAD and searchable PDF. Hard copies will be provided as required herein. Various other engineering tasks are also listed elsewhere in these Specifications as Contractor responsibilities.

WMATA may use provided material for internal purposes free of copyright restrictions.

- K. The prior approval of technical data in accordance with the provisions of another contract shall in no way obligate the Authority to accept and approve the use of such technical data for this Contract work.
- L. If the test unit has not been provided to WMATA under a previous contract, the Contractor is required to furnish a test unit module, which becomes the property of WMATA upon completion of the maintenance training program and is not to be counted or considered in any spare equipment quantities. This test unit shall be for training purposes only.

1.20 TECHNICAL MANUALS

- A. The Contractor shall produce and furnish Maintenance Manuals. The manuals first draft must be submitted prior to delivery of the equipment as described below.
- B. The Contractor shall submit the following Maintenance Manuals for each type of equipment provided during this Contract. All documents, comments and revisions shall be made via Procore submittals. In those cases where a hard copy is also required, the delivery shall be tracked within Procore.
 - 1. Operation & Maintenance Manual.

For Maintenance of the equipment in the field to the board level.
 - 2. Shop Maintenance Manual.

For maintenance of the equipment in the shop to the component level.
 - 3. Test Platform Manual

For maintenance and operation of Test Platform. Optionally, this information may be included with the Shop Maintenance Manual.
 - 4. Programming Maintenance Manual (if applicable).

If a microprocessor is used then information on running diagnostics, reviewing, troubleshooting and modifying parameters shall be provided. Optionally, this information may be included with the Shop Maintenance Manual.
- C. All Manuals shall be supplied in both printed and electronic versions (Word and searchable PDF).
- D. In the event the quantity of material for each type would make the manual too bulky or inconvenient to use, more than one binder may be used, but closely related subsystems shall be grouped under the same cover.
- E. Manual Outline

The Contractor shall submit for approval, no more than ninety (90) days after receipt of Notice to Proceed, a Preliminary Submittal consisting of an outline of the material to be included in each manual.
- F. First Draft Approval

Following the approval of the manual outline, the Contractor shall submit to the Project Engineer for approval one bound hard copy and an electronic copy of the manual in Word using tracked changes for review and comment of each Maintenance Manual in a first draft form.

 - 1. Usability of Manuals

An electronic courtesy copy of the draft manual shall be provided to the WMATA ATCM, Training and Shop Departments.

Usability of the field manuals shall be demonstrated to the satisfaction of WMATA by review with the end user for each type of manual prior to submitting the final manuals. All references to Shop Manuals shall be reviewed by the repair shop managers prior to acceptance.

The final manuals shall not be reproduced until the end user has signed-off on reviewing the manuals for usability.

G. Approved Maintenance Manuals

1. Operation & Maintenance Manual

When the Contractor has received written approval of the first draft submittal, they shall, within thirty (30) calendar days, furnish an electronic copy of the manual (Word and searchable PDF) and one (1) bound copy of the manual complete with corrections for review. After final approval by WMATA, the Contractor shall furnish the final version of the approved manual in both Word and searchable PDF format suitable for the reprinting of any manual without loss of resolution or quality. The Contractor shall also provide eighty-four (84) copies of the bound manual for use in training and placement in the TCR and FO locations.

2. Shop Maintenance Manual

When the Contractor has received written approval of the first draft submittal, they shall, within thirty (30) days, furnish an electronic copy of the manual (Word and searchable PDF) and one (1) bound copy of the manual complete with corrections for review. After final approval by WMATA, the Contractor shall furnish the final version of the approved manual in both Word and searchable PDF format suitable for the reprinting of any manual without loss of resolution or quality. The Contractor shall also provide twenty (20) copies of the bound manual for use during training and placement in the Shop and Engineering libraries.

H. Manuals approved on a previous Contract may not meet the requirements of this Specification. Such manuals will not automatically be approved. The Contractor may submit, within thirty (30) working days of receipt of notice to proceed, a list of previously approved manuals or sections of manuals which meet the requirements and for which approval is requested under this Contract.

I. Revisions

1. Furnish with each revision submittal a replacement title page for the affected manual or manual section, with the current revision date in place.
2. The revision submittal shall be made in Word format with tracked changes for comment. Upon approval, the Contractor shall furnish sufficient hard copies of effected pages with all pages punched for the impacted manual. In addition and updated electronic copy of the manual shall be provided. The hard copies shall be furnished in an envelope or package marked with the Contract number and the name and all other designations of the manual to be revised. An unbound and un-punched master copy of each revised page shall be submitted by the Contractor for the Authority use in updating its master copy of the manual.
3. Revisions shall be submitted in groups which are not so small as to present a continual nuisance to the Authority and not so large that they overload review and approval personnel or delay getting needed revisions to the field.

J. Manual Construction

1. Personnel Qualifications

The Contractor shall submit to the Authority the names and proof of the qualifications of the personnel selected for preparing the Maintenance Manuals.

- (a) At least one person shall have demonstrated ability in the procedures of preparing manuals and shall be proficient in all of the following:
 - (i) Technical Writing
 - (ii) Graphic Arts
 - (iii) Ability to read, understand and write the English Language clearly and accurately
 - (iv) Educational Training
- (b) At least one person shall have demonstrated ability in comprehensive knowledge of the ATC system supplied by the Contractor under this Contract. Proof of this knowledge shall take the form of the following:
 - (i) Specific information documenting prior experience with the design, installation and/or testing of a similar system.
 - (ii) An engineering degree or equivalent work experience.
 - (iii) Ability to read, understand and write the English Language clearly and accurately.
 - (iv) Previous instruction manual experience.
- (c) Proof of these qualifications may be one or more of the following items, but the submittal shall be adequate to provide that the candidate is qualified.
 - (i) A resume
 - (ii) A certificate or diploma
 - (iii) A curriculum vitae
 - (iv) Documentary evidence of qualifications

2. Binder

Manuals furnished by the Contractor shall be bound in a high quality three-ring (minimum), lever operated, and loose-leaf binder with the following characteristics:

- (a) The ring shall be sized so that all of the material in the book may be accommodated on one half of the ring when the rings are open. When the material occupies less than two thirds of a half ring, a smaller ring size shall be selected. The maximum size of the rings shall be two and one-quarter inches. When more material needs to be bound than will fit in a two and one quarter inch ring binder, two or more binders shall be furnished with the material divided among them in a logical manner. The number of binders in a complete set of a divided manual shall be obvious from the title of each binder. If a three ring binder is used, the rings shall have the standard four and one quarter inch spacing.
- (b) The cover of the binder shall be constructed from rigid, heavy cardboard stock covered with a high quality vinyl which will not become sticky, or adhere to adjacent materials under conditions of heat and humidity. The color of each individual binder shall be uniform but the colors of the various binders may vary, allowing one logical division of the material to have one color and other divisions to have their own uniform colors.

- (c) A legend bearing the title of the manual shall be affixed to the outside of the binder in a manner which will last the life of the binder. The legend shall be located on the spine of the binder. The legend shall contain the title of the manual. Other markings such as the Contractor's name will be acceptable only if they do not interfere with, or detract from, the required legend. Such markings shall be as approved by the Project Engineer.
- (d) Each manual shall be divided into logical sections by the use of labeled tab dividers. Each divider shall bear a legend which identifies the contents of the section and is shown in the Table of Contents. The holes of the dividers shall be reinforced.
- (e) Dividers
Each manual shall be divided into logical sections by the use of labeled tab dividers. Each divider shall bear a legend which identifies the contents of the section and is shown in the Table of Contents. The holes of the dividers shall be reinforced.
- (f) Title Page
Each Maintenance Manual and manual section shall have a title page which explains in detail the content of the manual or manual section, its limits and the system or subsystem of which it is a part. The title page shall also contain the name of the Contractor and the signature and title of the person designated by the Contractor as responsible for the content of the manual. The title page shall bear a numerical designation, such as a volume and part number, by which it may be uniquely identified and keyed to the Master Maintenance Manual List. The title page shall bear the date of the original issue (after approval) as well as the latest revision date, if any.
- (g) Table of Contents
 - (i) Each Manual shall have a Table of Contents located immediately after the title page. This table shall list all articles that are contained within the manual and their page numbers. The articles shall be grouped into sections which correspond to the dividers. The page numbering shall list the numbers of the first and last page of each article.
 - (ii) The text of articles which are long or cover various aspects of a subject, shall be further divided into paragraphs which are identified by headings. These headings shall be included in the Table of Contents with their page numbers.
 - (iii) When the Table of Contents consists of more than one page, its pages shall be numbered consecutively.
 - (iv) The Table of Contents shall account for each and every page in the manual, in a manner which will allow detection of a missing page.

- (h) Composition of Each Section of a Maintenance Manual shall include:
 - (i) The section title as listed in the Table of Contents
 - (ii) An introduction, giving an overall view of the material covered by the section, listing, in general terms, the equipment described.
 - (iii) A General Description of the function of the equipment with an explanation of any interfaces the equipment may have with other equipment, systems or subsystems.
 - (iv) Illustrations supporting discussions of equipment or equipment functions and test descriptions.
 - (v) Incorporation of approved WMATA procedures, instructions and tests in accordance with WMATA standards, as applicable.
 - (vi) Applicable warnings, cautions and symbols, prominently boxed, to bring attention to equipment to be handled or maintained that contains parts, components and circuits which are sensitive to electrostatic discharge or cannot be removed or worked on when energized or any other items relating to system or personnel safety.
 - (vii) The balance of the detailed, explanatory content as required in these Specifications.
- (i) Figures
 - (i) The use of block diagrams, exploded view, illustrated parts breakdown and schematic drawings shall be maximized to facilitate descriptions of assemblies and the relationship of components, sub-systems and systems.
 - (ii) The manual shall utilize figures consisting of graphs, charts, drawings, diagrams and any other illustrative material in black and white that can be reproduced by an office copier. Complicated half-tones, photographs and colored printing may only be included by special request to, and approved by the Project Engineer. The figures shall be located within the section of which they are a part and where possible within or following the paragraph describing them. Figures shall be liberally utilized where they can contribute to the grasp and understanding of the subject. Each figure shall be titled. Figures shall be identified with a designation consisting of the word Figure, the section number, a hyphen and a sequential number starting with one at the beginning of each section.
 - (iii) Large size drawings may be reduced slightly for inclusion as figures in the manuals, but caution shall be exercised because the figure will not be acceptable if the information or printing becomes illegible due to excessive reduction. If large size drawings are included as figures, the drawing number, title block and border shall be removed and a figure number and proper title added. Large drawings, if used as figures, because of their size, shall be grouped together at the back of the book or in one section. These drawings shall be folded so that the page title and page number will be visible without unfolding the page.

(j) Page Size

The manual shall be composed of loose leaf pages of twenty (20) pound paper, which are 8-1/2 inches wide by 11 inches high. To accommodate large drawings such as circuits, fold-out pages of the same weight or heavier paper may be utilized. These fold-out pages shall be uniform size of 11 inches high by 17 inches wide. With the exception of large drawings, pages larger than 11 by 17 inches shall not be utilized and will not be approved.

(k) Page Margins

- (i) Each page shall have an adequate margin at the left side for accommodating the ring holes. This margin shall not be less than one inch.
- (ii) Each page shall have a margin at the remaining three sides of not less than one-half inch.
- (iii) Page number and dates, if any shall be placed just above the bottom margin and within the side margin.

(l) Page Numbering

Manual identification, revision and release date shall be included on each page. The pages of the section shall be identified at the bottom with a designation consisting of the section number, a hyphen, and a consecutive page number starting with one. As an option, the Contractor may precede this designation with a number or letter identifying the manner of which it is a part and a hyphen. This would provide each page with a unique number.

(m) Difficulty of Material

- (i) The Contractor shall assume that a person reading an Operations and Maintenance Manual has had the benefit of no more than a twelfth grade education, plus two years in a technical school. Long and difficult words shall be avoided. Technical words may be used only where common words are inadequate, provided that words not likely to have been encountered with the education mentioned in this paragraph are fully explained. Under no circumstances shall any form of slang, or jargon, applicable to a specific industry, be used unless it is thoroughly defined in common terms. Proper English shall be used throughout the text. All sentences shall be complete. Abbreviated sentences leaving out words such as a "of" and "the" will not be acceptable.
- (ii) The Contractor shall assume that a person reading a Shop Maintainer Maintenance Manual has received education through the twelfth grade, has had the benefit of sufficient additional education to comprehend the technical words common to the particular technology being discussed, is skilled in the use of electronic test equipment and is competent in the repair of electronic equipment. This does not however relieve the Contractor of the responsibility of explaining any technical words or procedures specific to the equipment being described. Slang or jargon shall not be used and will not be approved.

- (iii) The Contractor shall assume that a person reading a Programming Maintenance Manual has received a bachelor's degree or equivalent and is familiar with computer user interfaces. This does not however relieve the Contractor of the responsibility of explaining any technical words or procedures specific to the equipment being described. Slang or jargon shall not be used and will not be approved.
- (n) **Reproduction Quality**
 - (i) The text of manuals shall be cleanly defined and legible. It shall have the quality of line produced by a photo typesetter or laser printer.
 - (ii) The resolution shall be a minimum of 300 dots per inch, and it shall be capable of printing mixed text and graphics. The Contractor shall submit to the designated Project Manager, no more than thirty (30) working days after receiving NTP, a sample of the final output for approval of the type form and legibility.
- (o) The Contractor shall check the DC Power Supply Manuals for both form and content before submittal. Points to be checked shall include, but not be limited to the following:
 - (i) Conformance to the Specification
 - (ii) Logical grouping and arrangement of subject matter
 - (iii) Accuracy
 - (iv) Legibility
 - (v) Neatness
 - (vi) Line and lettering quality of figures
 - (vii) Reproduction quality
 - (viii) Recognition and inclusion of interfaces with other subsystems
 - (ix) Binder material, labeling and adequacy of ring size
- (p) **Operation & Maintenance Manual**
 The purpose of the Operation and Maintenance Manual is to describe in detail all of the operating and set up characteristics and to instruct the signal system maintainer in the field maintenance of each piece of equipment to be furnished under this Contract in order to allow restoration of operation in the shortest possible time. The manual shall detail procedures for isolating trouble to the "smallest field replaceable device" and contain complete technical descriptions of the operation of each and every item of equipment.

These manual sections shall include where applicable, but not be limited to, the following:

- (i) Basic description
- (ii) Theory of operation
- (iii) Operating instructions
- (iv) Block diagrams of the system
- (v) Relation to other equipment with which the system interfaces
- (vi) Equipment arrangement drawings
- (vii) Module arrangement drawings
- (viii) Connection wiring diagrams

- (ix) Test procedure descriptions
- (x) Preventive and Corrective Maintenance procedures
- (xi) Field Adjustment procedures
- (xii) Methods and description of repair
- (xiii) Troubleshooting guide
- (xiv) Removal and replacement procedures
- (xv) List of recommended troubleshooting test equipment
- (xvi) List of spare parts to the board, module level with recommended quantities.
- (xvii) List of special tools
- (xviii) Quick reference section
- (xix) The inclusion of superfluous information shall be avoided

(q) Shop Maintenance Manual

The Contractor shall furnish Shop Maintainers Manuals for each piece of equipment. The Shop Maintainer's Manual shall provide all information necessary for complete trouble isolation and repair to the component level. All circuitry shall be thoroughly described with complete engineering level schematics.

Shop manuals shall contain, but not be limited to, the following:

- (i) Theory of operation
- (ii) Technical drawings and schematics with full technical detail:
 - 1. Block Diagram
 - 2. Board Layout
 - 1. Full scale layouts documenting each printed circuit board and all components front and back identified by reference number.
 - 2. Printed circuit board full scale art work including reproducible layouts for each level of multilayer boards.
 - 3. Schematics (engineering level, complete)
 - 1. Component Identification, i.e., R1, C1, Q1, U1, . . .
 - 2. Component Value, i.e., 2.2K, 1N34, 2N3904, . . .
 - 3. Component Rating, i.e., ¼ W, . . .
 - 4. Connector & Wire Identification
 - 5. Voltage Levels & Waveforms
 - 6. Signal Names
 - 7. Control and signal lines shall be labeled and their active state indicated.
 - 8. Interconnections between schematic pages and connections between boards (and components) shall be identified
 - 9. Identification of all test points
- (iii) Maintenance Procedures
- (iv) Methods and Description of Repair
- (v) Adjustment and Calibration Procedures
- (vi) Waveform analysis (if applicable)
- (vii) Complete BOM including value, manufacture, and manufacture part number
- (viii) List of recommended troubleshooting test equipment
- (ix) Datasheets for all active components shall be provided

(r) Programming Manual

If a microprocessor is integrated into the power supplies, the Programmers Manual shall provide all information necessary for reviewing, troubleshooting and modifying the parameters or set points.

The manual shall contain, but not be limited to, the following:

- (i) A brief operational description.
- (ii) Sample logic equations with equivalent circuits.
- (iii) Methods used to access troubleshoot and modify software set points, e.g. meter settings, delays, current limits or trip points, etcetera.
- (iv) The inclusion of superfluous information shall be avoided.