survey before the manufacturing of the switchgear. Where such discrepancies exist between the field survey data and the contract drawings, field survey data of the station arrangements shall govern.

d. Verify the entrance of existing power cables (top or bottom). New equipment shall be designed and manufactured so that no field splice of existing power cables is required.

3. The Authority will provide available shop drawings of existing equipment to the Contractor to facilitate determination of electrical and mechanical interfaces. However, the accuracy or availability of shop drawings is not guaranteed.

D. The Contractor shall be responsible for providing all required support from equipment manufacturers (for equipment furnished under this contract) during field-assembly, installation, testing and start-up of each traction power facility. This effort will include, but not be limited to, the following:

1. Provide shop-drawings and test-plans.

2. Provide manufacturer's field-engineering assistance during installation, field-testing, initial energization; and up to 1 day after initial energization to resolve any operational issues. The services of qualified manufacturer's engineering representative shall be made available if there are issues concerning equipment operation after installation under warranty. AM3

3. Provide services of manufacturer’s engineering representative during initial energization for verification of all equipment functions during train operation.

4. Make all changes on the equipment which may result from manufacturing discrepancies noted during equipment installation at no additional cost to the Authority.

5. Manufacturers’ engineering representatives shall be provided during Operations and Maintenance Training specified in Special Provisions and specifications. The exact schedule and location shall be coordinated with the Authority and the Contractor.

E. The work shall generally include the following (this description of work does vary by site according to requirements defined on the drawings):

1. Furnish and install equipment and materials as indicated to accomplish equipment replacements and capacity upgrades.

2. Provide new power circuits (wire and conduit) within the substations:

a. Sub-600 volt AC circuits (e.g., 277/480 volt, 120/208 volt, and 120 volt)

b. 125 VDC (nominal) circuits

c. Provide 125VDC control Power to RTU and HMI

d. Provide 120VAC power to RTU receptacle and lighting

3. Provide new fiber optical cables between each microprocessor based relay and the substation network switch as specified in section 16051D.

4. Verification of number of grounding points between existing substation ground bus and grounding grid. Provide visual check of exposed grounding connections. Notify Authority if less than two connecting points are identified. Measure the ground resistance of the

2.04 DEVICE MEASURING AND MONITORING REQUIREMENTS

The SCADA system shall be capable of displaying meter values concerning TBS equipment at the SCADA/AEMS Master Stations, AIM, and at individual HMI panels on demand as described in individual equipment specifications and as listed in Section 4 (Tables) of this specification.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. CONTRACTOR shall retain the services of the SCADA RTU manufacturer or their authorized representativeto be the system integrator, supervise and/or perform check-out and start-up of all system components. As part of these services, the contractor shall include for those equipment items not manufactured by the RTU manufacturer, the services of an authorized manufacturers' representative to check the equipment installation and place the equipment in operation. The manufacturers' representative shall be horoughly knowledgeable about the installation, operation and maintenance of the equipment. AM1

B. Tie Breaker Station RTUs will be furnished by the Contractor. The CONTRACTOR must install these RTU's as required by the Contract Documents. The programming and integration of the RTU's will be done by the manufacturer of RTU or the representative. AM1

C. RTU interface circuitry shall be installed in conformance with the typical RTU control and indication circuits shown on the Contract Drawings and connected to the RTU as indicated on the approved RTU Scan Sheets submitted.

D AM1

AM3

E. The CONTRACTOR shall provide and install Multi-mode fiber optic cables specified by WMATA IT to link each DC switchgear MPR, DIO, DTR, IED,SCADA RTU and equipment with fiber ports to the facility's Network Switches as specified in Section 16604.

F. The WMATA IT will install the WMATA furnished network switches on the RTU equipment rack, the contractor shall provide control power the network switches.

G. The CONTRACTOR shall provide and install fiber patch panel and connectors for the DC switchgear, SCADA RTU and the Network Switch. The CONTRACTOR shall also provide and install pre-fabricated jumper fiber cables between patch panels and end devices.

H. The CONTRACTOR shall provide and install Human Machine Interface (HMI) as specified in the technical specification 16291A in each Tie Breaker Station. The programming and integration of the HMI's will be done by the Contractor.

I. Microprocessor based DC relays (MPR), Distributed Input output modules (DIO), DC Trace Recorders (DTR), Track Feeder shielded cable monitors (CSM) installed by the manufacturer of the DC switchgear shall be integrated to the TBS SCADA system by the contractor.

Typical TBS				Control			Indication				
Equipment	Item	Point description	Signal Type	Local HMI	AIM	AEMS	Local HMI	AIM	AEMS	WEB Access	IED type
ETS Trip Cabinet	1	ETS Trip Circuit Normal TRk1 Inbound	hardwired				x	x	x	x	
	2	ETS Trip Circuit Trip TRk1 Inbound	hardwired				x	x	x	x	
	3	ETS Trip Circuit Normal TRk2 Inbound	hardwired				x	x	x	x	
	4	ETS Trip Circuit Trip TRk2 Inbound	hardwired				x	x	x	x	
	5	ETS Trip Circuit Normal TRk1 Outbound	hardwired				x	x	x	x	
	6	ETS Trip Circuit Trip TRk1 Outbound	hardwired				x	x	x	x	
	7	ETS Trip Circuit Normal TRk2 Outbound	hardwired				x	x	x	x	
	8	ETS Trip Circuit Trip TRk2 Outbound	hardwired				x	x	x	x	
	9	ETS Trip Circuit Normal TRk3 (Where available)	hardwired				x	x	x	x	
	10	ETS Trip Circuit Trip TRk3 (Where available)	hardwired				x	x	x	x	
											AM3

Typical TBS				Control			Indication				
Equipment	Item	Point description	Signal Type	Local HMI	AIM	AEMS	Local HMI	AIM	AEMS	WEB Access	IED type
Cable Shield Monitor	1	Cable Shield Monitor Communication Failure	Ethernet				x		x	x	VG Controls
	2	Cable Shield Monitor Healthy/Fail	Ethernet				x		x	x	VG Controls
	3	Cable Shield Overvoltage	Ethernet				x		x	x	VG Controls
	4	Cable Shield Leakage Current	Ethernet				x		x	x	VG Controls
	5	Cable Shield Low Resistance to Ground	Ethernet				x		x	x	VG Controls
	6	Broken connection from cable Shield to SCM	Ethernet				x		x	x	VG Controls
	7	SCM sensor Overtemperature	Ethernet				x		x	x	VG Controls
	8	Cable Shield Common Alarm	Ethernet				x	x	x	x	VG Controls
DTR's	1	DTR Communication Failure	Ethernet				x		x		Analog Signal
	2	DC Bus Voltage	Ethernet				x		x		Analog Signal

AM3

b. Rated voltage, ac or dc

c. Rated interrupting current.

d. Trip setting.

e. Frame size.

3. Enclosed Circuit Breaker:

a. NEMA AB1.

b. Circuit breaker: As shown and specified. Overcurrent trip device coordinated to provide selective tripping under overload conditions.

c. Enclosure:

1) Galvanized steel, surface-mounted, unless otherwise shown.

d. Type:

1) Above-ground indoor locations and electrical rooms: NEMA 1.

2) Tunnel areas and underground locations, except electrical rooms: NEMA 12.

3) Outdoor locations: NEMA 3R.

4. Panelboard:

a. NEMA PB1, UL 67. Breakers' KAIC: 480V-14KAIC; 208V - 10KAIC AM3

b. Enclosure:

1) UL 50.

2) Galvanized steel, surface mounted unless otherwise shown.

3) NEMA 250, Type 1

4) Gutter size

Main Bus Rating Amperes	Minimum Top and Bottom Gutter Size in Inches	Minimum Side Gutter in Inches
100 and below	4	4
225	6	4

5) Interior components mounted on back plate of reinforced steel for rigid support and accurate alignment.

6) One piece sheet steel front panels with hinged door and lock so constructed that when panelboard door is locked front cannot be removed.

after receiving the "control selection" message, the "control execute" command is not received within the set time period.

d) No control command shall be generated during power up or power down of RTU.

b. The RTU shall provide the capability for a master station to select and change the state of digital output points. These control outputs shall be used to control power system devices such as Circuit breakers relay disable/enable and other two-state devices, which shall be supported by the RTU.

c. A set of control outputs shall be provided for each controllable device. On receipt of command from a master station using the select check-before-execute operate (SCBO) sequence; the appropriate control output shall be operated for a preset time period which is adjustable for each point from 0.1 to 2 seconds. Outputs shall be latching continuous output contact closure. Receipt of a point selection address shall cause the RTU to return a verification message to the master station. Execute commands only after the dispatcher has verified that the selected point is the desired point and has issued an execute command for the function to be performed.

d. Control relays shall be installed between the output modules and terminal strips. Each control output shall consist of one set of potential free NO contact. The output contacts shall be rated for at least 10Amperes at 120 Volts ac resistive load. These output contact shall be used to drive heavy duty relays. In case Control output module of RTU does not provide potential free control output contact of this rating, then separate control output relays shall be provided by the contractor. These relay coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils & shall conform to the relevant requirements.

5. Analog Input Modules:

a. The real time values like, Active power, Reactive Power, Apparent power three phase Current & Voltage and frequency, power factor & accumulated values of energy values will be acquired by the RTU. AM3

b. The RTU analog-to-digital (A/D) converters shall have a digital resolution of at least twelve (12) bits plus sign. The overall accuracy of the analog input system shall be at least 0.2%(i.e. 99.8%) at 25 ºC of full scale . Mean accuracy shall not drift more than 0.002% per degree C within the temperature range of –5 to +55 degree Linearity shall be better than 0.05%. Each input shall have suitable protection and filtering to provide protection against voltage spikes and residual current. Loading up to 150% of the input value shall not sustain any failures to the RTU input.

c. The ability of the RTU to accommodate dc inputs shall include the following signal ranges:

1) Unipolar Voltage:0-0.5V, 0-1V, 0-5V, 0-10V,
2) Unipolar Current: 0-1mA, 0-10mA, 0-20mA, 4-20Ma,
3) Bipolar Voltage: 0.5V, 2.5V, 5V, -20-0-20mA (- to +)
4) Bipolar Current: -1mA-0-1mA, -20mA-0-10mA, -20-0-20mA