RFI 18-114/CY

WASHINGTON
METROPOLITAN
AREA TRANSIT
AUTHORITY
(WMATA)

REQUEST FOR INFORMATION (RFI)

AF800 TRACK CIRCUIT REPLACEMENT

APRIL 24, 2018

Contents

1.0 Introduction

The Washington Metropolitan Area Transit Authority (WMATA) submits this Request for Information (RFI) from those qualified entities (Contractor/Respondent) interested in engineering design and build-out or purchase to specifications of an AF800 Track Circuit Replacement. Interested entities must demonstrate the ability to manufacture the above mentioned Track Circuit as described in the provided performance specification.

The purpose of this RFI is to solicit information that will enable WMATA to determine industry participation in response to the release of a future Invitation for Bid (IFB).

This is a Request for Information only and your response is not an offer. This Request for Information does not commit WMATA to any incurred costs in preparation of any submission to this notice, or to contract for services and it is issued for WMATA Market Research purposes only

2.0 Background Information

The Washington Metropolitan Area Transit Authority (WMATA) plans to replace existing AF800 track circuits. The existing AF800 locations on the rail system have exceeded reasonable expectation of maintainability. The equipment is challenging to maintain, this sometimes causes repairs to exceed budget projections. Included in the Specifications are the minimum requirements for the Contractor to design, furnish, install, test and place in service a complete fully operational state-of-the-art Automatic Train Protection (ATP) Track Circuit Systems within Train Control Rooms (TCRs) at 13 AF800 locations and the requirements for a design proposal for the installation of the new ATP modules and associated equipment in a TCR at a representative Location.

This new system has requirements that would require the use of processors to be in compliance with the specifications. Therefore it is recommended that the new ATP system be a system that utilizes processor controlled speed commands. The new ATP Track Circuit System shall provide transmission of ATP train detection, cab and train to wayside communications (TWC) signals and reception of ATP train detection, Door Commands and TWC signals and shall include, but not be limited to, new ATP Track Circuit Modules, impedance bonds, two (2) foot mini-loops, four (4) foot loops, single turn speed command loops and bridging receivers and all interlocking bonding.

This Work shall also include, but not be limited to all required mounting hardware and accessories, bond to rail connections, bond to bus connections, bond to traction power return mole connections, bus bar to rail connections, local cable between the impedance bond or loop and the associated junction box and all internal wiring. If the type of ATP modules provided by the contractor are not processor controlled the vital speed command logic wiring or plug couplers that is wired to the ATP modules shall not be modified for installation of the new ATP modules. ATP modules shall come equipped with the identical plug couplers as now installed if processor controlled ATP modules are not provided.

2.1 Scope Overview

This is a Request for Information (RFI) wherein WMATA is requesting review and feedback from the industry on the feasibility of the developed performance specification. The specification aims to stipulate and AF800 Track Circuit Replacement that take into consideration the environment in which it will exist, aligning with industry standards concerning warranty, guarantee, and maintenance. We encourage this conversation to reflect innovation, opportunities for improvement, and insight into industry capabilities and willingness to provide WMATA with the design intent.

2.2 Submission of Information

2.2.1 Qualified Contractors / Respondents are required to review the above Scope Overview and submit the following information:

1. The name of your organization with telephone/fax numbers, and name, email address, and mailing address of primary point of contact.

2. Demonstrate the ability to product/manufacture Train Control Power Supply Systems conforming to the above mentioned specifications.

3. Clearly demonstrate that Contractor / Respondent have successfully provided similar goods for other customers within the last four (4) years.

4. Qualified Contractors / Respondents must provide three (3) references for past performance; WMATA will verify contractor past performance by contacting the provided references. Please provide, name, title, address, telephone number and Email address for reference point of contact.

2.2.2 This Request for Information (RFI) is issued for informational and planning purposes only. It is not to be construed as a commitment by WMATA to issue a solicitation or ultimately award a contract. Responses will not be considered as proposals nor will any award be made because of this RFI. WMATA will NOT be responsible for any costs incurred by interested parties in responding to this Request for Information.

3.0 WMATAs Point of Contact

WMATAs sole point of contact (POC) for matters related to the RFI shall be Carolina Young, Contract Administrator. WMATAs POC is the only individual authorized to discuss this RFI with any interested parties. All communications with WMATAs POC about this RFI shall be in writing.

Name: Carolina Young, Contract Administrator

Address: Washington Metropolitan Area Transit Authority
8100 Professional Place Suite 206
Hyattsville MD, 20785

Phone: (301) 955-2033

Email: cyoung2@wmata.com

WMATA disclaims the accuracy of information derived from any source other than WMATAs POC, and the use of any such information is at the sole risk of the Respondent.

All written communications to WMATA from Respondent shall specifically reference this RFI, No.: RFI 18-114/CY.

4.0 Submission of Information

Responses shall be no more than five (5) pages in addition to the standard informational or promotional literature of the submitting entity. The submission shall be clearly marked as RFI 18-114/CY.
Vendors shall provide written responses to the attached questions as part of their submission.

Submissions shall be made electronically, via Email to

Carolina Young, Contract Administrator
cyoung2@wmata.com

Submissions shall be emailed by **3 PM EST, May 23rd, 2018.**

Neither fax nor regular mail/courier submissions will be accepted. Respondents are responsible for effecting delivery by the deadline above. WMATA accepts no responsibility for misdirected or lost responses.

An Open Forum will be held by WMATA on 10:00 AM EST, June 5th, 2018 at

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
600 5th Street, N.W.
Washington, DC 20001

Potential Offerors are encouraged to participate in this event. Only two (2) representatives per vendor will be accommodated. Please RSVP via email to Ms. Carolina Young at cyoung2@wmata.com by 3 PM EST, May 30th, 2018. Please include the potential offeror name, and the attendees' name, title and contact information.

5.0 RFI Documents and Addenda

The RFI Documents and Addenda, if any, will be posted on the WMATA website:

http://www.wmata.com/business/procurement_and_contracting/solicitations/

6.0 Rights and Obligations of WMATA

6.1 Reservation of Rights

WMATA reserves to itself all rights (which rights shall be exercisable by WMATA in its sole discretion) available to it under applicable law, including without limitation, the following, with or without cause and with or without notice:

6.1.1 The right to cancel, withdraws postpone or extend the RFI in whole or in part at any time, without incurring any obligations or liabilities;

6.1.2 The right to issue a new RFI;

6.1.3 The right to reject any submittals and responses received at any time;

6.1.4 The right to modify all dates set or projected in this RFI;

6.1.5 The right to terminate evaluations of responses received at any time;

6.1.6 The right to suspend and terminate this RFI, at any time;

6.1.7 The right to waive or permit corrections to data submitted with any response to this RFI;

6.1.8 The right to issue addenda, supplements, and modifications to this RFI;

6.1.9 The right to permit submittal of addenda and supplements to data previously provided with any response to this RFI;

6.1.10 The right to hold meetings and conduct discussions and correspondence with one or more of the Respondents responding to this RFI to seek an improved understanding of the responses to the RFI.

AF800 RFI SCOPE OF WORK

1.01 GENERAL

A. Included in these Specifications are the minimum requirements for the Contractor to design, furnish, install, test and place in service a complete fully operational state-of-the-art Automatic Train Protection (ATP) Track Circuit Systems within Train Control Rooms (TCRs) at locations identified below and the requirements for a design proposal for the installation of the new ATP modules and associated equipment in a TCR at a representative Location. This new system has requirements that would require the use of processors to be in compliance with the specification. Therefore it is recommended that the new ATP system be a system that utilizes processor controlled speed commands. The new ATP Track Circuit System shall provide transmission of ATP train detection, cab and train to wayside communications (TWC) signals and reception of ATP train detection, Door Commands and TWC signals and shall include, but not be limited to, new ATP Track Circuit Modules, impedance bonds, two (2) foot mini-loops, four (4) foot loops, single turn speed command loops and bridging receivers and all interlocking bonding. This Work shall also include, but not be limited to all required mounting hardware and accessories, bond to rail connections, bond to bus connections, bond to traction power return mole connections, bus bar to rail connections, local cable between the impedance bond or loop and the associated junction box and all internal wiring. If the type of ATP modules provided by the contractor are not processor controlled the vital speed command logic wiring or plug couplers that is wired to the ATP modules shall not be modified for installation of the new ATP modules. ATP modules shall come equipped with the identical plug couplers as now installed if processor controlled ATP modules are not provided. As part of this scope for this contract the contractor shall obtain a copy of WMATA's bobbing track circuit report and determine if any track circuits within the contract limits are bobbing. The contractor shall investigate these bobbing track circuits and determine what is causing the bobbing. The contractor shall take all required steps to eliminate the bobbing after the contractor replaces the track circuits. The track circuit shall be designed to be able to handle 700 amps of imbalance. Overall track circuit system design shall together with the impedance bond and the ATP module be able to handle 700 amps of imbalance.

1. The equipment to be replaced under this contract is within the limits of the following Locations:

    a) B Line: B09 (Forest Glenn) through B11 (Glenmont)

    b) E Line: E06 (Fort Totten)through E10 Greenbelt)

    c) J Line: J01 (Quaker Lane) through J03 (Franconia Springfield)

B. In addition to this work at the aforementioned locations, the Authority may choose to expand the scope of work by requesting the Contractor to redraw each sheet in the entire book of plans for each Location modified under this project. Payment, if any, for this option will be on a negotiated time and material basis.

C. The Contractor shall provide all engineering, equipment and material as required for temporary or interim phases of installation and cutover, including, but not limited to relay racks, track circuits, impedance bonds, loops and cable and wire. Upon the completion of any temporary, interim or final work, the ATP System in-service testing by the Contractor shall prove to the satisfaction of the Engineer that each system, subsystem and component is functioning in a fail-safe manner and is fully operational in accordance with the approved design upon the completion of the installation.

D. The Contractor shall develop and submit to the Engineer for approval a complete installation staging/phasing plan for installing, pre-testing, and safety certification and cutover of new TCR and wayside track circuit equipment, including all temporary, interim or final track circuit configurations. The Contractor's plan, which shall be approved prior to the performance of any work, shall address keeping existing and newly cutover track circuits fully operational during the performance of all work. Testing and Safety Certification of all work shall be required prior to returning to revenue operational service. Track access for the cutover of new track circuits shall be in accordance with the requirements of Specification Section 1.07, C.

E. The Contractor shall submit to the Engineer for approval a detailed Safety Analysis and Failure mode, effects and criticality analysis (FMECA) of the ATC system at each Location, including all track circuits in all proposed temporary, interim and/or permanent configurations. This includes interfacing (if applicable) with all existing signaling equipment, all TCR and wayside components and appurtenances and certify that it is of "Fail Safe" design and functionality.

F. The Contractor shall provide added detail in describing the performance ability of their impedance bonds. Full technical specifications manuals as related to tuning characteristics, field and shops procedures and pass/fail criterion should be authored. Impedance bond testing documentation shall show that the bond shall be capable of a minimum of 700 amps of imbalance from J bar to J bar before the bond shows any loss of signal amplitude from either track detection signals or cab signals.

G. The audio frequency track circuits use eight frequencies (two sets of four) for train detection purposes. The frequencies used are:

Set 1 (for TK 1 & TK 3)	Set 2 (for TK 2)
F1 - 2100 Hz	F2 - 2320 Hz
F3 - 2580 Hz	F4 - 2820 Hz
F5 - 3100 Hz	F6 - 3370 Hz
F7 - 3660 Hz	F8 - 3900 Hz

Only one set of the above frequencies is used on a given track.

H. Speed command transmission is via one of two audio frequency carriers, 4550 Hz and 5525 Hz, ON/OFF AM modulated at one of five discrete frequency code rates. One additional code rate is used for the transmission of door opening commands. The command code chart is as follows:

Audio Frequency Carrier Modulation

No.	Frequency	Code Rate F9 4550	Code Rate F10 5525	No Carrier
1	3.0 Hz	Open Doors Left (when stopped)	Open Doors Right (when stopped)	0 MPH
2	4.5 Hz	15 MPH	45 MPH	0 MPH
3	6.83Hz	22 MPH	50 MPH	0 MPH
4	10.1 Hz	28 MPH	55 MPH	0 MPH
5	15.3 Hz	35 MPH	65 MPH	0 MPH
6	21.5 Hz	40 MPH	75 MPH	0 MPH

1.02 HAZARD MODE AND EFFECT ANALYSIS

A. System Safety Program:

1. The Contractor shall develop and submit to the Engineer for approval a System Safety Program which has been developed in accordance with WMATA ATC Standard Specifications 16919 (ATC SYSTEM SAFETY PROGRAM) for the Track Circuit system to be delivered as per this specification.

2. The System Safety Program shall describe how the contractor plans to carry out the system safety tasks and demonstrate the system is safe in accordance with Specification 16919 and the requirements of this specification. The contractor is responsible to identify any design changes to system, subsystems, interface logic, or software that may result in new hazards to equipment and personnel – these should be identified in the applicable Safety Analysis, FMECA or hazard mode and effect analysis (HMEA).

B. Hazard Mode and Effect Analysis:

1. The contractor shall provide a Hazard Mode and Effect Analysis, which, as a minimum, identifies one example of each hazard that may be produced by each possible failure in their equipment and software. The analysis shall be performed by a third party and shall describe the preventive measures taken to reduce the risk to an acceptable level. The analysis shall describe and apply to each hazard's level of occurrence (probability) and result (i.e., delay through catastrophic) both before mitigation and after.

2. Each AF Track Circuit module, impedance bond, mini loop, four (4) foot loop and bridging receiver provided under this Contract shall be factory tested in accordance with a factory test procedure provided by the Contractor and approved by the Engineer. The factory test shall be a subset of the Type Acceptance Test and the applicable sections of the PISC tests, providing proof, through the testing of key operational factors, that each AF Track Circuit Module is operating as well as the Type Accepted unit and meets the requirements of these Specifications. One hundred percent of the above mentioned products shall be so tested.

1.03 OPERATIONS AND MAINTENANCE TRAINING

A. Field Maintenance

The Contractor shall provide a recommended program of Operation/Maintenance Training for WMATA field maintenance personnel on the ATP Track Circuit equipment being installed under this Contract. The training is to be presented to a core group of WMATA training and maintenance personnel, prior to the first ATP Track Circuit change out, during 3- 8-hour shifts(day and night shifts), and then repeated 3 times, for approximately 120 personnel. Each training session shall include at least the following:

1. Course topics:

    a. Theory of operation

    b. Equipment locations

    c. Software descriptions and residence (where applicable)

    d. Preventative maintenance instructions (PMI)

    e. Troubleshooting and fault isolation to the board level

    f. Contractor’s set-up procedure used in this contract

    g. Use of any required test or diagnostic equipment

1.04 ATP TRACK MODULES

A. Code Rate Generation

1. The code generators shall be able to generate code rates currently used on the WMATA system with a tolerance factor of plus/minus 2% and shall be selectable by the existing code rate selection circuitry. Existing code rate selection circuitry requirement will not apply if the contractor provides a new system that provides for processor controlled speed commands.

2. Code rates shall be selectable from the existing external relay logic. The code rate selection circuit provides a closed circuit from the module's "code rate select" input to one of the module's code rate generator outputs, or to "N28G", a ground applied during an Intrusion, Detection and Warning (IDW) zone alarm. The selection of code rates from existing relay logic will not apply if the contractor provides a new system that provides for processor controlled speed commands.

3. Modules shall be equipped with a means to disable unused code rates where required. The term module, in this application shall include the chassis and motherboard, excluding any readily removable boards. This will not apply if the contractor provides a new system that provides for processor controlled speed commands.

4. Code rate generators or processor shall generate the following code rates presently used on WMATA, as listed below:

5. Code rate frequencies shall not vary in frequency when the power supply voltage varies.

6. ATP module speed commands maybe controlled by a processor.

CODE RATE FREQUENCIES

CODE RATE NUMBER	FREQUENCY (Hz)	SPEED RATES (MPH)	
		F9 4550 (Hz)	F10 5525 (Hz)
1	3.0	-	-
2	4.5	15	45
3	6.83	22	50
4	10.1	28	55
5	15.3	35	65
6	21.5	40	75

7. The ATP Track Module shall include a Temporary Speed Restriction (TSR) rotary switch device located on front of the module cabinet, which will permit imposing RESTRICTED speed limits on the immediate track circuit and shall conform to each specific location. The restrictions "Nor", "Slow", "Med" and "Stop" shall conform to each specific location and its speed command logic. The selection of TSR commands shall be made from a separate panel should a speed control processor be used. The present state shall be identified and be apparent by visual inspection from any distance up to four feet and in any direction (up/down/side) at any angle up to 60% from perpendicular to the front plane of the module in operation. The ATP module shall have the ability for TSR commands to be controlled from ROCC (Rail Operations Control Center) via the WMATA Ethernet. If the AIM computer software is not ready to send the TSR speeds the contractor will test the function of the TSR commands up to the ATP module, but will not be required to perform end to end testing from ROCC.

8. ATP modules shall have fault detection capabilities in detecting when the track circuit transmit and receive signals are showing abnormalities and be able to alarm the maintainer that there is a fault with the track circuit.

B. Transmission Modulation

1. Both the track detection carrier frequency and cab-signal transmission carrier frequency shall be alternately modulated at the selected code rate. The modulator shall be designed to be immune to noise of any kind and all external codes transmitted by other sources or electromagnetic interference as induced into the system.

2. Modulation circuitry for each track circuit within each ATP module must be discrete for the track detection carrier and for each cab signal carrier. The cab signal carrier shall only be modulated via the code rate selected by the speed command external relay logic or speed command processor.

3. A means shall be provided for the modulator, to allow the track module to be selected for the following modes, without the use of an extender board:

    a. Normal code
    b. Steady track carrier on
    c. Steady track carrier off
    d. Steady 4550 Hz Cab signal on
    e. Steady 5525 Hz Cab signal on

4. Test points are required for measuring track detection and F9/F10 signals shall be accessible from the front of the module.

C. Track Detection must provide detection of occupancy, broken rail, open bond connections, defective impedance bonds and defective rail joints.

D. Power Amplifier

1. The power amplifier shall have a stable design and all adjustments shall not cause-unsafe conditions. Power adjustments shall be accomplished in a fail-safe manner. The power amplifier output devices shall be mounted on heat sinks, in open air on the rear of the module that will maintain the temperature of the output devices at least 40% below the device maximum temperature rating.

2. Output level of the transmitter shall not be required to be adjusted above 85% of the units maximum output level to provide adequate rail current to energize the track relay. Tests shall be performed with a 0.06 ohm shunt placed across the gauge of rail 10 feet inside the entering end (receiver) of the track circuit, the mid-point in the circuit and 10 feet inside the leaving end (transmitter) of the track circuit to verify the track relay de-energizes.

3. The output of the power amplifier shall be constantly monitored to check for abnormalities in the power amplifier level and signal quality.

4. The power amplifier shall be capable of providing sufficient signal to power a minimum of two (2) 2000-foot track circuits. In lieu of meeting this requirement and for the convenience of the Contractor, the Contractor may subject to Engineer for approval circuit modifications to the existing system to divide a specific track circuit into two (2) discrete circuits, providing the modification is done without changing the control line. The contractor shall be solely responsible for all associated design, furnish and installation work.

5. ATP track circuit module shall have 10 power levels evenly spaced throughout the 5% to 100% output range, independently set for each carrier frequency. These settings may be set by PC board or module mounted components, or by module design utilizing the existing jumper configurations of the “PCZ2" coupler or a combination thereof.

6. The above power level settings shall not have any effect on the TWC signals also amplified and transmitted via the module.

7. The signal strength of the ATP transmitter shall be capable of driving the cab signal level of the longest bond-to-bond and mini loop track circuits with a minimum of 200 milliamps and a maximum of 400 milliamps in the longest track within the WMATA system measured at the rail location most attenuated (signal strength measured with the approved WMATA Cab Level Adjustment Test Fixture and a hard shunt five feet beyond). The required cab level output for each track circuit shall be attainable at no more than 85% of the maximum level of the transmitter.

8. Separate adjustments shall be provided for the power levels for each track and each train carrier frequency. Once adjusted by the approved procedures, the output shall not drift to cause unsafe conditions.

9. The amplifier design must be fail-safe to a maximum adjusted gain setting, which shall not increase by a single component failure in the circuitry.

10. Impedance matching networks and output transformers shall meet latest AREMA standards.

11. Power amplifier circuitry shall be free of any sort of parasitic oscillation or unwanted oscillation.

E. Receiver

12. The equipment receiving the train detection signal from the track coupling device shall produce a voltage of the required polarity to drive a biased neutral relay (two independent 1050 ohm coils separately wired to the module) only when the received signal is within the specified range of normal frequency, amplitude and input signal coding is detected. The requirement for driving two 1050 ohm coils will not apply if the contractor provides a processor controlled ATP module.

1. The equipment shall be constructed and installed in a manner to provide immunity from crosstalk between each receiver and its transmitter.

2. The frequency ranges at 3db down shall be as listed in the table below:

TRAIN DETECTION CARRIER FREQUENCIES

CARRIER NUMBER	FREQUENCY (Hz)
F1	2100 +/- 0.5%
F2	2320 +/- 0.5%
F3	2580 +/- 0.5%
F4	2820 +/- 0.5%
F5	3100 +/- 0.5%
F6	3370 +/- 0.5%
F7	3660 +/- 0.5%
F8	3900 +/- 0.5%

Note - Odd Carrier Number Frequencies are used on Track-1 and Even Carrier Number Frequencies are used on Track-2.

3. The frequency tolerances in the preceding paragraph necessitate a filter with a narrow bandwidth. The Contractor shall design the filter to minimize ringing (fill-in) between track frequency pulses. The Contractor shall also design the receiver detection circuitry to minimize the detrimental effect of the residual amount of ringing that remains. The signal-to-noise ratio shall be greater than ten-to-one. Track carrier frequencies shall not vary from changes in power supply voltage.

4. Receiver Filter

   The following characteristics shall apply:

   a. Receiver filter shall be a fail-safe band pass filter tuned for the train detection carrier frequencies of the track circuit that applies. Filter design shall consider the safety nature of this device and incorporate techniques to assure proper operation in an electrified rapid transit environment. The filter must be able to withstand 1000 volts from its input to output terminals. The input and output connections must be dc isolated and the case can't be part of the terminal connection. The filter design must be such that it can operate within the voltage and the tuned frequency range of 0.5 VRMS to 5 VRMS at its input.

   b. Shorting or opening of any element or component within the filter shall disable the filter to pass any frequencies.

   c. A single failure of a component opening or shorting shall be self-detecting and, where not self-detecting, shall not cause, either alone or in combination with other failures, the filter to pass any frequencies outside of its pass band.

   d. Filter design shall be such that the input impedance must rise to a level of at least ten times the nominal input impedance for all out of band signals.

   e. 0 dB attenuation at center frequency.

   f. Maximum attenuation shall not be greater than -3dB at (±) 0.5% off the carrier frequency.

   g. Must reject all side-band frequencies that are more than 2.5 percent off the center frequency with a minimum attenuation of -20dB up to 3 percent off center frequency and -6dB on all other frequencies.

   h. Receiver filter shall be a self-contained unit with no external adjustable elements.

   i. Receiver section shall have an amplifier section, which shall be gain adjustable. The gain shall be set no more than 75%, such that the receiver sensitivity may be varied to enable the setting of track circuit pre-shunt distance. Components in the receiver section shall be designed such that a single component failure shall cause the track relay to de-energize.

j. The receiver shall be designed to pass only code rates generated by the code generator of each paired module for that track circuit. Any code rate that is not of the same frequency as shown in the code rate generator frequency chart in section 2.1.A.5 shall be rejected. The transmitter and receiver code rates shall be synchronized to ensure that only coder rates from the paired transmitter will be accepted by the associated receiver.

5. Relay Driver

A. Relay driver shall energize the track relay when the proper coded carrier is being received. The relay driver must not permit the track relay to pick up, until there are at a minimum of Three (3) complete code periods and a maximum of ½ second of valid coding, detected. The relay driver output shall be isolated energy, which shall not allow the track relay to be energized with a single wire jumper. The relay driver shall not permit the relay to pick up due to internal oscillations of any electronic circuit or if a steady signal of the correct track frequency that is not coded is detected. Any failure that interrupts the normal sequence of the relay driver must immediately de-energize the relay. The design must be fail-safe and no failures shall cause the output to exceed the adjusted value. Relay driver will not be required if a processor controlled ATP module is provided.

B. The relay driver may alternately energize the two relay coils at the code rate with a nominal 50% duty cycle, but no less than 35%, using between 11.6 ma and 13.4ma DC, or the relay driver may utilize both coils simultaneously each with steady current between 5.8ma and 6.7ma DC.

F. Test Points

1. Test points shall be provided to monitor voltages and wave forms throughout the unit as well as points to inject test signals to the track module, which are required for troubleshooting and preventive maintenance. Test points shall be located on the front of the module, when in its normal operating configuration.
2. Test points required for maintenance to adjust power level or shunt sensitivity and to detect defective printed circuit boards or equipment modules shall be accessible from the front of the modules, without disconnecting wires, plug couplers or removal of printed circuit boards.

G. Each module shall have a transparent front dust cover (min. 1/4 inch thick) with labels clearly showing the associated track and loop nomenclature, which will permit easy viewing of the PC Boards name tags and diagnostic LED's. This dust cover shall be made of a shatter-proof material which will not support combustion or emit poisonous or corrosive gases, even when exposed to flame or extreme heat. The cover shall provide easy removal from the module. Fasteners for the front dust cover shall be of the rugged, metal, half-turn, twist-lock design. Light duty fasteners such as a plastic plunger and grommet design shall not be used. The Engineer shall approve all fasteners.

H. Identification Nomenclature

1. The transmitter section of the ATP Module shall be labeled to identify its track carrier's track circuit name(s).

2. When a module transmits to a 4' loop or crossover speed command hose loop, the nomenclature(s) of the loop(s) shall also be made part of the track circuit name on the label, each name separated by a slash (/).

3. When a module transmits reverse traffic, cab-only, to an impedance bond transmitter, the transmitter's label shall include the name of the track circuit receiver that shares the bond, followed by the letter "R".

4. The receiver section shall be labeled to identify its track circuit name.

5. Each module or printed circuit board slot, switch, test jack, LED, plug coupler, etc. shall be labeled with its identity.

6. Proper tags shall be as described in section 2.03.

B. Modules

1. All modules shall interface with the existing room 28-way plug coupler cables, without modification to the room equipment. No modification to the existing plug coupler wiring shall be permitted. This is not a requirement if the contractor decides to provide processor controlled speed commands.

2. All modules shall receive power from the existing 28 Volt DC power supplies unless the contractor provides processor controlled speed command ATP modules with their own individual power supplies.

1.05 PLUG CONNECTORS

A. Plug connectors shall be AMP PN 205690-2 or approved connector by ATC engineering

1. Each plug connector assembly shall consist of the following:

a. A two-part molded plastic connector block, equipped to hold an appropriate number (28) of solder-less, pin-and-socket contacts.

b. Devices for the mechanical locking and keying of the connector block halves.

c. Protective shells.

d. A strain relief device for the external wiring portion of the connector assembly.

e. Solder-less, pin-and-socket contacts.

f. Where required, embedded wire wrap terminals for the wiring portion of the connector block.

B. The pin-and-socket contacts shall be fabricated from commercial bronze or brass and plated with gold over nickel underplots. The retention springs of the pin-and-socket contacts shall be fabricated from stainless steel.

C. The contacts shall be fabricated and classified in the required selection of sizes to accept wire sizes 16 through 22 AWG.

D. Contact current rating and termination resistance shall meet the requirements of the following table with properly sized contacts applied to the wire sizes specified.

WIRE SIZE	16	18	20	22
Minimum Current Rating (Amperes)	13.0	10.0	7.5	5.0
Maximum Termination Resistance (Milliohms) At Rated Current	1.7	2.0	2.7	4.0

E. Contact termination resistance shall be measured in accordance with Method 307 of MIL-STD-202 at the rated current specified for each wire size.

F. Existing pin assignments shall be as shown in the existing Location Drawings.

1.06 IMPEDANCE BONDS

A. Each impedance bond shall consist basically of a center-tapped, single turn track coil (composed of two heavy copper "J" bars) around which the applicable coils for train detection, speed command, and TWC signals are wound. The signal coils and signal coupling devices for external cable connections shall be contained in an epoxy-encapsulated assembly on the track coil. The "J" bars of the impedance bond shall be bonded to the body of the impedance bond. This bonding shall prevent rotation of the "J" bars, and shall prevent moisture and dirt from penetrating between the "J" bars and the body of the bond. The exposed portions of the two "J" bars forming the single-turn copper coil shall be thoroughly cleaned, treated and coated at the factory to prevent corrosion. The corrosion preventive coating shall be as approved by the Engineer.

B. The impedance bonds shall be sized such that they can be either mounted between the running rails or next to the running rails if there is room. The impedance bond shall be able to be installed on all types of road-bed construction included under this Contract without any part of the impedance bond extending above the top of rail. If required it shall be allowed to place the impedance bond next to the running rails with permission from the project engineer.

C. The impedance bonds weight shall be approved by the ATC engineer. High current bonds are exempt from this weight limitation.

D. Track coil terminal lugs shall be provided to connect the required number of rail connection cables to the ends of the track coil, and center tap terminal lugs shall be provided to connect the required number 1000 KCMIL cables from the center-tap for negative propulsion return feeders and cross-bonding. The Contractor shall provide all material including the protective lugs for connection to Mac-moles, at substation return locations.

E. The track coil shall be rated for 2500 amperes from each rail to center tap continuously. High current impedance bonds installed at substations shall be rated for 4000 amperes per rail.

F. High current Impedance bonds at SSR locations, entrance to interlocking’s and cross bonds shall be designed as a track circuit system along with the ATP module and the track circuit shall function properly with an imbalance of 700 amps between the two running rails.

G. Regular impedance bonds shall be designed as a track circuit system along with the ATP module and the track circuit shall function properly with an imbalance of 700 amps between the two running rails.

H. The DC resistance of the track coil of the bond shall not exceed 0.000025 ohms.

I. Impedance bonds shall be furnished in either in accordance with the requirements of Standard Specification Section 16962, Impedance Bond Layouts or this specification.

J. The impedance bonds shall operate in conformance with all specified requirements when subjected to the extremes of environmental conditions described in Section 16914, Environmental Requirements.

K. Receive/receive bonds in interlocking's shall not be tuned and shall have capacitors installed between one J bar of the bond to the running rail to block traction power return current from going through the impedance bond. The capacitor units shall be ALSTOM part number 47630-076-03 or approved equal.

L. Impedance bonds in bond to bond circuits in where imbalance between the running rails exceeds 360 amps shall have capacitors installed between one J bar and the running rail to block traction power return current from going through the impedance bond. The capacitor unit shall be ALSTOM part number 47630-076-03 or approved equal. The contractor shall be responsible to perform the fail-safe testing of each set of frequencies for each impedance bond for each bond the bond track circuit to ensure the vitality of the track circuit with the ALSTOM capacitor circuit.

M. Connections from the J bar of the impedance bond for none high current bonds shall be made with two (2) five hundred (500) MCM cabled to the running rail.

1.07 BOND ANCILLARY DEVICE

A. The size, weight, and environmental requirements for any trackside impedance bond ancillary device shall be submitted to the ATC engineer for approval. All components of such a device shall be appropriate for dependable operation of the unit in the applicable environment.

1.08 BOND CONNECTION CABLES

A. All cables connecting impedance-bond end taps to the rails at a given bond location shall be the same length.

B. The type and size of cable used for track and center-tap connections shall be as specified in the TA-2 External Cable.

C. The number of cables used for track and center-tap connections shall be as specified herein and as indicated on the Contract Drawings.

1.09 BOND CONNECTING HARDWARE

A. Rail connections and other hardware required to make track and center tap connections shall be as shown on the Contract Drawings.

B. Terminals for control cable connection to the impedance bond and any ancillary device required shall be of the pressure-clamp or locking plug connector type, and shall readily accept the appropriate cable specified.

C. Any exposed fastening hardware such as cover bolts and name tag screws shall be stainless steel, brass or monel.

D. Track circuit bonding and negative return bonding connections within interlockings and on the mainline shall be furnished, installed and tested in accordance with the requirements of Standard Specification Section 16968. All track circuit bonding rail connections around non-insulated rail joints shall be with either Cembre Rail Fasteners or Clamps or approved equal.

E. Negative return bonding of special track work within interlockings shall be furnished and installed in accordance with the requirements of Standard Specification Section 16968.

1.10 MULTIPLE-TURN INDUCTIVE TRACK LOOPS

A. The four (4) loop shall be a multiple-turn inductive track loop shall consisting of a length of 30-turn conductor size 19 AWG cable encased in a one piece fiberglass reinforced, filament wound channel, which shall be filled with an epoxy resin upon completion of wiring. Channel shall be 1 5/8 inches and have a minimum wall thickness of 0.155 inches. All channels shall meet or exceed the requirements of these specifications.

B. The channel shall be arranged in a rectangular configuration as shown on the Contract Drawings. This cable shall meet the requirements of internal multi-conductor cable as specified in TA-1 (Internal Wire and Cable).

C. The two leads for the multi-turn loop thus formed shall be connected to a weather proof connector. The mating half will accommodate the local wayside cable as specified in section TA-2 and be mounted in the center of one transverse leg of the rectangular loop as shown on the Contract Drawings. The complete installation, including the 1000 KCMIL cable shall be no less than ½ inch below the top of the rail.

D. The Mini loop shall have an inductance of 3.7 Mh. Sufficient turns of wire shall be installed within the channel of the D loop to obtain the 3.7 Mh. The wire shall be encased in a one piece fiberglass reinforced, filament wound channel, which shall be filled with an epoxy resin upon completion of wiring. Channel shall be 1 5/8 inches and have a minimum wall thickness of 0.155 inches. All channels shall meet or exceed the requirements of these specifications.

1.11 SINGLE-TURN INDUCTIVE TRACK LOOPS

A. Each single-turn inductive track loop layout shall consist of a single conductor size 10 AWG flex cable loop encased in 1/2 inch I.D. hose hardware for attaching the hose-encased loop to the track structure in the required configuration, and a wayside junction box.

B. Hose construction shall be molded lead-press process, vertically braided, oil resistant, nonporous, resistant to the effect of aging with braided lay-on yarn and a cover of oil, abrasion, and age resistant red neoprene, as manufactured by American Biltrite Rubber Co., or approved equal.

1.12 JUNCTION BOXES

A. All junction boxes shall be commercial off the shelf (COTS) and conform to standard specification 16972, NEMA-4X and Underwriters Laboratories (UL) requirements. All ATC metallic cases, junction boxes, track circuit cable splice boxes and all support and fastening hardware furnished and installed by the contractor within tunnels or other above ground and underground exposed areas shall be made of stainless steel, ASTM A276, Type 304, or approved equal, unless otherwise directed by the Engineer. Track circuit junction boxes to be furnished and installed in ballast shall be cast iron with a pedestal as supplied by Invensys Incorporated

B. Covers shall be hinged and provided with a neoprene gasket to provide a dustproof and weatherproof enclosure. Covers shall be equipped with a three-point latching arrangement, complete with handle and facilities for accepting the shackle of a padlock.

D. Junction boxes shall be of sufficient size to provide ample space for the specified minimum bending radii of cables and wires

E. Junction boxes shall be provided complete with all necessary terminals

F. Junction boxes shall be provided complete with print pockets if applicable, sized as per manufacturer's standard, and located on the inside of the junction box cover or door. Junction boxes shall be equipped with drain plugs.

1.13 TEST EQUIPMENT

A. If the ATP module speed commands are processor controlled the contractor shall provide a portable computer based test system to simulate the train cab signal receiver and display the speed commands that the ATP MODULE is sending to the impedance bond in the track circuit. This system shall be called a Train Simulator. The Train simulator shall verify that the cab signal the processor controlled ATP module is sending to the wayside via the bond lines is the proper frequency and that the code rate is within specification. The Train Simulator shall be connected to the bond lines with clip leaps to be able to test each track circuit control line circuitry.

B. To test TSR codes that are controlled over the WMATA intranet the contractor shall provide a current state of the are portable laptop with software that shall emulate the ROCC and enable the ATCM technicians to be able to send all the possible TSR speed commands to the new ATP modules.