The Afghanistan Engineering Support Program assembled this deliverable. It is an approved, official USAID document. Budget information contained herein is for illustrative purposes. All policy, personal, financial, and procurement sensitive information has been removed. Additional information on the report can be obtained from Firouz Rooyani, Tetra Tech Sr. VP International Operations, (703) 387-2151.

AFGHANISTAN ENGINEERING SUPPORT PROGRAM

WO-LT-0063 - AMENDMENT 4
SALANG TUNNEL SUBSTATION
PRE-PURCHASE EQUIPMENT SPECIFICATIONS

REQUEST FOR PROPOSALS- TECHNICAL SECTION
RFP NO: DABS-92-ICB-028
RFP TITLE: PROCUREMENT OF ELECTRICAL EQUIPMENT FOR SALANG TUNNEL SUBSTATION IN TWO LOTS

AFG NO: 830021

Contents

Appendices

1.0 Abbreviations, Acronyms & Glossary

A	Amperes, a unit of electrical current. Larger currents require larger physical conductors to move without overheating.
Circuit Breaker	ANSI device number 52. An electrical system element used to interrupt the circuit both under load and no-load conditions. Circuit breakers are also designed to interrupt a rated level of fault current that may be present under short circuit fault conditions.
Coordination Study	An electrical study to determine settings for protective relays and settings/sizes for other protective devices such as automatic switches or fuses. The purpose of having proper settings and sizes is to prevent large area "black outs" due to small local faults or disturbances.
DABS	Da Afghanistan Breshna Sherkat (DABS) operates and manages electric power generation, importation, transmission, and distribution throughout Afghanistan on a commercial basis. DABS shares are owned by: Ministry of Finance 45%, Ministry of Energy and Water (MEW) 35%, Ministry of Economy (MoEc) 10%, Ministry of Urban Development (MoUD) 10%.
Distribution (Distribution System)	Typically 33kV and below. These systems are used to bring power to service transformers that provide power to consumers, businesses and local users.
Electrical Demand	The instantaneous electricity volume required by users in an electrical distribution system. Usually expressed as real power demand in kW or MW and total apparent power demand in kVA and MVA.
Fault	An event on an electrical system that connects current carrying conductors (phase conductors) to either ground (line to ground or phase to ground) or each other (phase to phase). These events are normally disruptive and require 'clearing' (de-energizing the faulted circuit) to retain system stability and for protection of property and personnel.
Feeder	An electrical circuit that originates from a circuit breaker, switch or fused-switch combination. The Feeder Circuit is typically defined by the upstream protective device (circuit breaker/fuse switch) and the wire that terminates to the load.
IEEE (Institute of Electrical and Electronics Engineers)	A US-based organization of electrical engineers. IEEE publishes the color book series and other technical manuals including the "Encyclopedia of Electrical Engineering" as well as extensive standards for electrical equipment and guides for application of electrical equipment.
kV	kilo-Volts, 1,000V, a unit of electrical potential (voltage).

kVA	kilo-Volt-Ampere (1,000VA), a unit of total apparent electrical power (energy/time) including both real and imaginary (reactive) power. Also known as total apparent electrical demand. The square root of the sum of the squares of the real and imaginary (reactive) power is the total power. The kVA is the hypotenuse of a right triangle consisting of real and imaginary (reactive) power as its legs. The cosine of the angle between real and apparent/total power is called the power factor. (See MVA)
kW	Kilowatts, 1,000W, a unit of electrical real power (energy/time). Also known as electrical demand.
Line	In the context of this report, generally referring to 15kV or 20kV distribution line.
Load	A device connected to an electrical system that consumes electrical energy. Examples of loads at the consumer level are light bulbs, computers and air conditioning units.
MEW	Government of the Islamic Republic of Afghanistan (GIRoA) Ministry of Energy and Water.
Medium Voltage	Equipment or systems designed to operate greater than 1000V and less than 100,000 V (IEEE Std. 100-2000)6 Distribution systems are operated at medium voltage (typically 2.4 kV through 34.5 kV) to efficiently move moderately large blocks (typically several MW) of power between high voltage substations and loads that may be up to tens of kilometers distant from the high voltage substation. Larger loads and longer distances make High Voltage lines more attractive, while Low Voltage systems are more attractive for smaller loads and shorter distances (such as occur within a neighborhood or large building).
MVA	mega-Volt-Amperes, 1,000,000VA, 1,000kVA, a unit of total apparent electrical power (energy/time) including both real and imaginary (reactive) power. Also known as total apparent electrical demand. (See kVA.)
MW	mega-Watts, 1,000,000W, 1,000kW, a unit of electrical real power (energy/time). Also known as electrical demand.
NTP	Notice to proceed
One-Line Diagram	An electrical diagram typically representing a three phase system showing only one phase of the system for simplicity.
Phase (Ph) (P)	Also known as phi (φ). Commonly referring to one of the typically three conductors of an AC power system that is intended to operate at the nominal voltage above the ground potential. A typical AC utilization system in Afghanistan will therefore have 4 wires; three phase conductors, called A, B and C operating at 400V and a neutral conductor nominally operating at 0V. Transmission circuits typically consist of three phases but do not have a neutral or fourth wire. Transmission circuits often have a shield wire whose only purpose is to protect the transmission circuit from lighting.
TCC	Time Current Characteristic curve

2.0 Equipment Bill of Quantities

2.1 Equipment Bill of Quantities – Lot 1

Item Description	Specification	Quantity Required
Power Transformer , 220kV, 4MVA	33 73 10_Rev 1	2

2.2 Equipment Bill of Quantities – Lot 2

Item Description	Specification	Quantity Required
Circuit Breaker, 220kV	Section 33 77 20_Rev1	5
Disconnect Switch, 220kV, Double-Break, Horizontal Mounted, Type I	Section 33 77 22_Rev1	6
Disconnect Switch, 220kV, Single-End Break, Vertical Mounted, Type II	Section 33 77 22_Rev1	6
Surge Arrester, 220kV	Section 33 71 01_Rev1	18
Current Transformer, 220kV,Type I	Section 33 75 40_Rev2	9
Current Transformer, 220kV,Type II	Section 33 75 40_Rev2	6
Capacitor Voltage Transformer, 220kV	Section 33 75 50_Rev1	12
Switchgear, Medium Voltage, Metal Clad, Indoor	Section 33 75 10_Rev2	1
Relay and Control Panels	Section 33 75 00 00 40	1

Appendices

Appendix A – List of Standards

220kV Transformers	
IEEE Std 4	High Voltage Testing
IEEE Std 100	The Authoritative Dictionary of IEEE Standards Terms
IEEE Std 315	Graphical Symbols
IEEE Std 315A	Graphical Symbols - Supplement
IEEE Std 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 469	Electrical Noise Test - Transformers
IEEE Std C2	National Electrical Safety Code
IEEE Std C37.47	Standard for High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches
IEEE Std C57.12.00	General Requirements for Liquid Immersed Transformers
IEEE Std C57.12.10	Standard Requirements for Liquid Immersed Transformers
IEEE Std C57.12.28	Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE Std C57.12.80	Standard Terminology for Transformers
IEEE Std C57.12.90	Test Code for Liquid-Immersed Transformers
IEEE Std C57.13.1	IEEE Guide for Field Testing of Relaying Current Transformers
IEEE Std C57.19.01	Performance Characteristics for Outdoor Bushings
IEEE Std C57.91	Loading Mineral Oil Transformer
IEEE Std C57.98	Guide for Transformer Impulse Tests
IEEE Std C57.106	Maintenance of Insulating Oil
IEEE Std C57.131	Requirements for Load Tap Changers
IEEE Std C62.11	Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std C62.22	Application of Metal-Oxide Surge Arrestors
ANSI C92.2	Electrical Systems - Preferred voltage Ratings
ANSI C84.1	Voltage Ratings for Electric Power Systems
ANSI V-1	Compressed Gas Cylinder Valve Outlet
NETA ATS	Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
ASTM A153/153M	Zinc Coating on Iron and Steel Hardware
ASTM D92	Standard Test Methods for Flash and Fire
ASTM D1499	Operating Light and Water Exposure
ASTM D1933	Nitrogen Gas as Electrical Insulator
ASTM D2225	Silicon Fluids in Electrical Apparatus
ASTM D2565	Xenon Arc Exposure of Plastics
ASTM D5222	High Fire Point Mineral Oil
ASTM G154	UV Exposure
IEC 60076-1	Power transformers - Part 1: General
IEC 60076-7	Power transformers - Part 7: Loading guide for oil-immersed power transformers
IEC 60076-10	Power transformers - Part 10: Determination of sound levels
IEC 60137	Insulated bushings for alternating voltages above 1000 V
IEC 60616	Terminal and tapping markings for power transformers
IEC 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles

220kV Transformers	
IEC 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 2: Ceramic and glass insulators for a.c. systems
IEC 62581	Electrical steel - Methods of measurement of the magnetostriction characteristics by means of single sheet and Epstein test specimens
IEC 60317-0-1	Specifications for particular types of winding wires - Part 0-1: General requirements - Enameled round copper wire
IEC 60296	Fluids for electro technical applications - Unused mineral insulating oils for transformers and switchgear
IEC 60814	Insulating liquids - Oil-impregnated paper and pressboard - Determination of water by automatic coulometric Karl Fischer titration
IEC 60567	Oil-filled electrical equipment - Sampling of gases and analysis of free and dissolved gases - Guidance
IEC 60156	Insulating liquids - Determination of the breakdown voltage at power frequency - Test method
IEC 60695-2-10	Fire Hazard testing - Part 2-10: Glowing/hot-wire based test methods - Glow-wire apparatus and common test procedure
IEC 60695-2-11	Fire hazard testing - Part 2-11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end-products
IEC 60247	Insulating liquids - Measurement of relative permittivity, dielectric dissipation factor (tan d) and d.c. resistivity
IEC 61198	Mineral insulating oils - Methods for the determination of 2-furfural and related compounds
BS 4360	Specification for weldable structural steels
BS 5493	Code of practice for protective coating of iron and steel structures against corrosion
BS 7671	Requirements for Electrical Installations. IET Wiring Regulations

220kV Breakers	
IEEE Std C37.100.1	Common Requirements for HV Switchgear
IEEE Std 1	Temperature Limits in Rating Electrical Equipment
IEEE Std 4	High Voltage Testing
IEEE Std 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 693	Seismic Design of Substations
IEEE Std 1125	Moisture Measurement in SF6 Equipment
IEEE Std 1291	Partial Discharge Measurement
IEEE Std 1313.1	Insulation Coordination - Definitions
IEEE Std 1313.2	Insulation Coordination - Application
IEEE Std C37.04	Rating Structure HV Circuit Breakers
IEEE Std C37.06	AC HV Circuit Breakers
IEEE Std C37.010	Application Guide for AC Circuit Breakers
IEEE Std C37.22	Preferred Ratings and Related Required Capabilities for Indoor AC Medium-Voltage Switches Used in Metal-Enclosed Switchgear
IEEE Std C37.90.1	Surge Withstand Capacity Test
IEEE Std C57.12.28	Standard for Pad-Mounted Equipment - Enclosure Integrity
ANSI C29.1	Power Insulators - Test Methods
ANSI C29.9	Wet-Process Porcelain Insulators
ANSI C37.09a	Standard for Testing of AC High-Voltage Breakers
ANSI C37.32	Schedules of Preferred Ratings
ANSI C37.34	Test Code for HV Switches
ANSI C63.2	Electromagnetic Noise and Field Strength
ANSI MG 1	Motors and Generators
ASTM A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/153M	Zinc Coating on Iron and Steel Hardware
ASTM D 2472	Specification for Sulphur Hexaflouride
ASTM D1499	Operating Light and Water Exposure
ASTM D2565	Xenon Arc Exposure of Plastics
ASTM G154	UV Exposure
NEMA SG 6	Power Switching Equipment
NEMA 107	Methods for Measuring RIV
NEMA CC1	Power Connectors for Substations
NEMA MG 1	Motors and Generators
IEC 62271-1	High-voltage switchgear - Part 1: Common specifications
IEC 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles
IEC 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 2: Ceramic and glass insulators for a.c. systems

220kV Disconnect Switches	
IEEE Std C37.30.1	Requirements for AC HV Air Switches
IEEE Std 4	High Voltage Testing
IEEE Std 142	Grounding
IEEE Std 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 1247	Interrupter Switches for AC
IEEE Std C37.100.1	HV Power Switchgear
IEEE Std C57.12.28	Standard for Pad-Mounted Equipment - Enclosure Integrity
ANSI C29.1	Power Insulators - Test Methods
ANSI C29.9	Wet-Process Porcelain Insulators
ANSI C37.04	Standard Rating Structure for AC High-Voltage Circuit Breakers
ANSI C37.06	Standard for Rating AC High-Voltage Circuit Breakers on a symmetrical current basis.
ANSI C37.09a	Standard for Testing of AC High-Voltage Breakers
ANSI C37.30.1	Requirements for AC High-Voltage Air Switches Rated Above 1000 V
ANSI C37.32	Schedules of Preferred Ratings
ANSI C37.34	Test Code for HV Switches
ANSI C63.2	Electromagnetic Noise and Field Strength
ANSI MG 1	Motors and Generators
ASTM A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/153M	Zinc Coating on Iron and Steel Hardware
ASTM D 2472	Specification for Sulphur Hexaflouride
ASTM D1499	Operationg Light and Water Exposure
ASTM D2565	Xenon Arc Exposure of Plastics
ASTM G154	UV Exposure
NEMA SG 6	Power Switching Equipment
NEMA 107	Methods for Measuring RIV
NEMA CC1	Power Connectors for Substations
NEMA MG 1	Motors and Generators
IEC 62271-1	High-voltage switchgear - Part 1: Common specifications
IEC 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles
IEC 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 2: Ceramic and glass insulators for a.c. systems

220kV Surge Arrestors	
IEEE Std 4	High Voltage Testing
IEEE Std C84.1	Electric Power Systems and Equipment
IEEE Std 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600V
IEEE Std 738	Standard for Calculating the Current-Temperature of Bare Overhead Conductors
IEEE Std 998	Direct Lightning Stroke Shielding
IEEE Std 1299	Connection of Surge Arresters
IEEE Std 1313.1	Insulation Coordination - Definitions
IEEE Std 1313.2	Insulation Coordination - Application
IEEE Std C37.015	Shunt Reactor Switching
IEEE Std C37.04	Rating Structure HV Circuit Breakers
IEEE Std C37.301	High Voltage Switchgear - Test Techniques
IEEE Std C57.12.10	Requirements for Liquid Immersed Transformers
IEEE Std C62.1	IEEE Standard for Gapped Silicon-Carbide Surge Arresters for AC Power Circuits
IEEE Std C62.11	Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std C62.22	Application of Metal-Oxide Surge Arrestors
ANSI C29.1	Power Insulators - Test Methods
ANSI C29.9	Wet-Process Porcelain Insulators
ASTM A153/153M	Zinc Coating on Iron and Steel Hardware
ASTM B3	Soft Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
ATSM B230	Aluminum, 1350-H19 Wire for Electrical Purposes
ATSM B231	Aluminum 1350 Conductors, Concentric-Lay-Stranded
ATSM B232/B232M	Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
ATSM B609	Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes
ASTM D1499	Operating Light and Water Exposure
ASTM D2565	Xenon Arc Exposure of Plastics
ASTM G154	UV Exposure
NEMA CC1	Power Connectors for Substations
IEC 60044	Voltage Transformers Part 2 and Part 5
IEC 60060-1	High voltage test techniques -- Part 1: General definitions and test requirements
IEC 60071-1	Insulation co-ordination
IEC 60099-7	Surge arresters -- Part 7: Glossary of terms and definitions
IEC 60104	Aluminum-magnesium-silicon alloy wire for overhead line conductors
IEC 60120	Dimensions of Ball and Socket Couplings of String Insulator Units

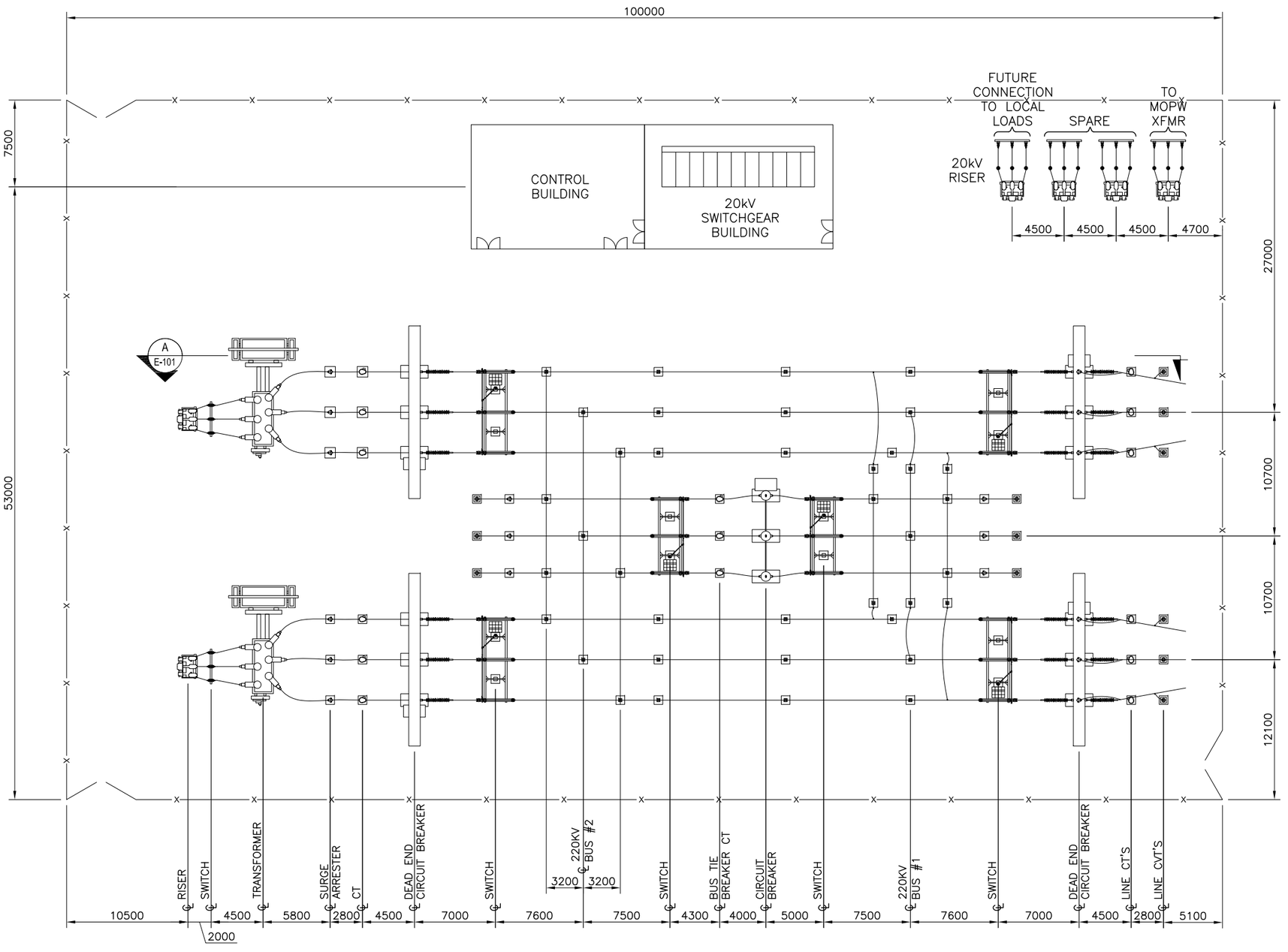
IEC 60273	Characteristic of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V
IEC 60305	Insulators for overhead lines with a nominal voltage above 1000 V - Ceramic or glass insulator units for A.C. systems - Characteristics of insulator units of the cap and pin type
IEC 60372	Locking devices for ball and socket couplings of string insulator units - Dimensions and tests
IEC 60383	Insulators for overhead lines with a nominal voltage above 1000 V
IEC 60888	Zinc-coated steel wires for stranded conductors
IEC 60889	Hard-drawn aluminum wire for overhead line conductors
IEC 61089	Round wire concentric lay overhead electrical stranded conductors
BS EN 61394	0verhead lines. Requirements for greases for aluminum, aluminum alloy and steel bare conductors
BS EN 62004	Thermal-resistant aluminum alloy wire for overhead line conductor
BS EN 60305	Insulators for overhead lines with a nominal voltage above 1 kV – Ceramic or glass insulator units for ac systems – Characteristics of insulator units of the cap and pin type.
BS EN 60372	Locking devices for ball and socket couplings of string insulator units -- Dimensions and tests
BS EN 60383-1	Insulators for overhead lines with nominal voltage above 1 kV -- Part 1: Ceramic or glass insulator units for ac systems -- Definitions, test methods and acceptance criteria
BS EN 60383-2	Insulators for overhead lines with nominal voltage above 1 kV -- Part 2: Insulator strings and insulator sets for ac systems
BS EN 60437	Radio interference test on high voltage insulators
BS EN 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions -- Part 1: Definitions, information and general principles
BS EN 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions -- Part 2: Ceramic and glass insulators for ac systems

220kV Current Transformers	
IEEE Std C57.12.10	Requirements for Liquid Immersed Transformers
IEEE Std C57.12.90	Test Code for Liquid-Immersed Transformers
IEEE Std C57.13	Instrument Transformers
IEEE Std 57.19.01	Outdoor Apparatus Bushings
ANSI C37.32	Schedules of Preferred Ratings
NEMA SG-4	AC HV Circuit Breakers
IEC 44	Instrument Transformers
IEC 185	Current Transformers
IEC 186	Potential Transformers
IEC 255	Electrical Relays
IEC 1036	Static Meters
IEC 60481	Coupling devices for power line carrier systems
Voltage Transformers	
IEEE Std 4	High Voltage Testing
IEEE Std 693	Seismic Design of Substations
IEEE Std C57.13.5	Instrument Transformers over 115kV
IEEE Std 57.19.01	Outdoort Apparatus Bushings
IEEE Std C57.106	Maintenance of Insulating Oil
ANSI C29.1	Power Insulators - Test Methods
ANSI C29.9	Wet-Process Porcelain Insulators
ANSI C93	Requirements for Power Line Carrier Coupling Capacitors and Coupling Capacitor Voltage Transformers
ASTM A153/153M	Zinc Coating on Iron and Steel Hardware
ASTM D1499	Operating Light and Water Exposure
ASTM D2565	Xenon Arc Exposure of Plastics
ASTM G154	UV Exposure
ASTM D1275-06	Test Method for Corrosive Sulphur in Oils
NEMA 107	Methods for Measuring RIV
IEC 44	Instrument Transformers
IEC 185	Current Transformers
IEC 186	Potential Transformers
IEC 255	Electrical Relays
IEC 1036	Static Meters
IEC 60481	Coupling devices for power line carrier systems

Medium Voltage Switchgear	
IEEE Std C37.100.1	Common Requirements for HV Switchgear
IEEE Std 1	Temperature Limits in Rating Electrical Equipment
IEEE Std 4	High Voltage Testing
IEEE Std 693	Seismic Design of Substations
IEEE Std 1125	Moisture Measurement in SF6 Equipment
IEEE Std 1291	Partial Discharge Measurement
IEEE Std 1313.1	Insulation Coordination – Definitions
IEEE Std 1313.2	Insulation Coordination – Application
IEEE Std C37.010	Application Guide for AC Circuit Breakers
IEEE Std C37.04	Rating Structure HV Circuit Breakers
IEEE Std C37.06	AC HV Circuit Breakers
IEEE Std C37.24	Effect of Solar Radiation on Outdoor Metal Gear
IEEE Std C37.81	Seismic Qualification for Metal Enclosed Gear
IEEE Std C37.90.1	Surge Withstand Capacity Test
IEEE C37.09	IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.20.2	IEEE Standard for Metal-Clad Switchgear
IEEE C37.121	American National Standard for Switchgear - Unit Substations – Requirements
IEEE C37.90	IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.13	IEEE Standard Requirements for Instrument Transformers
ANSI C29.1	Power Insulators - Test Methods
ANSI C29.9	Wet-Process Porcelain Insulators
ANSI C37.32	Schedules of Preferred Ratings
ANSI C37.34	Test Code for HV Switches
ANSI C37.85	AC High Voltage Vacuum Interrupters
ANSI C39.1	Requirements for Electrical Analog Indicating Instruments
ANSI C63.2	Electromagnetic Noise and Field Strength
ANSI MG 1	Motors and Generators
ANSI 60529	Protection Provided by Enclosures
ASTM A153/153M	Zinc Coating on Iron and Steel Hardware
ASTM D 2472	Specification for Sulphur Hexafluoride
ASTM D1499	Operating Light and Water Exposure
ASTM D2565	Xenon Arc Exposure of Plastics
ASTM G154	UV Exposure
NEMA SG4	Power Circuit Breakers
NEMA SG5	Power Switchgear Assemblies
NEMA SG6	Power Switching Equipment
NEMA 107	Methods for Measuring RIV
NEMA CC1	Power Connectors for Substations
NEMA MG 1	Motors and Generators

Medium Voltage Switchgear	
IEC 62271-1	High-voltage switchgear and control gear – Part 1: Common specifications
IEC 62271-200	High Voltage Switchgear and Control Gear
IEC 62271-100	High-voltage switchgear and control gear - Part 100: Alternating current circuit-breakers
IEC 62271-103	High-voltage switchgear and control gear - Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
IEC 60071-2	Insulation co-ordination – Part 2: Application guide

Appendix B – Electrical Drawings



SUBSTATION GENERAL ARRANGEMENT PLAN
1:200

NOT FOR CONSTRUCTION

UNLESS OTHERWISE NOTED, LINEAR DIMENSIONS SHOWN ARE IN MILLIMETERS.

NOTE: A3 SIZE REDUCED TO HALF SCALE

5 0 5 10 15
1:200

LEGEND

PROPOSED FENCE

CAPACITIVE VOLTAGE TRANSFORMER

CURRENT TRANSFORMER

SURGE ARRESTER

POST INSULATOR

STRAIN INSULATOR

CIRCUIT BREAKER (3 PH)

220KV DISCONNECT SWITCH

20KV LOAD BREAKER SWITCH

NOTES:

1. THIS IS A GENERAL ARRANGEMENT PLAN. CONTRACTOR SHALL SUBMIT CONSTRUCTION DRAWINGS TO THE ASSIGNED OWNER'S REPRESENTATIVE FOR APPROVAL. CONSTRUCTION DRAWINGS SHALL SATISFY DABS AND THE OWNER'S REPRESENTATIVE.
2. THE 20KV DISTRIBUTION LINES FOR OUTGOING FEEDERS SHALL BE TERMINATED AT THE 20KV LOAD BREAK SWITCHES THAT ARE TO BE INSTALLED AT THE 20KV STEEL STRUCTURE LOCATED IN THE SS SITE AS SHOWN IN THE PLAN. THE 20KV LOAD BREAK SWITCHES ARE TO BE SUPPLIED, INSTALLED, AND CONNECTED COMPLETELY BY THE SS CONTRACTOR. PROVIDE 20KV UNDERGROUND DUCT BANK SYSTEM BETWEEN THE 20KV SWITCHGEAR ROOM/BUILDING AND THE 20KV DISTRIBUTION STEEL STRUCTURE. THE SS CONTRACTOR IS TO PROVIDE AND INSTALL CONDUITS (OF SUFFICIENT SIZE AND QUANTITIES) FROM THAT UNDERGROUND DUCT BANK TO THE 20KV DISTRIBUTION STEEL STRUCTURE.
3. PROVIDE 20KV UNDERGROUND DUCT BANK SYSTEM BETWEEN 220/20KV TRANSFORMERS SWITCHYARD AND THE 20KV SWITCHGEAR ROOM/BUILDING. THE DUCT BANK SYSTEM SIZING SHALL INCLUDE ADEQUATE SPACE FOR FUTURE FEEDER NEEDS.
4. THE 20KV SWITCHGEAR ROOM/BUILDING SHALL BE COMBINED WITH OR ADJOINING THE CONTROL BUILDING. SUBMIT PROPOSED LAYOUTS FOR APPROVAL. THE PROPOSED LAYOUTS SHALL SATISFY DABS AND THE OWNER'S REPRESENTATIVES. THE LOCATION OF THE SWITCHGEAR ROOM/BUILDING IS TO BE LOCATED AS CLOSE AS POSSIBLE TO THE BOUNDARY WALL AT WHICH THE FIRST 20KV DISTRIBUTION STEEL STRUCTURE WILL BE LOCATED.
5. PROVIDE SUFFICIENT PROVISIONS FOR INCOMING AND OUTGOING MV, COMMUNICATION, AND LV CIRCUITS FOR EACH BUILDING.
6. DABS WILL PROVIDE AVAILABLE LAND TO THE CONTRACTOR FOR THEIR STORAGE AND OTHER CONSTRUCTION NEEDS. THE REQUIRED AREA SHALL BE SPECIFIED BY THE CONTRACTOR IN THEIR BID RESPONSE.

SUBSTATION EQUIPMENT LIST (MAJOR ITEMS ONLY)

- 220kV MOTORIZED DISCONNECT SWITCH
- 220kV AIR CIRCUIT BREAKER
- 220kV CURRENT TRANSFORMER
- 220kV CAPACITOR VOLTAGE TRANSFORMER
- 220kV 4 MVA TRANSFORMER
- 220kV SURGE ARRESTER
- 20kV METAL CLAD SWITCHGEAR
- 125 kW GENERATOR
- CONTROL PANEL

THIS PROJECT WAS MADE POSSIBLE BY THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT AND THE GENEROUS SUPPORT OF THE AMERICAN PEOPLE THROUGH USAID GLOBAL ARCHITECTURE AND ENGINEERING IQC CONTRACTS

CONCEPT DESIGN SUBMITTAL

STMB	DESCRIPTION	DATE	APR
B	LT Xfr protection & secondary voltage revised	16/11/13	DJ
A	Concept Design Submittal	07/09/13	KF

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: RC
DATE: 07/08/13
SUBMITTED BY: Tetra Tech
CAD FILE NAME: E-100-Substation GA

USAID FROM THE AMERICAN PEOPLE

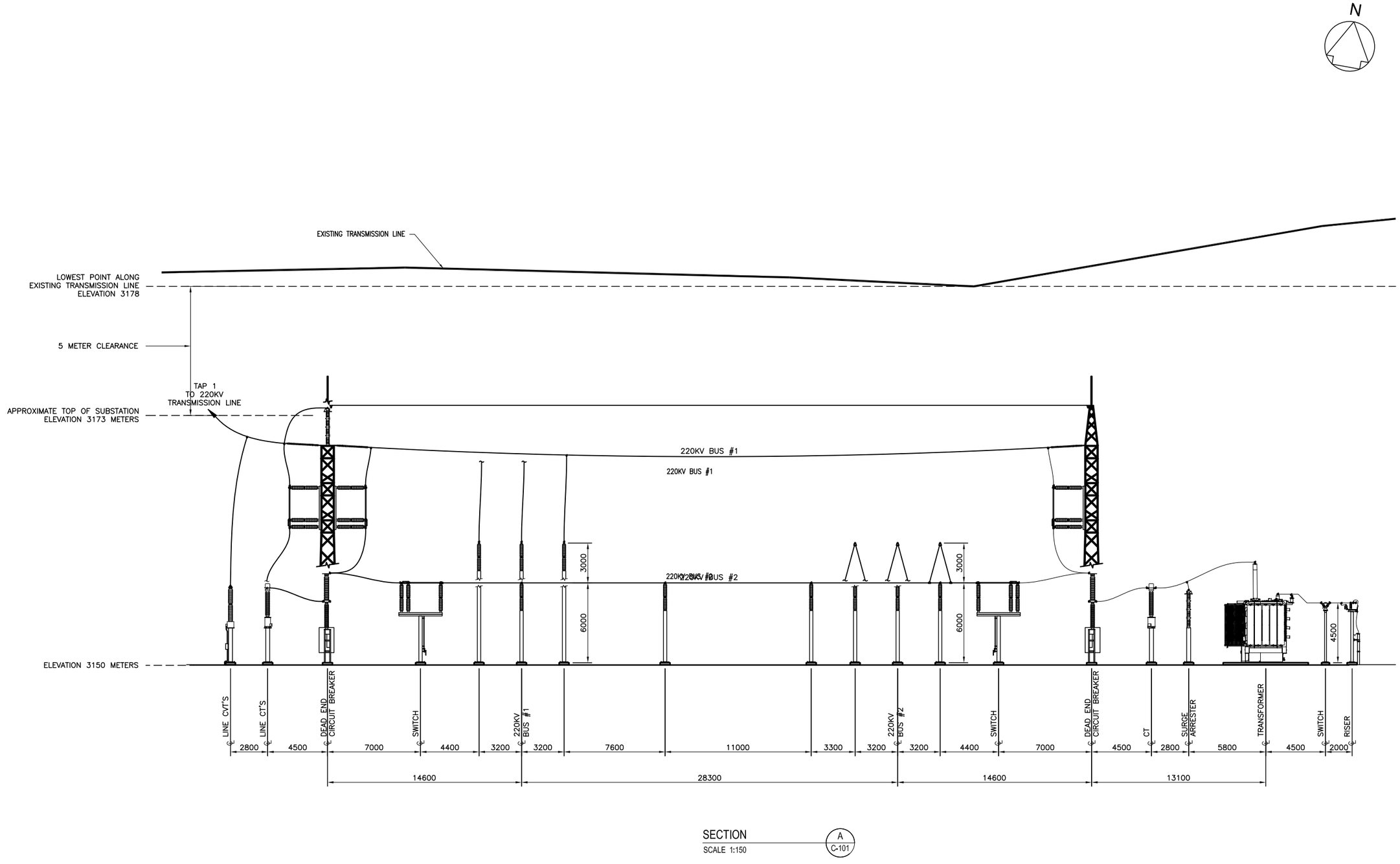
A E S P

DRAFT

USAID – OEGI
PRIMARY SELECTIVE SUBSTATION
SALANG TUNNEL SUBSTATION

SUBSTATION GENERAL ARRANGEMENT

SHEET REFERENCE NUMBER:
E–100



SECTION A
SCALE 1:150
C-101

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CONCEPT DESIGN SUBMITTAL

SYMB	SUBMITTAL/REVISION DESCRIPTION	DATE	APR
1	LT Xfr protection & secondary voltage revised	16/11/13	DJ
A	Concept Design Submittal	07/09/13	KF

DESIGNED BY: MAY
DRAWN BY: MAY
CHECKED BY: KF
DATE: 07/08/13
SUBMITTED BY: Tetra Tech
CAD FILE NAME: E-101-Substation Section A

USAID FROM THE AMERICAN PEOPLE

A E S P

DRAFT

USAID – OEGI
PRIMARY SELECTIVE SUBSTATION
SALANG TUNNEL SUBSTATION

SUBSTATION SECTION A

SHEET REFERENCE NUMBER:
E-101

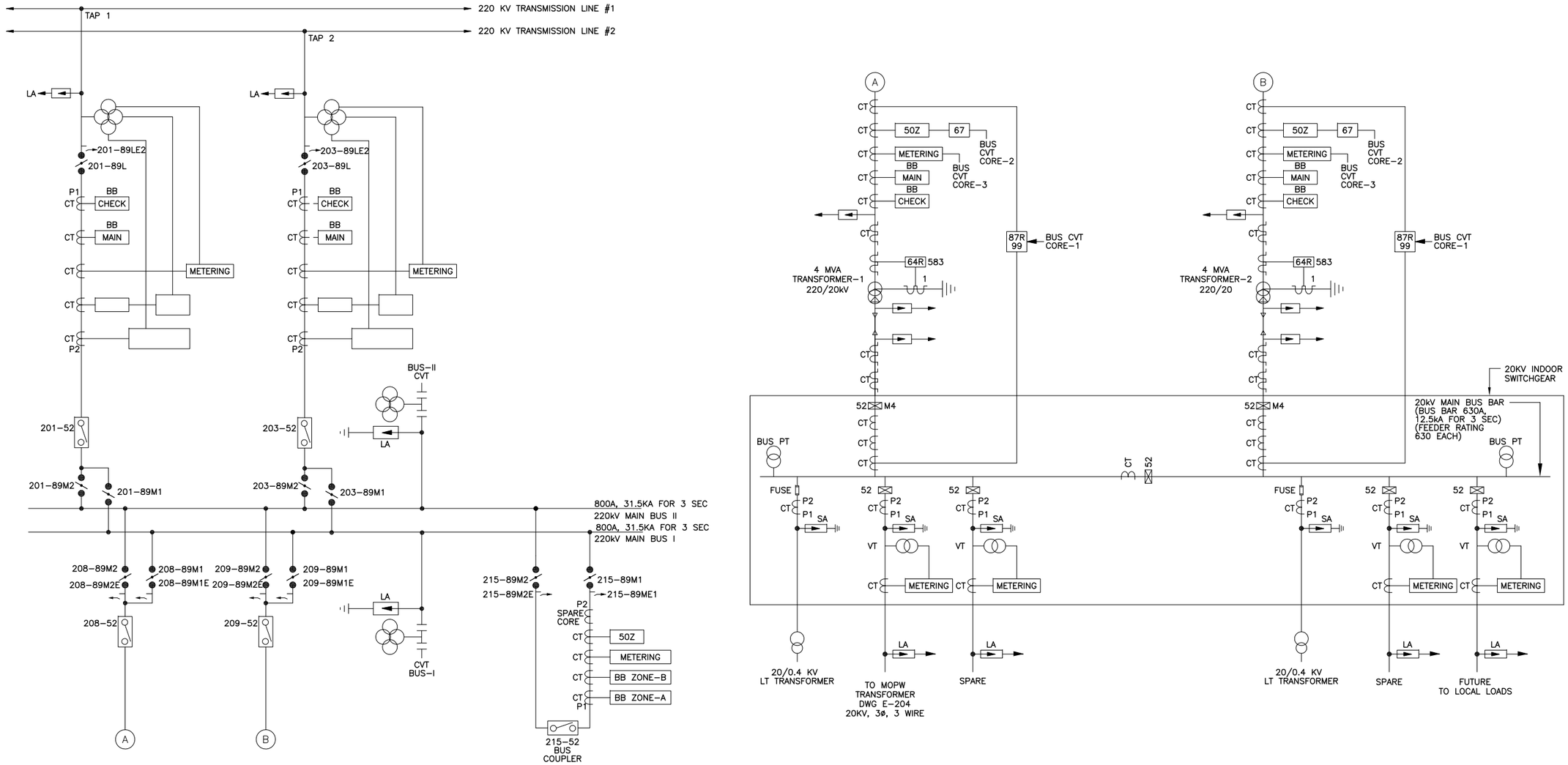
0.025 0.0125 0 0.025
2:1

NOTE: A3 SIZE REDUCED TO HALF SCALE

NOT FOR CONSTRUCTION

UNLESS OTHERWISE NOTED, LINEAR DIMENSIONS SHOWN ARE IN MILLIMETERS.

P:\1298\Work Orders\WO-LT\WO-LT-0063 Salang Tunnel SS Technical Sections\CAD\SheetFiles\Concept Design\E-101-Substation Section A.dwg 11/23/2013 2:15:10 PM Yarmand, Mohammad Arash



LEGEND

RELAY	21–	DISTANCE RELAY
	50–	INSTANTANEOUS OVERCURRENT RELAY
	52–	AC CIRCUIT BREAKER
	64–	GROUND DETECTOR RELAY
	67–	AC DIRECTIONAL OVERCURRENT RELAY
	87–	DIFFERENTIAL PROTECTIVE RELAY
	89–	LINE SWITCH
	BB	CHECK–BUS DIFFERENTIAL RELAY
ABBREVIATION	LA–	LIGHTNING ARRESTOR
	CT–	CURRENT TRANSFORMER
	Z–	IMPEDANCE RELAY
	CVT–	CAPACITOR VOLTAGE TRANSFORMER
	LT–	STATION SERVICE
	SA–	SURGE ARRESTOR

NOTES:

1. THIS IS A PRELIMINARY DESIGN ONLY. CONTRACTOR SHALL SUBMIT CONSTRUCTION DRAWINGS TO THE ASSIGNED OWNER'S REPRESENTATIVE FOR THEIR APPROVAL. THE CONSTRUCTION DRAWINGS SHALL SATISFY DABS AND THE OWNER'S REPRESENTATIVES.
2. ALL SUBSTATION BUS BAR SHALL BE FULLY RATED

ONE–LINE LEGEND

- CAPACITIVE VOLTAGE TRANSFORMER, X = QUANTITY, 3 EA UNO
- CURRENT TRANSFORMER, X = QUANTITY, 3 EA UNO
- DISCONNECT (ISOLATOR)
- HV AC CIRCUIT BREAKER
- HV DISCONNECT (ISOLATOR) WITH EARTHING SWITCH
- HV DISCONNECT (ISOLATOR) WITH TWO EARTHING SWITCH
- LIGHTING ARRESTOR (LA) SURGE ARRESTOR (SA)
- XX PROTECTIVE RELAY/METERING/ELECTRONIC RELAY
- XX DEDICATED NUMBER TRANSFORMER
- SWITCHGEAR CIRCUIT BREAKER
- MV FUSE, 10AMP

NOT FOR CONSTRUCTION

UNLESS OTHERWISE NOTED, LINEAR DIMENSIONS SHOWN ARE IN MILLIMETERS.

NOTE: A3 SIZE REDUCED TO HALF SCALE

THIS PROJECT WAS MADE POSSIBLE BY THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT AND THE GENEROUS SUPPORT OF THE AMERICAN PEOPLE THROUGH USAID GLOBAL ARCHITECTURE AND ENGINEERING IQC CONTRACTS

CONCEPT DESIGN SUBMITTAL

SYMB	SUBMITTAL/REVISION DESCRIPTION	DATE	APR
1	LT Xfr protection & secondary voltage revised	16/11/13	DJ
0	Concept Design Submittal	27/10/13	KF

DESIGNED BY: MAY | DRAWN BY: MAY | CHECKED BY: GS
DATE: 07/08/13
SUBMITTED BY: Tetra Tech
CAD FILE NAME: E-102-Substation SLD

USAID FROM THE AMERICAN PEOPLE

A E S P

DRAFT

USAID – OEGI
PRIMARY SELECTIVE SUBSTATION
SALANG TUNNEL SUBSTATION

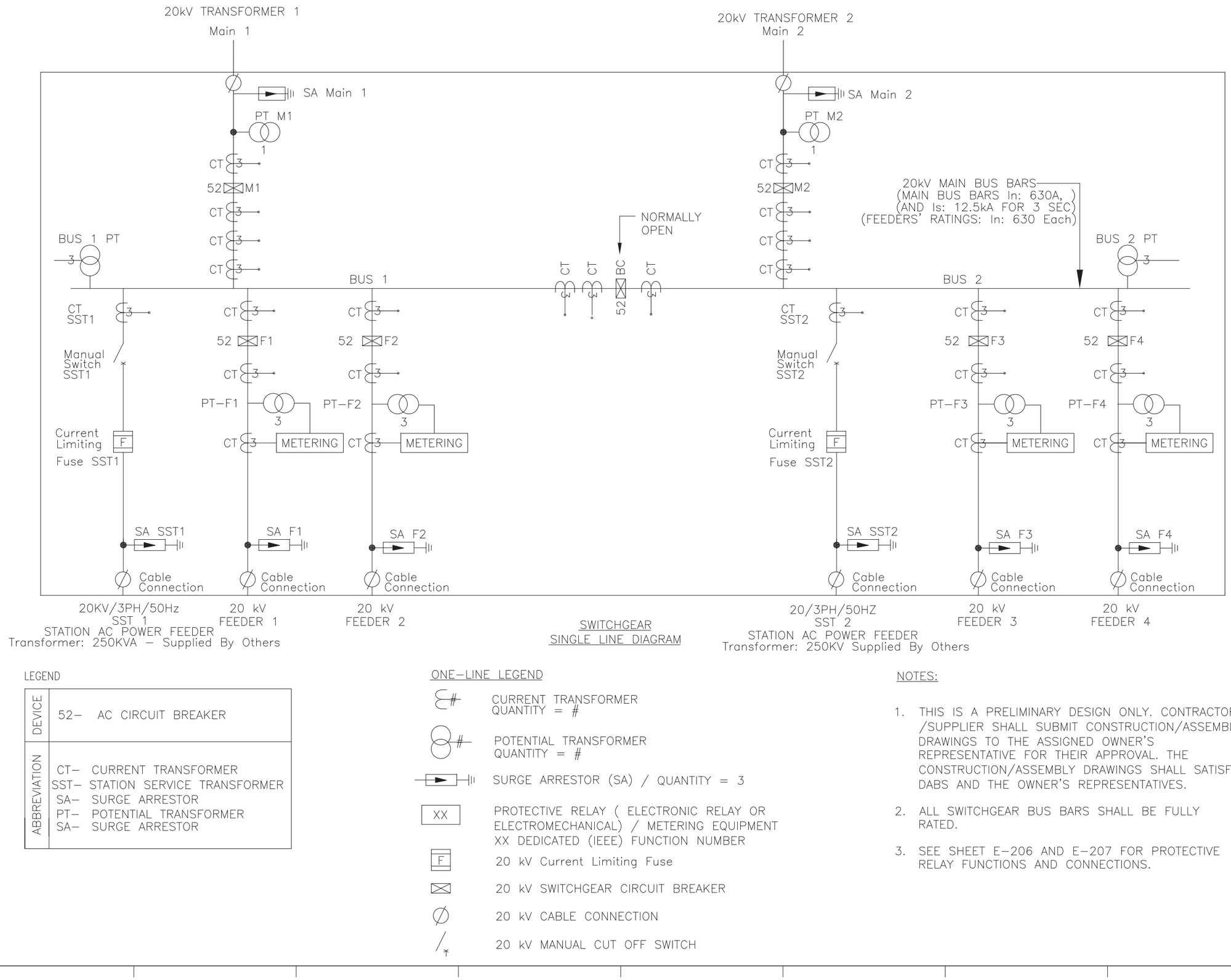
SUBSTATION SINGLE LINE DIAGRAM

SHEET REFERENCE NUMBER:

E–102

RFP #: DABS-92-ICB-028

P:\1298\Work Orders\WO-LT\WO-LT-0063 Salang Tunnel SS Technical Sections\CAD\SheetFiles\Concept Design\E-102-Substation Single Line Diagram.dwg 11/23/2013 1:32:21 PM Yarmand, Mohammad Arash



SWITCHGEAR
SINGLE LINE DIAGRAM

LEGEND

DEVICE	52– AC CIRCUIT BREAKER
ABBREVIATION	CT– CURRENT TRANSFORMER SST– STATION SERVICE TRANSFORMER SA– SURGE ARRESTOR PT– POTENTIAL TRANSFORMER SA– SURGE ARRESTOR

ONE–LINE LEGEND

- CURRENT TRANSFORMER QUANTITY = #
- POTENTIAL TRANSFORMER QUANTITY = #
- SURGE ARRESTOR (SA) / QUANTITY = 3
- XX — PROTECTIVE RELAY (ELECTRONIC RELAY OR ELECTROMECHANICAL) / METERING EQUIPMENT XX DEDICATED (IEEE) FUNCTION NUMBER
- F — 20 kV Current Limiting Fuse
- 20 kV SWITCHGEAR CIRCUIT BREAKER
- 20 kV CABLE CONNECTION
- 20 kV MANUAL CUT OFF SWITCH

NOTES:

1. THIS IS A PRELIMINARY DESIGN ONLY. CONTRACTOR /SUPPLIER SHALL SUBMIT CONSTRUCTION/ASSEMBLY DRAWINGS TO THE ASSIGNED OWNER'S REPRESENTATIVE FOR THEIR APPROVAL. THE CONSTRUCTION/ASSEMBLY DRAWINGS SHALL SATISFY DABS AND THE OWNER'S REPRESENTATIVES.
2. ALL SWITCHGEAR BUS BARS SHALL BE FULLY RATED.
3. SEE SHEET E–206 AND E–207 FOR PROTECTIVE RELAY FUNCTIONS AND CONNECTIONS.

THIS PROJECT WAS MADE POSSIBLE BY THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT AND THE GENEROUS SUPPORT OF THE AMERICAN PEOPLE THROUGH USAID GLOBAL ARCHITECTURE AND ENGINEERING IQC CONTRACTS

FINAL DESIGN SUBMITTAL

SYMB	DESCRIPTION	DATE	APR
B	Removed SS transformers from the switchgear	12/06/2013	NF
A	Concept Design Submittal	07/09/13	KF

SUBMITTAL/REVISION

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: NF
DATE: 07/09/13
SUBMITTED BY: Tetra Tech
CAD FILE NAME: LT0063-E-103

USAID FROM THE AMERICAN PEOPLE

AESP

USAID – OEGI
SALANG TUNNEL SUBSTATION
GOWARAH, AFGHANISTAN
20KV SWITCHGEAR
SINGLE LINE DIAGRAM

SHEET REFERENCE NUMBER:
E–103

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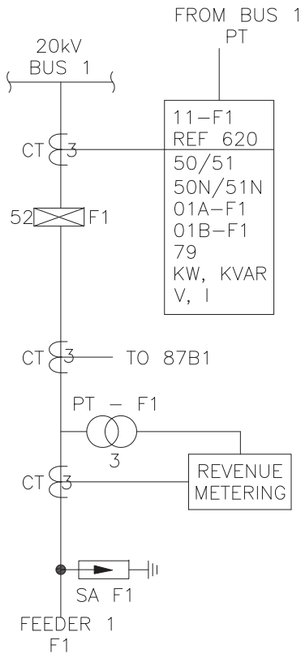
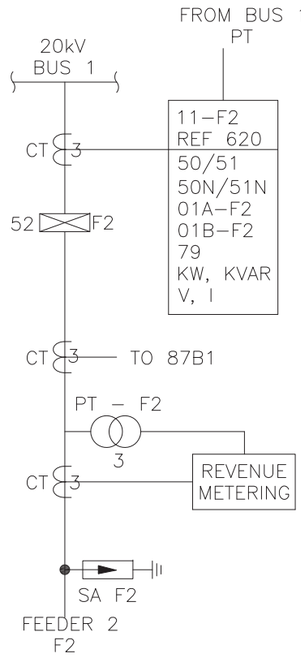


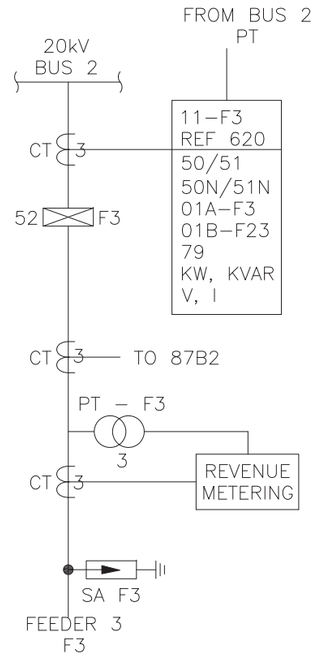
NOTES:

1. 01A–F1 IS LOCAL CONTROLLER HMI IN 11–F1 CONTROLLING 52–F1.
2. 01B–F1 IS SCADA CONTROL OF 52–F1 THROUGH 11–F1.



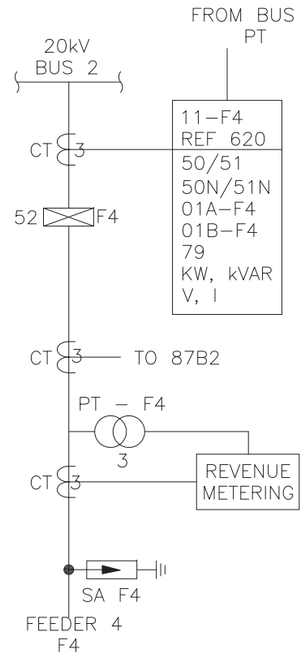
NOTES:

1. 01A–F2 IS LOCAL CONTROLLER HMI IN 11–F2 CONTROLLING 52–F2.
2. 01B–F2 IS SCADA CONTROL OF 52–F2 THROUGH 11–F2.



NOTES:

1. 01A–F3 IS LOCAL CONTROLLER HMI IN 11–F3 CONTROLLING 52–F3.
2. 01B–F3 IS SCADA CONTROL OF 52–F3 THROUGH 11–F3.



NOTES:

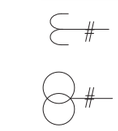
1. 01A–F4 IS LOCAL CONTROLLER HMI IN 11–F4 CONTROLLING 52–F4.
2. 01B–F4 IS SCADA CONTROL OF 52–F4 THROUGH 11–F4.

20kV SWITCHGEAR FEEDER BREAKERS SINGLE LINE DIAGRAMS

LEGEND

ID	RELAY FUNCTIONS
1	MASTER ELEMENT (TRIP/CLOSED)
11	MULTI–FUNCTIONS RELAY DEVICE
50	INSTANTANEOUS OVERCURRENT
51	AC INVERSE TIME OVERCURRENT
52	AC CIRCUIT BREAKER
79	AC RECLOSING
87B	BUS DIFFERENTIAL PROTECTION

ONE–LINE LEGEND



THIS PROJECT WAS MADE POSSIBLE BY THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT AND THE GENEROUS SUPPORT OF THE AMERICAN PEOPLE THROUGH USAID GLOBAL ARCHITECTURE AND ENGINEERING IQC CONTRACTS

CONCEPT DESIGN SUBMITTAL

SYMB	SUBMITTAL/REVISION DESCRIPTION	DATE	APR
B	Replaced switches with breakers	11/15/2013	RC
A	Concept Design Submittal	07/09/13	KF

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: NF
DATE: 07/09/13
SUBMITTED BY: Tetra Tech
CAD FILE NAME: LT0063-E-104

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SALANG TUNNEL SUBSTATION
GOWARAH, AFGHANISTAN
20kV SWITCHGEAR FEEDER BREAKERS
SINGLE LINE DIAGRAMS

SHEET REFERENCE NUMBER:
E104

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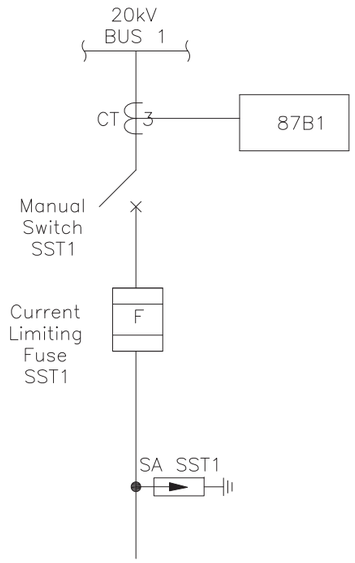
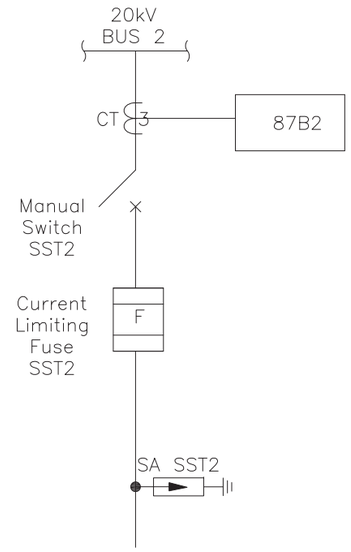


TO
SUB STATION TRANSFORMER 1



TO
SUB STATION TRANSFORMER 2

20kV STATION SERVICE TRANSFORMERS FEEDERS
SINGLE LINE DIAGRAMS

LEGEND

ID	FUNCTION
87B	BUS DIFFERENTIAL PROTECTIVE

ONE-LINE LEGEND

- CT # — CURRENT TRANSFORMER QUANTITY = #
- SURGE ARRESTOR (SA) QUANTITY = 3
- F — 20KV Current Limiting Fuse

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FINAL DESIGN SUBMITTAL

SYMB	SUBMITTAL/REVISION DESCRIPTION	DATE	APR
B	Removed Relays , CTs and Notes:	12/06/2013	RC
A	Concept Design Submittal	07/09/13	KF

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: NF
DATE: 07/09/13
SUBMITTED BY: Tetra Tech
CAD FILE NAME: LT0063 - E - 105

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USAID - OEGI
SALANG TUNNEL SUBSTATION
GOWARAH, AFGHNISTAN

STATION SERVICE FEEDERS
SINGLE LINE DIAGRAMS

SHEET REFERENCE NUMBER:
E-105

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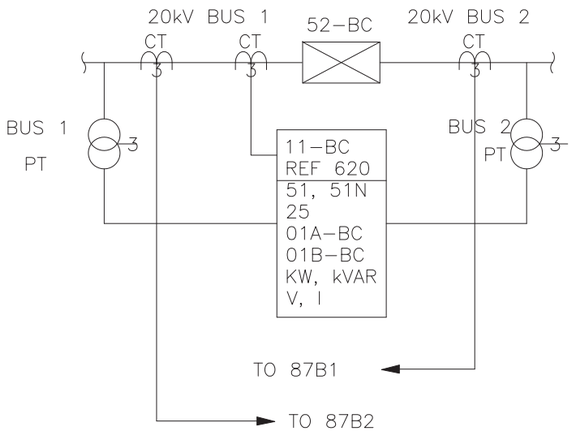
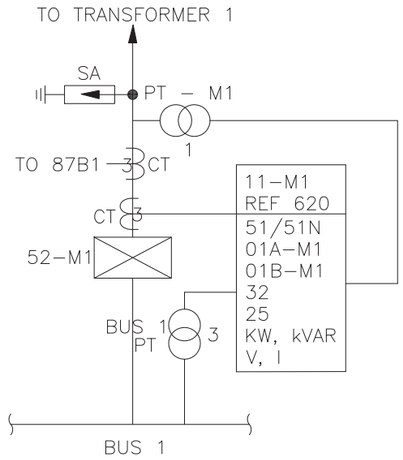


NOTES:

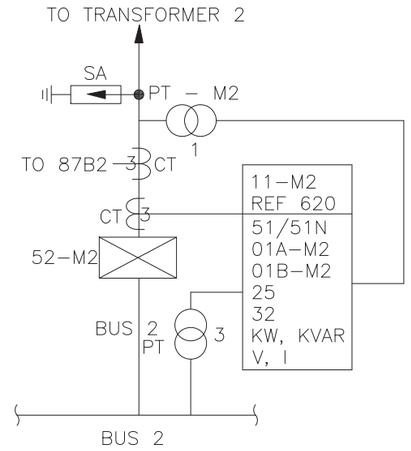
1. 01A–BC IS LOCAL CONTROLLER HMI IN 11–BC CONTROLLING 52–BC.
2. 01B–BC IS SCADA CONTROL OF 52–BC THROUGH 11–BC.

20kV LT TIE BREAKER
SINGLE LINE DIAGRAMS



NOTES:

1. 01A–M1 IS LOCAL CONTROLLER HMI IN 11–M1 CONTROLLING 52–M1.
2. 01B–M1 IS SCADA CONTROL OF 52–M1 THROUGH 11–M1.



NOTES:

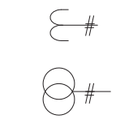
1. 01A–M2 IS LOCAL CONTROLLER HMI IN 11–M2 CONTROLLING 52–M2.
2. 01B–M2 IS SCADA CONTROL OF 52–M2 THROUGH 11–M2.

20kV LT MAIN BREAKERS
SINGLE LINE DIAGRAMS

LEGEND

ID	FUNCTION
1	MASTER ELEMENT
11	MULTI–FUNCTION DEVICE
50	INSTANTANEOUS OVERCURRENT RELAY
51	AC INVERSE TIME OVERCURRENT RELAY
52	AC CIRCUIT BREAKER
87B	BUS DIFFERENTIAL PROTECTIVE
32	REVERSE POWER

ONE–LINE LEGEND



NOTE: A3 SIZE REDUCED TO HALF SCALE

THIS PROJECT WAS MADE POSSIBLE BY THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT AND THE GENEROUS SUPPORT OF THE AMERICAN PEOPLE THROUGH USAID GLOBAL ARCHITECTURE AND ENGINEERING IQC CONTRACTS

FINAL DESIGN SUBMITTAL

SYMB	SUBMITTAL/REVISION DESCRIPTION	DATE	APR
B	Replaced switches with breakers	11/15/13	RC
A	Concept Design Submittal	07/09/13	KF

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: NF
DATE: 07/09/2013
SUBMITTED BY: Tetra Tech
CAD FILE NAME: LT0063 – E – 106

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GOWARAH, AFGHANISTAN

20kV SWITCHGEAR MAIN BREAKERS
SINGLE LINE DIAGRAMS

SHEET REFERENCE NUMBER:
E–106

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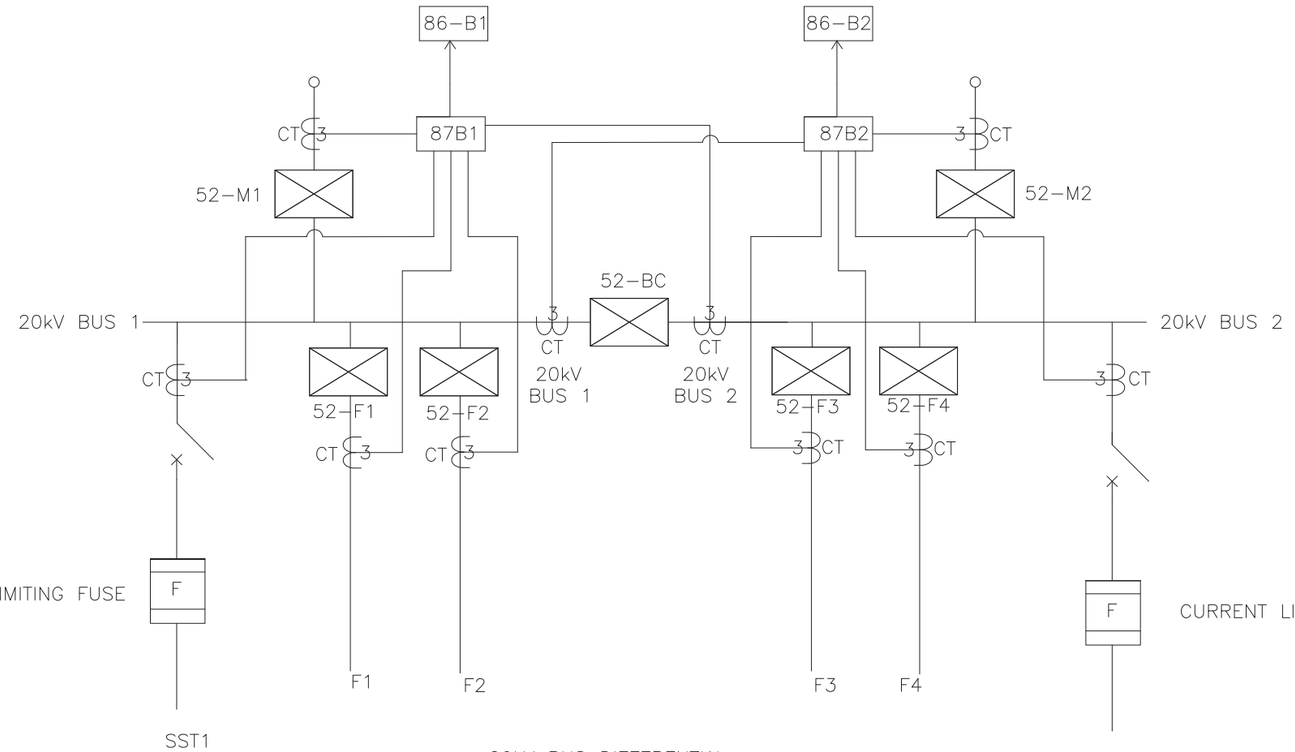
27 OF 30



20kV BUS DIFFERENTIAL SINGLE LINE DIAGRAMS

LEGEND

ID	RELAY FUNCTIONS
52	AC CIRCUIT BREAKER
79	AC RECLOSING RELAY
87B	BUS DIFFERENTIAL PROTECTIVE RELAY
86	LOCK OUT RELAY

ONE-LINE LEGEND

- CURRENT TRANSFORMER, QUANTITY = #
- 20KV SWITCHGEAR CIRCUIT BREAKER
- SURGE ARRESTOR (SA) / QUANTITY = 3
- 20KV MANUAL SWITCH
- 20KV CURRENT LIMITING FUSE

THIS PROJECT WAS MADE POSSIBLE BY THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT AND THE GENEROUS SUPPORT OF THE AMERICAN PEOPLE THROUGH USAID GLOBAL ARCHITECTURE AND ENGINEERING IQC CONTRACTS

FINAL DESIGN SUBMITTAL

SYMB	DESCRIPTION	DATE	APR
B	Replaced switches with breakers	11/15/13	RC
A	Concept Design Submittal	07/09/13	KF

SUBMITTAL/REVISION

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: NF
DATE:
SUBMITTED BY: Tetra Tech
CAD FILE NAME: LTG06- E-107

USAID FROM THE AMERICAN PEOPLE

AESP

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SALANG TUNNEL SUBSTATION
GOWARAH, AFGHANISTAN

20kV SWITCHGEAR BUS DIFFERENTIAL SINGLE LINE DIAGRAMS

SHEET REFERENCE NUMBER:
E-107

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Appendix C – 220kV Power Transformers

SECTION 33 73 10_Rev1

220 kV POWER TRANSFORMER

PART 1 GENERAL

This specification describes the technical features and details for: Description: 4MVA, 220kV/20kV, 50 Hz, 3-Phase, Delta primary, Wye secondary, isolated neutral, power transformers configured as 3.2/4MVA(ONAN/ONAF).

Quantity: Two (2) complete units.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60076-1	Power transformers - Part 1: General
IEC 60076-7	Power transformers - Part 7: Loading guide for oil-immersed power transformers
IEC 60076-10	Power transformers - Part 10: Determination of sound levels
IEC 60137	Insulated bushings for alternating voltages above 1000 V
IEC 60616	Terminal and tapping markings for power transformers
IEC 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles
IEC 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramic and glass insulators for AC systems
IEC 62581	Electrical steel - Methods of measurement of the magnetostriction characteristics by means of single sheet and Epstein test specimens
IEC 60317-0-1	Specifications for particular types of winding wires - Part 0-1: General requirements -Enameled round copper wire
IEC 60296	Fluids for electro technical applications -Unused mineral insulating oils for transformers and switchgear
IEC 60814	Insulating liquids - Oil-impregnated paper and pressboard - Determination of water by automatic coulometric Karl Fischer titration
IEC 60567	Oil-filled electrical equipment - Sampling of gases and analysis of free and dissolved gases -Guidance
IEC 60156	Insulating liquids - Determination of the breakdown voltage at power frequency – Test method
IEC 60695-2-10	Fire Hazard testing - Part 2-10: Glowing/hotwire based test methods - Glow-wire apparatus and common test procedure

IEC 60695-2-11	Fire hazard testing - Part 2-11: Glowing/hotwire based test methods - Glow-wire flammability test method for end-products
IEC 60247	Insulating liquids - Measurement of relative permittivity, dielectric dissipation factor (tand) and DC resistivity
IEC 61198	Mineral insulating oils - Methods for the determination of 2-furfural and related compounds

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 4	High Voltage Testing
IEEE 100	The Authoritative Dictionary of IEEE Standards Terms
IEEE 315	Graphical Symbols
IEEE 315A	Graphical Symbols - Supplement
IEEE 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems Above600V
IEEE 469	Electrical Noise Test - Transformers
IEEE C2	National Electrical Safety Code
IEEE C37.47	Standard for High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches
IEEE C57.12.00	Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.10	IEEE Standard Requirements for Liquid-Immersed Power Transformers
IEEE C57.12.28	Standard for Pad-Mounted Equipment – Enclosure Integrity
IEEE C57.12.80	Standard Terminology for Transformers
IEEE C57.12.90	Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.13.1	IEEE Guide for Field Testing of Relaying Current Transformers
IEEE C57.19.01	Performance Characteristics for Outdoor Bushings
IEEE C57.91	Loading Mineral Oil Transformer
IEEE C57.98	Guide for Transformer Impulse Tests
IEEE C57.106	Maintenance of Insulating Oil
IEEE C57.131	Requirements for Load Tap Changers
IEEE C62.11	Standard for Metal- Oxide Surge Arresters for Alternating

	Current Power Circuits (>1kv)
IEEE C62.22	Application of Metal-Oxide Surge Arrestors

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

BRITISH STANDARDS INSTITUTION

BS 4360	Specification for weldable structural steels
BS 5493	Code of practice for protective coating of iron and steel structures against corrosion
BS 7671	Requirements for Electrical Installations. IET Wiring Regulations

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C92.2	Electrical Systems - Preferred voltage Ratings
ANSI C84.1	Voltage Ratings for Electric Power Systems
ANSI V-1	Compressed Gas Cylinder Valve Outlet

ASTM INTERNATIONAL (ASTM)

ASTM A153/153M	Zinc Coating on Iron and Steel Hardware
ASTM D92	Standard Test Methods for Flash and Fire
ASTM D1499	Operating Light and Water Exposure
ASTM D1933	Nitrogen Gas as Electrical Insulator
ASTM D2225	Silicon Fluids in Electrical Apparatus
ASTM D2565	Xenon Arc Exposure of Plastics
ASTM D5222	High Fire Point Mineral Oil
ASTM G 154	UV Exposure

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.3 GENERAL REQUIREMENTS

All equipment shall be manufactured in accordance with the latest edition of applicable IEC-EN or ANSI/IEEE organization standards. Manufacturers may choose to consistently follow IEC or ANSI/IEEE standards based on the manufacturer’s usual compliance ratings. Specific standard references from one organization may be substituted by an equivalent standard from another

organization for consistency of the manufacturer’s compliance ratings. For example, an IEEE standard reference may be substituted by an equivalent IEC standard reference.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. All Submittals shall be provided in electronic format. Drawings shall be provided in AutoCAD format. SD-02 Shop Drawings (G)

Power transformer drawings;

SD-03 Product Data (G)

Power transformers;

Submittal shall include manufacturer's information for each component, device, insulating fluid, and accessory provided with the transformer.

SD-06 Test Reports (G)

Acceptance checks and tests;

Submittal shall include acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

SD-09 Manufacturer's Field Reports (G)

Power transformer routine and other tests;

SD-10 Operation and Maintenance Data (G)

Transformer(s)

a. Safety precautions

b. Operator prestart

c. Start-up, shutdown, and post-shutdown procedures

d. Normal operations

e. Environmental conditions

f. Preventive maintenance plan and schedule

g. Troubleshooting guides and diagnostic techniques

h. Wiring and control diagrams

i. Maintenance and repair procedures

j. Removal and replacement instructions

k. Spare parts and supply list

l. Product submittal data

m. Manufacturer's instructions

n. O&M submittal data

o. Parts identification

p. Testing equipment and special tool information

q. Warranty information

r. Testing and performance data

s. Contractor information

SD-11 Closeout Submittals (G)

Transformer test schedule;

1.5 QUALITY ASSURANCE

1.5.1 Power Transformer Drawings

Drawings shall indicate, but not be limited to the following:

1) An outline drawing, with front, top, and side views.

2) Nameplate data.

3) Elementary and point to point diagrams and wiring diagrams

4) One-line diagram, including any switch (es), current transformers, meters, and fuses.

All drawings to be provided in AutoCad format.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of BS 7671 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-yearperiod. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.4 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.5 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

In addition to requirements of Section 1.3, include the following on the actual transformer(s) provided:

1) An instruction manual with pertinent items and information highlighted

2) An outline drawing, front, top, and side views

3) Spare parts and supply list

4) Routine and field acceptance test reports

5) Fuse curves for primary fuses

6) Actual nameplate diagram

7) Date of purchase

1.7 WARRANTY

The supplier shall warrant all transformers and associated equipment supplied under this specification for a minimum period of 1 year. Certificates of warranty shall be submitted.

PART 2 PRODUCTS

2.1 THREE-PHASE POWER TRANSFORMERS – 220/20kV – 4MVA IEEE C57.12.00, IEEE C57.12.10, or IEC 60076 and as specified herein.

2.2 TANK

The transformer tank shall be manufactured from steel plates with welded seams. No welded seams shall be allowed on the tank corners.

It shall conform to the requirements of IEEE C57.12.10.

Handholes and manholes shall be located such that access does not require removal of equipment or accessories. A circular, bolted manhole shall be provided. Manholes shall be a minimum of 50 cm (20 inches) in diameter.

A device that is suitable for mounting a safety device in the approximate center of the tank cover and capable of supporting hardware including harnesses utilizing gravity brakes shall be provided.

The cover shall be domed to shed water and welded to the tank. During welding of the transformer cover, an inorganic gasket will be permanently located between the cover and tank flange to prevent the entrance of welds platter into the tank.

The base shall have additional means to prevent corrosion such as a mastic coating or neoprene cover over the bottom of the base plate.

2.3 GROUNDING

Grounding pads shall consist of two NEMA two-hole copper-faced steel pads, which are drilled, tapped, and attached to the tank per ANSIC57.12.10.

A ground pad shall be welded to the tank cover near the neutral bushing(s).

A complete ground bus system for the transformer neutral shall be provided. A copper bus bar of appropriate size shall be routed from the neutral bushing down the tank to a point 150 mm (6 inches) above the transformer base. The bus bar shall be terminated with a bolted bronze connector sized to accept 70 mm² through 120 mm² stranded copper cable. The ground bus system shall be completely assembled and finished with the same paint system as the transformer, except for surfaces that provide electrical grounding connections.

2.3.1 Facilities for Lifting, Moving, Jacking, and Anchoring

Facilities for lifting, moving, jacking and anchoring the complete transformer (with oil), as well as for separately lifting the cover, and for lifting the core and coil assembly from the tank, shall be provided in compliance with ANSI C57.12.10.

2.3.2 Core

The transformer core shall be constructed of the highest quality, non-aging, cold-rolled, grain-oriented, stress-free, thin, silicon-steel laminations having high permeability and low hysteresis loss. The steel shall be properly annealed and have smooth surfaces at the edges. Each sheet shall have an insulated surface which is impervious to hot transformer oil. The core shall be rigidly clamped and blocked to prevent deteriorating vibrations, interference with oil circulation, short circuits, objectionable noise levels and shipment distortions. Any internal blocking or bracing used which is to be removed from the transformer at its destination shall be painted a bright color, such as red or yellow. The core shall be securely grounded to the tank in a location accessible from a manhole cover without lowering the oil. A means shall be provided for properly handling the core assembly when it is removed from the tank.

2.3.3 Windings

All transformer windings shall be designed and wound with maximum short circuit strength as a primary design criterion. All windings shall be furnished with insulation that will permit continuous operation at a winding rise of 65°C above ambient and a hotspot rise of 80°C above ambient without affecting the normal life expectancy of insulation. Winding leads shall be readily accessible from a manhole in the tank cover.

Copper windings are required.

The transformer shall be capable of withstanding a bolted fault from an infinite bus. The only limitation to the through fault current shall be the impedance of the transformer.

2.3.4 Bushings

All bushings shall be removable without removing the tank cover. Bushings shall be mounted in accordance with ANSI C57.12.10. Oil-filled bushings shall be equipped with expansion chambers and oil level indicators. All bushings shall be designed such that there will be no undue stress placed on any parts due to temperature changes.

Standard, threaded, tinned, bronze, stud-type terminals with NEMA four-hole pads shall be furnished on all bushings. Porcelain used in the bushings shall be manufactured by the wet process and shall be homogeneous, free from laminations, cavities, or other flaws affecting its mechanical strength or dielectric quality. The glazing of the porcelain shall be free from imperfections, such as blisters or burns. Bushing color shall be light gray.

220kV bushings shall be capable of accepting three (3) bushing-type current transformers each. 20kV and neutral bushings shall be capable of accepting two (2) bushing-type current transformers each. Each bushing shall have provisions for measuring the power factor.

All bushings shall meet the requirements of the latest ANSI StandardC57.19.00 and C57.19.01 and shall safely withstand specified transformer test levels.

2.3.5 De-energized Tap Changer

Five full capacity taps shall be supplied on the high voltage (220kV)winding. Two (2) taps shall be provided below the nominal voltage specified in Specification Table 1, and two (2) taps shall be provided above the nominal voltage. Each tap shall represent a voltage change of2.5% of the nominal voltage.

The tap voltages and maximum line currents shall be shown on the transformer

nameplate. The taps shall be designated both on the nameplate and the tap changer indicating plate by numbers in sequence with the numeral "1" being assigned to the voltage rating which provides the greatest ratio of transformation.

The tap changer shall be capable of being operated only while the transformer is de-energized. It shall be hand-wheel operated with a position indicator and shall be located on the transformer tank at a level such that it may be operated from ground level. Facilities for locking in any tap position shall be provided.

The tap changer shall be capable of withstanding transformer short circuits.

2.3.6 On Load Tap Changer

An on load tap changer (OLTC) shall be supplied on the low voltage (20kV)winding. The OLTC shall be furnished with the arcing contacts housed in separate compartments, designed to prevent any interchange of oil between the OLTC compartment and the main transformer tank. Removable bolted covers shall be provided for access to the switch compartment without opening or lowering the oil in the main transformer tank. A drain valve with sampling device shall be located in the bottom of the OLTC compartment to provide complete oil drainage. A magnetic liquid level gauge shall be mounted on the side of the oil-filled compartment. A mechanical pressure relief device shall be mounted on the top of the oil-filled compartment. The tap changer shall provide full rated MVA on taps above and below rated voltage.

The tap changer shall be designed to provide at least 500,000 operations at the maximum nameplate current rating before contact replacement. When a current limiting series transformer is provided, it must have circular windings and meet all the same criteria as the main core and coil.

The OLTC shall be furnished with a controller to provide regulation in 16steps in the positive (forward - voltage raise) direction and 16 steps in negative (reverse - voltage lower) direction. The controller shall be furnished within the transformer OLTC cabinet/control panel and shall provide current OLTC position, forward or reverse movements for the OLTC contacts, upper and lower limit indications (drag hands), quantity of operations, neutral indication, and interlock indications between manual and automatic mode of operation for the OLTC.

Equipment for the automatic and manual control of the OLTC shall be furnished in a weatherproof compartment mounted adjacent to the tap changer compartment. Access and operation of the controller at ground level shall be provided. The following equipment shall be furnished, as necessary, to provide the specified OLTC controls:

a) Manual Control
- Operating mechanism with motor drive.
- Weatherproof compartment with convenience outlet, anti-condensation heater
- Mechanically operated limit switches and stops to prevent over-travel of the drive mechanism beyond the maximum raise and lower positions.
- Local position indicator.
- Operations counter.
- RAISE-LOWER selector switch for manual control
- Neutral indicating lamp

b) Automatic Control
- AUTOMATIC-OFF-MANUAL selector switch.

- Voltage testing terminals.
- Line drop compensator with adjustable resistance and reactive elements.
- Current transformers for line drop compensation.
- Voltage regulating settings
- Time-delay settings Neutral indicating lamp
- A hand crank for manual operation, with electrical interlock to prevent operation of the motor while the hand crank is being used.

c) Remote Control

- REMOTE-LOCAL selector switch. Remote tap position indicator for mounting on a remote control panel.

2.3.7 Surge Arresters

Station class surge arresters shall be mounted on the secondary side of the transformer.

Metal-oxide type surge arresters shall be provided rated for MCOV of15.3kV for the 20kV secondary.

The surge arresters shall be in compliance with ANSI C62.1 and shall be ANSI 70, light gray in color.

Aluminum NEMA 4-hole pads shall be furnished on the line terminals of all arresters.

2.3.8 Insulating and Cooling System

a) Oil

The transformer may be shipped with or without oil. Transformers shipped oil-filled shall employ an adequate method of oil preservation during transit. Transformers shipped without oil shall be shipped with tanks pressurized with dry air or nitrogen to insure exclusion of moisture and external atmosphere until filling.

Separately shipped oil shall be scheduled for delivery at the point of installation during the time that the Supplier's Engineer is supervising the installation. Oil shall be shipped F.O.B. destination. Total oil cost(including shipping) shall be included as part of the firm price quoted in the bid.

An additional 10% of extra cooling oil shall be supplied with the transformer.

Oil shall be pure, unadulterated, mineral oil obtained by the fractional distillation of petroleum. Oil shall be prepared and refined especially for use in transformers, having a minimum flash point of 160°C. It shall be free from moisture, acid, alkali, and injurious sulfur compounds. The oil shall not form a deposit under normal operating temperatures. The minimum allowable dielectric strength of the oil shall be 26kV when measured in accordance with the applicable ASTM standard.
The supplier shall furnish test results certifying the oil supplied with this equipment, and any oil used in the production or testing of this equipment, is classified as "No Detectable-PCB" (polychlorinated biphenyl). The purchaser will not accept delivery of the equipment until such results are received. The supplier is responsible for providing the same certification as listed above for any oil supplied by a subcontractor. Demurrage incurred due to lack of this certification will be paid by the Supplier.

b) Oil Preservation System

The Supplier's standard oil preservation system, equipped with a

pressure-vacuum bleeder device set to employed. A bleed tube for gas blanket dew point measurement shall be provided. Suitable valves shall be provided to permit purging the gas space and testing the seal on the tank by admitting dry nitrogen under pressure.

A combination drain and lower filter valve shall be provided. This valve shall provide for drainage of oil to within 25 mm (1 inch) of the tank bottom and for outlet of the oil to a filtering means. The size of the drain valve shall be 50 mm (2 inches) and have 50 mm (2 inch) NPT threads with a pipe plug in the open end. The drain valve shall have a built-in 9.52 mm (3/8 inch) sampling device which shall be located in the side of the valve between the main valve seat and the pipe plug. This sampling device shall have an 8 mm (5/16 inch) - 32 male threads and be equipped with a cap.

A globe type upper filter valve shall be located below the 25°C liquid level and shall be suitable for the return of filtered oil. The size of the upper filter shall be one (1) inch and have one (1) inch NPT threads with a pipe plug in the open end.

There shall be a top filling valve with a minimum size of two (2) inches.

2.3.9 Forced Cooling System

The transformer shall be designed for continuous self-cooled operation and force-cooled operation, as specified in Specification Table 1. The average winding temperature rise above ambient temperature shall not exceed 55°Cat rated kVA and the maximum (hottest-spot) winding temperature rise above ambient temperature shall not exceed 80°C at rated kVA when tested in accordance with IEEE standard C57.12.90 using combination of connections and taps that give the highest average winding temperature rise.

The forced cooling equipment (fans) shall be suitable for connection to a 230 volt, single phase, 50 Hertz power supply. The cooling equipment shall be individually connected to the power supply in a protective and weatherproof manner. The motors shall be totally enclosed, without a centrifugal clutch, permanently lubricated and protected by circuit breakers. Fans shall be mounted in a manner that will facilitate maintenance and/or replacement. The control for adjusting the temperature at which the cooling equipment starts shall be readily accessible.

The temperature relay nameplate shall state the recommended temperature at which the cooling equipment will be started. This information shall also be provided on the wiring diagram. Devices for automatic control of cooling equipment shall be provided with the following:

A thermally operated control device with thermal element mounted in a well responsive to top liquid temperature of the transformer.

Thermally operated control device responsive to the winding temperature of the primary winding.

The device shall have two sets of individually adjustable contacts with factory settings as follows:

Contact Functions:

1 Supply power to cooling system

2 Initiate alarm or actuate relay for over temperature operation

A switch shall be provided to select automatic or manual control.

A weatherproof control cabinet (see 2.3.13) enclosing switching equipment

shall be located on the transformer at a height suitable for operation when standing at base level. The cabinet shall have interior illumination.

Conduit and wiring for cooling equipment shall be provided.

2.3.10 Oil Heating System

The transformer shall be designed for operation in the low temperature and environmental conditions listed in the Specification Table 1. The transformer oil shall be heated to allow for worst-case low ambient conditions in an extended period non-energized state.

The Wattage of the heating system shall be selected by the manufacturer to maintain a minimum core temperature of 5°C, while de energized and worst-case cold operating environment shown in Specification Table 1.

The oil heating equipment shall be suitable for connection to a 400/230 volt, three phase, 50 Hertz power supply. The heating equipment shall be individually connected to the power supply in a protective and weatherproof manner. The heaters shall be totally enclosed and protected by circuit breakers. Heaters shall be mounted in a manner that will facilitate maintenance and/or replacement with minimal oil loss. The system shall allow normal transformer operation during maintenance or replacement operations. The control for adjusting the temperature at which the heating equipment starts shall be readily accessible.

The heating temperature relay nameplate shall state the recommended temperature at which the cooling equipment will be started. This information shall also be provided on the wiring diagram. Devices for automatic control of heating equipment shall be provided with the following:

A thermally operated control device with thermal element mounted in a well responsive to top liquid temperature of the transformer.

Thermally operated control device responsive to the winding temperature of the primary winding.

The device shall have two sets of individually adjustable contacts with factory settings as follows:

Contact Functions:

1 Supply power to heaters

2 Initiate alarm or actuate relay for under-temperature condition

A switch shall be provided to select automatic or manual control.

A weatherproof control cabinet (se 2.3.13) enclosing switching equipment shall be located on the transformer at a height suitable for operation when standing at base level. The cabinet shall have interior illumination.

Conduit and wiring for heating equipment shall be provided.

2.3.11 Radiators

The transformer shall be provided with a sufficient number of radiators to cool the oil properly. The radiators shall be attached to flanges welded into the tank wall, and the joints shall be made tight by means of suitable gaskets. Radiator valves shall be installed on each radiator connection so that any individual radiator may be removed for repair without removing the transformer from service. Provisions shall be made so that it will not be necessary to shut down all of the cooling equipment when removing any one radiator for repair. There shall be provisions for draining and filling each radiator individually. Each radiator shall be provided with a means for lifting. The radiators shall be galvanized.

2.3.12 Accessories

a) Liquid Level Indicator

The transformer shall be equipped with a magnetic liquid-level indicator which shall be readable when standing at base level.

The indicator shall have a dark-faced dial with light markings and alight-colored indicating hand. Dial marking shall show the 25°C level and the maximum and minimum levels. The words "Liquid Level" shall be marked on the dial.

b) Liquid Temperature Indicator

A dial-type thermometer shall be mounted on the side of the tank. The thermometer shall have a dark-faced dial with light markings, a light-colored indicating hand, and an orange-red maximum indicating hand with provisions for resetting. The dial markings shall cover a range of 0°C to120°C. The words "Liquid Temperature" shall be marked on the dial.

The thermometer shall be direct-stem mounted in a closed well at a suitable level to indicate the top-liquid temperature.

c) Winding Temperature Indicators

Dial-type winding temperature indicators shall be mounted on the side of the tank. The indicators shall have a dark-faced dial with light markings, a light-colored indicating hand, and an orange-red maximum indicating hand with provisions for resetting. The dial markings shall cover a range of 0°C to 120°C. The word "Winding Temperature" shall be marked on the dial with nameplates indicating the appropriate winding. Indicators shall be provided for each winding.

d) Alarm Contacts

Non-grounded alarm contacts for liquid-level and temperature indicators shall be furnished and be suitable for interrupting:

0.02-ampere direct current inductive load

0.20-ampere direct-current non-inductive load

2.5-ampere alternating-current non-inductive or inductive load

250 volts maximum in all cases

The liquid-level indicator alarm contacts shall be nonadjustable and shall be set to close at the minimum safe operating level of the liquid. The liquid-temperature indicator alarm contacts shall be adjustable over a (minimum) range of:

High temperature alarm, 65°C to 110°CLow
temperature alarm, 0°C to 20°C

e) Fault Pressure Relay

A fault pressure relay and reset switch shall be furnished for each separate compartment of the transformer. For each fault pressure relay, an auxiliary relay shall be provided with a minimum of three single-pole single-throw normally open contacts. The fault pressure relay, auxiliary relay and reset switch shall be supplied by the transformer manufacturer and be located in the transformer control cabinet.

f) Pressure/Vacuum Gauge

A pressure/vacuum gauge shall be furnished. The gauge shall have a dark-faced dial with light markings and a light-colored indicating hand. The scale range

for the pressure gage shall be between 10 psi negative and 10 psi positive. On sealed tank systems, a pressure/vacuum bleeder device with a gas sampling nozzle shall be furnished.

g) Pressure Relief Device

A pressure relief device shall be supplied for each sealed compartment of the transformer. The pressure relief device shall be the mechanical type which will automatically reseal after excess pressure has been vented. The pressure relief device shall have a form "C" alarm contact rated for 220VDC and a mechanical signal for indication of device operation.

h) Tools

The Supplier shall provide any special tools which are necessary for maintenance or installation of the transformer. These shall be included in the firm price.

i) Gaskets

All gaskets used in construction of the transformer shall be of reusable rubber with means provided for controlled compression. A spare set of gaskets for the transformer shall be furnished by the Supplier. These shall be included in the firm price.

j) Stud Connectors

Aluminum NEMA 4-hole pads shall be furnished on all bushings.

k) Cabinet Heaters

The Supplier shall provide suitable 230 volt, A.C. strip heaters in the control cabinets to accommodate the ambient temperatures specified.

2.3.13 Control Cabinet

The control cabinet shall include a minimum of the following items, each clearly labeled and housed within one weatherproof and dustproof enclosure mounted on the transformer:

Terminal blocks for attachment of incoming fan power leads.

Terminal strips for control wires.

Door-operated, 230 volt, A.C. service light with separate on-off switch.

230 volt, 50Hz, SCHUKO type 70114, A.C. convenience outlet.

230 volt, A.C. strip heater.

A molded case circuit breaker with residual current protection

Shorting type terminals for all taps of all CT leads. Terminal strips for CT leads shall be grouped according to sets of three-phase CT's.

A bolted, removable conduit plate, 1.506 mm (16 gauge) maximum, in the bottom of the cabinet which can be removed for conduit entry punching in the field.

All items of the cooling and heating control systems which are not mounted on external devices or on the transformer tank.

The interior of the control cabinet shall be white in color.

All control and alarm circuits shall be completely wired by the Supplier and brought to a weatherproof control cabinet. All connections to Purchaser's external circuits shall be brought to the control cabinet. All circuits for the required auxiliary equipment such as CT's fans, pumps, etc. shall be factory wired to terminal blocks in the control cabinet. The wiring shall be routed in rigid steel conduit and marked in accordance with the factory

wiring diagrams. Wiring insulation shall withstand the ambient temperatures described in Specification Table 1 without abnormal deterioration.

The required owner connections for control power, relaying, etc. shall be clearly identified on the control cabinet terminal diagrams. Ample space shall be provided for routing and termination of all Owner wiring. Connection diagrams shall be provided in AutoCAD format.

All contacts which are available for owner use shall be identified on the schematic and wiring diagrams.

2.3.14 Nameplate

A durable corrosion-resistant metal nameplate shall be affixed to the transformer by the Supplier. It shall bear the information listed on example nameplate C, IEEE C57.12.00. The following information shall also be included:

Current transformer locations and ratings.

Maximum positive and negative operating pressures of the oil preservation system.

Pounds of vacuum filling pressure for which tank is designed.

Oil level in inches below the top surface of the highest point of the manhole flange at 25°C. Oil level change in inches per 10°C change in oil temperature.

Any other information which the Supplier deems necessary for proper installation, maintenance, and operation of the transformer.

2.3.15 Surface Finish

The exterior color of all steel components shall be Light Gray and the interior cabinet color shall be white.

The top of the main tank shall be a non-skid coating.

Radiators shall be hot dipped galvanized. Galvanizing shall be in conformance with ASTM designation A-123.

Painting: Primer Coat

Surfaces shall be free of abrasives, oils, dirt, or contaminants when primed.

Handling of coating equipment and the steel surfaces to be primed shall be done in a manner to avoid contamination during and following application of the primer.

The surface temperature of the steel to be coated shall be 50° F minimum and at least 5° F above the wet bulb air temperature reading.

The primer coat shall be applied by air or airless spray in accordance with the paint manufacturer’s latest recommendations.

The primer thickness shall be 2.0 mils (dry). The primer thickness shall be monitored by a Wet Film Thickness method.

The primer shall be allowed to cure prior to application of second or top coating for a minimum of the time recommended by the paint manufacturer.

Areas with dry film thickness less than 1.7 mils or greater than 5.0 mils shall be corrected by additional primer coating or by re blasting and recoating.

The primer shall be of zinc rich inorganic type. It shall be recommended by the manufacturer as suitable for protecting against normal, noncorrosive outdoor weathering.

The primer coat shall be applied no more than 12 hours after blasting and on the same day it is blasted.

A minimum of 7.57 liters (2 gallons) of the primer shall be furnished with the transformer to the jobsite and delivered to the General Contractor for field painting of any areas where paint has been damaged during shipment and erection.

2.3.16 Painting Top Coat

The topcoat shall be a polyamide epoxy type. It shall be recommended by the manufacturer as suitable for protecting against normal, non-corrosive outdoor weathering.

Top coating shall be applied after any corrections have been made to the primed surface and the primer is fully cured.

The topcoat shall be applied to a thickness of 3.0 mils dry (primer plus topcoat =5.0 mils, dry) using the manufacturer's recommended procedures. The topcoat thickness shall be monitored by a Wet Film Thickness method.

Areas where the dry film thicknesses of the primer plus topcoat are less than 4.5 mils or greater than 8.0 mils shall be corrected.

A minimum of two (2) gallons of the topcoat shall be furnished to the job-site with the transformer and delivered to the general Contractor for field painting of any areas where paint has been damaged during shipment and erection.

PART 3 EXECUTION

3.1 TESTING

Before shipping, the Manufacturer shall test the transformer per the applicable standard tests. Two (2) copies of the test reports shall be forwarded to the Owner and the Engineer prior to shipping. The Manufacturer shall obtain release from the Owner prior to shipment.

The following tests shall be performed on the transformer in accordance with ANSI C57.12.90. Where permissible under this ANSI Standard, data from tests performed on duplicate units produced by the Supplier at the same time may be furnished in lieu of actual tests. Tests shall not be limited to those described in the Specification. The Supplier may perform additional tests which he deems necessary under his quality control program. The Supplier shall furnish the Purchaser with six (6) copies of guaranteed performance data and test reports which define the tests and list the certified test results. The costs of all factory tests performed by the Supplier shall be included in the firm price quoted in the Proposal.

Resistance measurements of all windings on the rated voltage connections and the tap connections

Ratio tests on the rated voltage connections and on all tap connections

Polarity and phase-relation tests on the rated voltage connections

Excitation loss at rated voltage and rated frequency on the rated voltage connections

Exciting current at rated voltage and rated frequency on the rated voltage connections

Induced potential test

Applied potential test

Quality control impulse test

Impedance and load loss at rated current on the rated voltage taps

Tested or calculated positive and zero sequence impedance between all windings at rated voltage

Temperature Test

Tests shall be made only when there is not available a record of a temperature test, made in accordance with ANSI Standards, on a duplicate or an essentially duplicate unit.

Temperature tests shall be made for each stage of cooling, including the maximum kVA rating given on the nameplate.

Transformer shall have sufficient mechanical strength to withstand, without damage or failure, all through-fault currents in accordance with ANSI C57.12.00. The Bidder shall demonstrate that the transformer(s)meets this requirement by at least one of the following methods:

Certified test data showing that a transformer with a core and coil identical in design and construction and identical or similar with respect to KVA capacity, kV ratings, BIL, impedance, and voltage taps has been tested under maximum short-circuit conditions without failure. A description of the test code under which the transformer was tested for short-circuit strength shall be provided by the Bidder to the Purchaser.

The Purchaser shall be immediately notified of any unusual damage occurring during construction of the transformer and all tests which do not meet specified or standard values. The Purchaser shall be permitted, at his option, to personally inspect such damages and/or test failures.

3.2 INSPECTION BY THE ENGINEER/OWNER

The Engineer and/or Owner shall be allowed to witness testing performed by the Seller, as well as inspect the equipment at any time. Inspection by the Engineer / Owner shall not relieve the Seller of his responsibility to inspect the equipment, confirm all requirements of testing, and supply complete equipment which satisfies all requirements of these Specifications.

3.3 SPECIAL SHIPPING REQUIREMENTS

Bidder will supply with his bid approximate gross weights, together with the overall physical dimensions of equipment of subassembly as packed for shipment, and a written proposal describing, briefly, the design, contents and number of shipping units.

3.4 SITE ASSEMBLY

Bid must specify all site assembly requirements, including but not limited to oil requirements per Section 2.3.8 above.

3.5 APPROVED SUPPLIERS

Approved suppliers of the 220kV transformer are Siemens, ABB, Schneider Electric, or Owner approved equal.

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220 kV POWER TRANSFORMER

SPECIFICATION TABLE 1

DESCRIPTION	UNIT	REQUIRED VALUE
Quantity Required	Each	2 (Two)
Type		Two (2) Winding
Rated frequency	Hz	50
Phase		3
Primary Voltage (phase to phase)	kV	220kV, DELTA
Secondary Voltage (phase to phase)	kV	20kV Gnd. Wye,
Vector Group		Dyn1
Class		ONAN/ONAF
Impedance H-X (@ ONAN)	%	9.5% + 10% tolerance
Coolant		Mineral Oil per ASTM D3487 – latest revision
Temperature Rise: By Resistance (ONAN/ONAF) Hottest Spot (ONAN/ONAF)		 55°C/65°C 65°C/80°C
Continuous rating (ONAN)	MVA	3.2MVA
Continuous rating (ONAF) level 1	MVA	4MVA
BIL Level, Windings HV Windings LV Windings HV Neutral LV Neutral	 kV kV kV kV	 750kV 150kV Not Applicable 150kV
BIL Level, Bushings HV Windings LV Windings HV Neutral LV Neutral	 kV kV kV kV	 1,000kV 200kV Not Applicable 200kV
DETC Location		High Voltage Winding
Number of DETC tapping positions		5
DETC Tapping range and steps	%	+5% to -5% in 2.5% steps
Surge Arrester MCOV Ratings Secondary Side (Station Class) Rated Voltage IEC Ur	kV kV	 Minimum 15.3kV
Auxiliary source voltages	VAC/VDC	230/400 VAC single/three phase 50 Hz 220 VDC
Winding Material	Cu	Copper only
220 kV Bushing Current Transformers Relaying	 qty	 3 per bushing maximum
220 kV Bushing Current Transformers Relaying	 qty	 2 per bushing supplied
Current ratio		#1 – 25/50:1 #2 – 25/50:1
ANSI Accuracy Class		#1 – C200 #2 – C200 #3 – 0.3
Location		High voltage bushing

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220 kV POWER TRANSFORMER

Neutral Current Transformer	qty	2
Current ratio		#1 – 150/300:1 #2 – 150/300:1
Location		Low voltage bushing
ANSI Accuracy Class		#1 – C200 #2 – C200
20 kV Current Transformers Relaying	qty	2 per bushing
Current ratio		#1 – 150/300:1 #2 – 150/300:1
ANSI Accuracy Class		#1 – C200 #2 – C200
Location		Low Voltage bushing
Seismic Zone (UBC)		Moderate hazard, Zone 2
Ambient Temperature Range	°C	-40 to 40
Radial Ice Build-up	Mm	13
Elevation Above Sea Level	m(ft)	3,500m (11,500ft) minimum
Wind Speed/NESC Loading District	km/h	High
Color		ANSI-70 Gray

--- End of Section ---

Appendix D – 220kV Circuit Breakers

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220 kV CIRCUIT BREAKERS

PART 1 GENERAL

This specification describes the technical features and details for:

Description: 220kV, 50 Hz, 3-Phase, 1250 amp (min.), SF6 Circuit breakers.

Quantity: Five (5) complete units.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. All equipment shall be in accordance with the latest versions of the applicable standards.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C29.1	Power Insulators - Test Methods
ANSI C29.9	Wet-Process Porcelain Insulators
ANSI C37.09a	Standard for Testing of AC High-Voltage Breakers
ANSI C37.32	Schedules of Preferred Ratings
ANSI C37.34	Test Code for HV Switches
ANSI C63.2	Electromagnetic Noise and Field Strength
ANSI MG 1	Motors and Generators

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM D2472	Standard Specification for Sulphur Hexafluoride (SF6)
ASTM D1499	Operating Light and Water Exposure
ASTM D2565	Xenon Arc Exposure of Plastics
ASTM G154	UV Exposure

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62271-1	High-voltage switchgear and controlgear - Part 1: Common specifications
IEC 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles

IEC 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions- Part 2: Ceramic and glass insulators for AC systems

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.100.1	Common Requirements for HV Switchgear
IEEE 1	Temperature Limits in Rating Electrical Equipment
IEEE 4	High Voltage Testing
IEEE 386	Standard for Separable Insulated Connector System for Power Distribution Systems Above 600V
IEEE 693	Seismic Design of Substations
IEEE 1125	Moisture Measurement in SF6 Equipment
IEEE 1291	Partial Discharge Measurement
IEEE 1313.1	Insulation Coordination - Definitions
IEEE 1313.2	Insulation Coordination - Application
IEEE C37.04	Standard Rating Structure for AC High-Voltage Circuit Breakers
IEEE C37.06	Standard for Rating AC High-Voltage Circuit Breakers on a symmetrical current basis.
IEEE C37.010	Application Guide for AC Circuit Breakers
IEEE C37.22	Preferred Ratings and Related Required Capabilities for Indoor AC Medium-Voltage Switches Used in Metal-Enclosed Switchgear
IEEE C37.90.1	Surge Withstand Capacity Test
IEEE C57.12.28	Standard for Pad-Mounted Equipment - Enclosure Integrity

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA SG 6	Power Switching Equipment
NEMA 107	Methods for Measuring RIV
NEMA CC1	Power Connectors for Substations
NEMA MG 1	Motors and Generators

1.2 GENERAL REQUIREMENTS

All equipment shall be manufactured in accordance with the latest edition of applicable IEC-EN or ANSI/IEEE organization standards.

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220 kV CIRCUIT BREAKERS

Manufacturers may choose to consistently follow IEC or ANSI/IEEE standards based on the manufacturer's usual compliance ratings. Specific standard references from one organization may be substituted by an equivalent standard from another organization for consistency of the manufacturer's compliance ratings. For example, an IEEE standard reference may be substituted by an equivalent IEC standard reference.

1.3 SUBMITTALS

SD-02 Shop Drawings

Submit Connection Diagrams for heater connections

Provide detail drawings that show mounting details and configuration for the following:

220 kV Circuit Breakers

SD-03 Product Data

Provide Equipment and performance data for the following items:

220kV SF6 Circuit Breakers

SD-06 Test Reports

Provide Test reports for the following in accordance with ANSI C37.72.

Basic Impulse Insulation Level

(BIL) Withstand Voltage Rating

Momentary RMS Asymmetrical Rating

Leak Tests

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for the following equipment:

Circuit breakers

Space Heaters

1.4 SHIPPING

Prior to shipment, perform leak tests and certify the completed circuit breakers assembly to have leak rate less than 10^{-7} (0.0000001) cubic centimeters per second via a helium mass spectrometer test. Seal and fill

Circuit breakers with SF6 to a nominal 70 kilopascal positive pressure at 24 degrees C.

The supplier shall pack all cylinders of SF6 gas in accordance with commercial standards to protect them from damage in transit. Each shipping unit shall be marked clearly with the name of the consignee,

shipping destination, purchase order and markings required by law. A complete packing list shall be securely attached to the outside of each shipping unit.

PART 2 PRODUCTS

2.1 220KV CIRCUIT BREAKERS

All 220kV circuit breakers shall be suitable for installation in an outdoor substation. Circuit breakers shall be provided with all mounting hardware, and structural support members integral to proper operation. Circuit breakers shall be new, free from defect and provided with all necessary accessories for normal and comprehensive operation.

2.2 220KV CIRCUIT BREAKERS

The supplier shall provide 220kV circuit breaker within the scope of this specification.

Circuit breakers shall be equipped with motor-charged spring operated mechanism rated for 220 V DC. The motor-charged spring-operated devices shall have a direct-on-line starter. It shall be possible to set the operating spring manually with a hand-crank. Motors shall be designed in accordance with valid IEC - EN publication and operate correctly between 85% and 110% of rated voltage.

The motors shall be effectively protected and designed for outdoor operation. The motor circuits shall be controlled 2-pole (Phase) from the motor-protection and end-position contacts. An auxiliary relay for alarm shall be connected to the motor-voltage and have a closed contact for no voltage, tripped motor-protection and unloaded spring. The operating mechanism shall be provided with an anti-pumping device.

Circuit breaker switching medium shall be sulphur hexafluoride (SF6) gas in accordance with IEC 62271-1.

The circuit breaker shall have 220 VDC shunt coils for closing and duplicate tripping. The coil and relays in the closing circuits shall operate correctly between 85% and 110% of the rated voltage. For tripping circuits the limits are 70% and 110%. The circuit breaker mechanism shall be provided with an operation counter for at least 9999 C/O-cycles.

2.3 ACCESSORIES

Provide fittings, lifting eyes, insulators, and other required accessories with the circuit breakers as necessary.

Provide all corrosion-resistant metal operating parts of circuit breakers assemblies.

Provide circuit breakers with suitable attachments to permit closing and opening under full rated load current, without damage. Provide circuit breakers with a visible break option that allows direct viewing of the switch contacts in the open and closed positions.

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220 kV CIRCUIT BREAKERS

Provide outdoor rated, control junction boxes rated IP65. Circuit breakers factory wire and all control/indication devices to junction boxes shall utilize outdoor rated, flexible conduit.

Each circuit breaker shall be furnished with standard accessories as required for breaker operation and maintenance, and the following accessories:

An auxiliary switch with thirty spare adjustable contacts wired to terminal blocks in the control compartment and available to the purchaser. Factory setting of contacts shall be fifteen (15) "a" and fifteen (15) "b".

A latch-check switch, or other means of performing an equivalent of the latch-checking function.

An operation counter arranged to count opening operations and visible from the outside of the cabinet.

Alarms to indicate low air and/or gas pressure and temperature, and failure of devices critical to breaker operation, including loss of voltage on essential auxiliary power and control circuits. Contact shall close when alarm is to be transmitted.

A Local/Remote switch that allows isolation of the trip and close circuits from remote operation inputs. A status contact (form C) from the Local/Remote switch shall be wired to the terminal block for customer use.

At least one (1) additional contact wired out from the "X" and "Y" closing relays for use in external automatic reclosing circuits.

A control switch located in the control cabinet that allows open and close operation of the circuit breaker when the Local/Remote switch mentioned above is in the "local" position.

A complete set of all special tools as required.

Two (2) NEMA two-hole copper-faced ground pads on frame on diagonally opposed locations.

A complete set of spare gaskets.

The Supplier shall provide the Purchaser with a list of recommended spare parts for the breaker and their costs. The cost of the spare parts shall not be included in the base bid price.

Breaker Manufacturer shall submit with the bid documents a sample of Breaker Nameplate. Please note that the circuit breaker nameplate data and approval Schematics shall include the following data for the trip coil, close coil and motor mechanism in addition to what is typically offered by the manufacturer.

- Trip coil operating voltage range and current
- Close coil operating voltage range and current

- Spring charge, motor operating voltage range, motor full load, locked rotor/inrush

2.4 CONTROL ENCLOSURE

Locally mounted control enclosure shall meet the following criteria:

The control enclosure shall be an insulated, weatherproof and dustproof steel cabinet: IP65 Rated.

Manually operated visible break type disconnect switches with overcurrent protection to protect the heater, charging spring motor, and control circuits. Each circuit shall be independently protected.

A door-operated, 230VAC 50 Hz service light with a separate on-off switch and a 230VAC "schuko" type CEE 7/4 receptacle.

Thermostatically controlled, 230 VAC heaters placed so as to avoid environmental damage to charging spring motor, solenoids, air receiver and control wiring. Heaters shall be suitable to accommodate the temperature range specified in Section 2.2 above. The thermostat shall have a field adjustable range of 50 F (10 C) to 90 F (33 C).

All control wiring marked at both ends and all components labeled in accordance with the control diagrams.

Provisions for locking doors in the open position to facilitate maintenance and testing.

A bolted, removable conduit plate, 16 gage maximum, in bottom of cabinet which can be removed for conduit entry punching in the field.

All circuits for the required auxiliary equipment such as CT's, fans, pumps, etc. factory wired to insulated barrier type terminal blocks located in the control cabinet. Terminal blocks shall have screw-type terminals to accept No. 10 lugs. The manufacturer shall use closed lug terminators for all control wiring. The wiring shall be routed in rigid steel conduit and marked in accordance with the factory wiring diagrams. Wiring insulation shall withstand the ambient temperatures as specified above without abnormal deterioration.

The required owner connections for control power, relaying, etc. shall be clearly identified on the control cabinet terminal diagrams. Ample space shall be provided for routing and termination of all owners' wiring.

All contacts that are available for the owners' use shall be identified on the schematic and wiring diagrams.

2.5 MOUNTING FRAMES

Furnish mounting frames that are of angle-iron construction and are hot- dipped galvanized after fabrication in accordance with ASTM A123/A123M.

After fabrication, clean and paint all exposed ferrous metal surfaces. Paint mounting frames in accordance with ANSI C37.72.

2.6 FACTORY FINISH

Provide switches with the manufacturer's standard paint finish when used for harsh indoor/outdoor environments.

2.7 SF6 GAS SYSTEM

The circuit breaker shall utilize sulfur hexafluoride (SF6) gas as an insulating and interrupting medium.

The manufacturer shall design the gas system assuring the unusual service conditions as described in IEEE standard C37.100.1 are rigidly applied.

The breaker shall be furnished with all standard accessory items that facilitate handling and sampling of the gas.

The Manufacturer shall supply sufficient gas for complete installation, operation of the breaker, and three (3) year supply of replacement gas as deemed necessary by manufacturer.

The SF6 gas shall be a high-purity, low-moisture grade gas, which is an inert compound and has a high dielectric strength. The SF6 gas shall meet the requirements of ASTM D2472.

- The moisture content shall not exceed that indicated by a max. dew point of 62 C.
- The hydrolysable fluorides, expressed as HF acidity, shall not exceed 0.3 ppm.
- The molecular nitrogen, expressed as N2, shall not exceed 0.05% by weight.
- The carbon tetrafluoromethane, CF4, shall not exceed 0.05% by weight.
- The total SF6 assay shall not be less than 99.8% by weight.

The supplier shall provide certification of compliance as to SF6 gas purity. The Supplier shall meet the labeling and safety warnings as required by OSHA. The supplier shall also certify that the SF6 gas supplied is at least as nontoxic as those substances in Underwriters Laboratories toxicity classification Group VI and supply the appropriate MSDS (Material SafetyData Sheet).

PART 3 EXECUTION

3.1 TESTING

Before shipping, the Manufacturer shall test the equipment per the pertinent standard test. Two (2) copies of the test reports shall be forwarded to the Owner and the Engineer prior to shipping. The Manufacturer shall obtain release from the Owner prior to shipment.

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220 kV CIRCUIT BREAKERS

3.2 INSPECTION BY THE ENGINEER/OWNER

The Engineer and/or Owner shall be allowed to witness testing performed by the Seller, as well as inspect the equipment at any time. Inspection by the Engineer / Owner shall not relieve the Seller of his responsibility to inspect the equipment, confirm all requirements of testing, and supply complete equipment which satisfies all requirements of these Specifications.

3.3 SPECIAL SHIPPING REQUIREMENTS

Bidder will supply with his bid approximate gross weights, together with the overall physical dimensions of equipment of subassembly as packed for shipment, and a written proposal describing, briefly, the design, contents and number of shipping units.

3.4 ASSEMBLY

Bid must specify all site assembly requirements.

3.5 APPROVED SUPPLIERS

Approved suppliers of the 220kV circuit breakers are Siemens, ABB, Schneider Electric, or Owner approved equal.

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220 kV CIRCUIT BREAKERS

Specification Table 1

DESCRIPTION UNIT		REQUIRED VALUE
Quantity Required	Each	5 (Five)
Type		SF6 Circuit Breakers
Nominal System Voltage	kV	220kV
Rated (maximum nominal) voltage	kV	245kV
Rated lightning impulse withstand voltage (BIL Peak value) kV		1,200kV
Rated 1 minute power-frequency withstand voltage (RMS)	kV	620kV
Rated frequency	Hz	50Hz
Rated normal current (minimum)	A	1,250A
Rated short time withstand current (3 second RMS)	kA	40kA
Rated Peak Withstand Current (Peak) kA		108kA
Creepage distance for outdoor insulators, minimum value (IEC 60815)		25mm/kV_{LL}
Operating temperature range		-40 C to 40 C
Maximum relative humidity		20g/m^3 (50%)
Rated Class		Outdoor
Rated operation sequence		0-0.3s-CO-3min-CO
Rated short-circuit breaking current kA		40kA
Rated making (Close/Latch) current kA		100kA
Total reclosing time		240ms
Number of Phases		3 phases
Rated Interrupting Time		60ms
Close Coil Voltage		220VDC
Charging Spring Motor Voltage		220VDC (+10%, -15%)
Mechanism and Control Heater Voltage		230VAC (+10%, -15%)
Seismic Zone		Moderate hazard - Zone 2
Radial Ice Build-up	mm	13mm
Elevation Above Sea Level		3,500 m (11,500 ft)
Wind Speed/NESC Loading District		High

--- END OF SECTION ---

Appendix E – 220kV Disconnect Switches

SECTION 33 77 22_Rev1

220 kV DISCONNECT SWITCHES

PART 1 GENERAL

This specification describes the technical features and details for:

Description: 220kV, 50 Hz, 3-Phase, 1250 amp, disconnect/earthing switches.

Quantity: Six (6) Type I, and six (6) Type II switches.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C29.1	Power Insulators - Test Methods
ANSI C29.9	Wet-Process Porcelain Insulators
ANSI C37.04	Standard Rating Structure for AC High-Voltage Circuit Breakers
ANSI C37.06	Standard for Rating AC High-Voltage Circuit Breakers on a symmetrical current basis
ANSI C37.09a	Standard for Testing of AC High-Voltage Breakers
ANSI C37.30.1	Requirements for AC High-Voltage Air Switches Rated Above 1000 V
ANSI C37.32	Schedules of Preferred Ratings
ANSI C37.34	Test Code for HV Switches
ANSI C63.2	Electromagnetic Noise and Field Strength
ANSI MG 1	Motors and Generators

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM D2472	Standard Specification for Sulphur Hexafluoride
ASTM D1499	Operating Light and Water Exposure
ASTM D2565	Xenon Arc Exposure of Plastics
ASTM G154	UV Exposure

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220 kV DISCONNECT SWITCHES

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62271-1	High-voltage switchgear and controlgear - Part 1: Common specifications
IEC 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles
IEC 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 2: Ceramic and glass insulators for a.c. systems

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.30.1	Requirements for AC HV Air Switches
IEEE 4	High Voltage Testing
IEEE 142	Grounding
IEEE 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE 1247	Interrupter Switches for AC
IEEE C37.100.1	HV Power Switchgear
IEEE C57.12.28	Standard for Pad-Mounted Equipment - Enclosure Integrity

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA SG 6	Power Switching Equipment
NEMA 107	Methods for Measuring RIV
NEMA CC1	Power Connectors for Substations
NEMA MG 1	Motors and Generators

1.2 GENERAL REQUIREMENTS

All equipment shall be manufactured in accordance with the latest edition of applicable IEC-EN or ANSI/IEEE organization standards. Manufacturers may choose to consistently follow IEC or ANSI/IEEE standards based on the manufacturer’s usual compliance ratings. Specific standard references from one organization may be substituted by an equivalent standard from another organization for consistency of the manufacturer’s compliance ratings. For example, an IEEE standard reference may be substituted by an equivalent IEC standard reference.

The manufacturer shall design the motor operated disconnect switch assuring the unusual service conditions as described in IEEE standard C37.30.1 are rigidly applied.

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220 kV DISCONNECT SWITCHES

1.3 DESCRIPTION

Type I – Double end break, motor operated, horizontally mounted, three- pole gang switch with single-end manual operated earthing switch.

Type II – Single end break, motor operated, vertically mounted, three- pole gang switch with single-end manual operated earthing switch.

1.4 SUBMITTALS

SD-02 Shop Drawings

Provide detail drawings that show mounting details and configuration for the following:

Disconnect Switches

SD-03 Product Data

Provide Equipment and performance data for the following items:

220kV Disconnect switches

SD-06 Test Reports

Provide Test reports for the following in accordance with IEEE

4.0.

Basic Impulse Insulation Level (BIL)

Withstand Voltage Rating

Momentary RMS Asymmetrical Rating

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for the following equipment:

Disconnect Switches

PART 2 PRODUCTS

2.1 220kV EQUIPMENT

All 220kV equipment shall be suitable for installation in an outdoor substation. Equipment shall be provided with all mounting hardware, and structural support members integral to proper operation. Equipment shall be new, free from defect and provided with all necessary accessories for operation.

2.2 220kV DISCONNECT SWITCHES

Disconnect switches shall have porcelain post type insulators. The switch shall, in the open position, prevent all electrical operations of circuit breakers. The switch shall have at least 10 auxiliary contacts and be labeled “OPERATION”.

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220 kV DISCONNECT SWITCHES

All 220kV disconnect switches shall be equipped with a single-end grounding switch. The manually operated earthing switch shall be configured such that all lines on one side of disconnect switch can be grounded. A mechanical interlock system shall be provided with the switch to prevent closing of the earthing switch when the disconnect switch is in the closed position.

The interphase linkage shall be torsional type or an Owner approved equal substitute. All interphase connections and mounting hardware shall be supplied for single gang-throw operation. All interphase connecting pipe fittings shall have piercing screws. Leveling nuts shall be incorporated for plumbing all insulator stacks. The switch linkage shall overtoggle into the fully open or fully closed positions and shall have adjustable mechanical stops for both the open and closed positions. The switch operator rod shall be supplied with an open/close indicator to identify current position of switch. Switch live parts shall be aluminum or
copper. The switch shall have arcing horns/accessories as necessary to meet the requirements of Specification Table 1 to protect the current- carrying contacts.

All 220kV switches shall be motor and manual operated via hand crank. Motor operated disconnect switches shall be designed to provide three- pole operation and shall operate on 220 VDC.

The motor shall be designed in accordance with valid IEC - EN publication and work correctly between 85% and 110% of rated voltage. The motors
shall be effectively protected and designed for outdoor operation.

Electric control shall always be two-pole to avoid malfunction in case of earth faults. Motor operated disconnect switches shall be designed for control and position indication from remote. The operating device shall
be equipped with a selector switch for local and remote control. All 220kV disconnect switches shall be equipped with a ground pad for operators to stand on while operating the switch and ground switch operating handle.

2.2.1 220kV Disconnect Switch Specifications

Provide operating mechanisms that are equipped with handles for manual operation and are operated by a snap-action, quick-make/quick-break. Make opening and closing of the main contacts totally independent of the speed or position of the operating handle. Secure operating handle to the
shaft in a manner that ensures tightness and alignment.

Operation of earthing switch shall be a separate operation from disconnect switch (except for mechanical interlock).

2.3 OPERATOR

The motor operator shall be readily accessible at ground level by a person of average height.

The motorized operator shall have provisions to uncouple and

disconnect switch operating linkage to allow maintenance and test operation of the operator without operating the switch and to allow manual operation of the switch if the motor operator is non-functional.

The motorized operator shall have sufficient torque to accomplish opening or closing of the switch in a single attempt with all accessories installed and maximum radial ice build-up on the switch.

The operator shall be enclosed in a rugged, weatherproof, housing with adequate access to all components for maintenance and troubleshooting. The housing shall be corrosion resistant metal or protected with a durable, corrosion resistant, weatherproof coating.

The motor operator control voltage and functionality shall be in accordance with ANSI C37.33

A DPST knife switch or 2-pole dead-front fused pullout shall be installed on the control circuit to allow removal of all power from the operating circuits for maintenance purposes.

The Manufacturer shall supply heating units as required by the design for reliable operation of the motor operator in the temperature range specified herein. All heating provisions shall operate at the voltage specified in Specification Table 1.

There shall be provisions for padlocking the operator in both the open and closed positions.

An appropriately sized, flexible ground jumper shall be provided for the operating handle and the motor operator.

There shall be provisions for manual operation of the switch with a swing handle/worm gear operator. The manual operator shall be readily accessible for operation by a person of average height. Operator shall have an interlocking mechanism to disable all motor operating circuits before manual operation can take place.

Control devices and/or circuitry shall be provided to:

- Prevent operation from accidental grounds in wiring or motor.
- Prevent over-travel of the device after the switch reaches the full open or closed positions.
- Prevent simultaneous energization of both open and close circuits.
- Produce seal-in of open or close circuits once they are initiated.

All control wiring to external circuits shall be terminated on terminal blocks located in an easily accessible location near the bottom of the enclosure. The terminal blocks shall be labeled according to the Manufacturer’s drawings.

Within the outdoor control enclosure, the Manufacturer shall supply a push button to initiate both open and close operation of the switch.

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220 kV DISCONNECT SWITCHES

A selector switch shall be provided for local or remote operation. Contact points shall be available for remote indication if this switch is in the local position.

Contact points shall be available for remote indication if the switch is open or closed.

Earthing switch shall have a mechanical interlock prohibiting the closing of the earth switch when the disconnect switch is in the closed position.

2.4 ACCESSORIES

Provide fittings, lifting eyes, insulators, and other required accessories with the switch as necessary.

Provide all corrosion-resistant metal operating parts of switch assemblies.

Provide switches with a visible break option that allows direct viewing of the switch contacts in the open and closed positions.

Provide outdoor rated, control junction boxes rated IP65. For switches and circuit breakers factory wire all control/indication devices to junction boxes utilizing outdoor rated, flexible conduit.

2.5 MOUNTING FRAMES

Furnish mounting frames that are of angle-iron construction and are hot- dipped galvanized after fabrication in accordance with ASTM A123/A123M.

After fabrication, clean and paint all exposed non-galvanized ferrous metal surfaces.

Paint mounting frames in accordance with ANSI C37.72.

2.6 FACTORY FINISH

Provide switches with the manufacturer's standard paint finish when used for harsh indoor/outdoor environments.

PART 3 EXECUTION

3.1 TESTING

Before shipping, the Manufacturer shall test the equipment per the applicable standard tests in IEEE 4.0. Two (2) copies of the test reports shall be forwarded to the Owner and the Engineer prior to shipping. The Manufacturer shall obtain release from the Owner prior to shipment.

3.2 INSPECTION BY THE ENGINEER/OWNER

The Engineer and/or Owner shall be allowed to witness testing performed by the Seller, as well as inspect the equipment at any time. Inspection by the Engineer / Owner shall not relieve the Seller of his responsibility to inspect the equipment, confirm all requirements of

testing, and supply complete equipment which satisfies all requirements of these Specifications.

3.3 SPECIAL SHIPPING REQUIREMENTS

Bidder will supply with his bid approximate gross weights, together with the overall physical dimensions of equipment of subassembly as packed for shipment, and a written proposal describing, briefly, the design, contents and number of shipping units.

3.4 ASSEMBLY

Bid must specify all site assembly requirements.

3.5 APPROVED SUPPLIERS

Approved suppliers of the 220kV disconnect switches are Siemens, ABB, Schneider Electric, or Owner approved equal.

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220 kV DISCONNECT SWITCHES

Specification Table 1

DESCRIPTION	UNIT	REQUIRED VALUE
Quantity Required	Each	6 (Six)
Type		Type I and Type II
Nominal Voltage	kV	220kV
Rated Voltage	kV	245kV
Rated lightning impulse withstand voltage (BIL peak)	kV	1,200kV
Rated 1 minute power-frequency withstand voltage (RMS)	kV	230kV
Rated Frequency	Hz	50Hz
Rated current (min.)	A	1,200A
Rated short time withstand current (3 second RMS)	kA	40kA
Type I Switch & Mounting		Center-break, Horizontal
Type II Switch & Mounting		Single-break, Vertical
Creepage distance		25mm/kV
Control Voltage		220VDC (+10%, -15%)
Motor Operator Voltage		220VDC (+10%, -15%)
Heater Voltage		230VAC
Auxiliary Switch		10 (ten)
Seismic Zone (IBC)		Moderate hazard – Zone 2
Radial Ice Build-up	mm	13mm
Elevation Above Sea Level		3,500 m (11,500 ft)
Wind Speed/NESC Loading District		High
Operating temperature range		-40° C to 40° C
Maximum relative humidity		(40° C) 100%

--- END OF SECTION ---

Appendix F – 220kV Surge Arresters

SECTION 33 72 01_Rev1

220kV SURGE ARRESTERS

PART 1 GENERAL

This specification describes the technical features and details for:

Description: 220kV, 50 Hz, Station duty, surge arresters

Quantity: Eighteen (18) complete units.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C29.1	Power Insulators - Test Methods
ANSI C29.9	Wet-Process Porcelain Insulators

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60044	Voltage Transformers Part 2 and Part 5
IEC 60060-1	High voltage test techniques -- Part 1: General definitions and test requirements
IEC 60071-1	Insulation co-ordination
IEC 60099-7	Surge arresters -- Part 7: Glossary of terms and definitions
IEC 60104	Aluminum-magnesium-silicon alloy wire for overhead line conductors
IEC 60120	Dimensions of Ball and Socket Couplings of String Insulator Units
IEC 60273	Characteristic of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V
IEC 60305	Insulators for overhead lines with a nominal voltage above 1000 V - Ceramic or glass insulator units for A.C. systems - Characteristics of insulator units of the cap and pin type
IEC 60372	Locking devices for ball and socket couplings of string insulator units - Dimensions and tests
IEC 60383	Insulators for overhead lines with a nominal voltage above 1000 V

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220kV SURGE ARRESTERS

IEC 60888	Zinc-coated steel wires for stranded conductors
IEC 60889	Hard-drawn aluminum wire for overhead line conductors
IEC 61089	Round wire concentric lay overhead electrical stranded conductors

AMERICAN STANDARDS FOR TESTING OF MATERIALS

A153/153M	Zinc Coating on Iron and Steel Hardware
B3	Soft Annealed Copper Wire
B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft
B230	Aluminum, 1350-H19 Wire for Electrical Purposes
B231	Aluminum 1350 Conductors, Concentric-Lay-Stranded
B232/B232M	Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
B609	Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes
D1499	Operating Light and Water Exposure
D2565	Xenon Arc Exposure of Plastics
G154	UV Exposure

BRITISH STANDARDS INSTITUTE

BS EN 61394	0verhead lines. Requirements for greases for aluminum, aluminum alloy and steel bare conductors
BS EN 62004	Thermal-resistant aluminum alloy wire for overhead line conductor
BS EN 60305	Insulators for overhead lines with a nominal voltage above 1 kV – Ceramic or glass insulator units for ac systems – Characteristics of insulator units of the cap and pin type.
BS EN 60372	Locking devices for ball and socket couplings of string insulator units -- Dimensions and tests

BS EN 60383-1	Insulators for overhead lines with nominal voltage above 1 kV -- Part 1: Ceramic or glass insulator units for ac systems -- Definitions, test methods and acceptance criteria
BS EN 60383-2	Insulators for overhead lines with nominal voltage above 1 kV -- Part 2: Insulator strings and insulator sets for ac systems
BS EN 60437	Radio interference test on high voltage insulators
BS EN 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions -- Part 1: Definitions, information and general principles
BS EN 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions -- Part 2: Ceramic and glass insulators for ac systems

INSTITUTE OF ELECTRONICS AND ELECTRICAL ENGINEERS

IEEE 4	High Voltage Testing
IEEE C84.1	Electric Power Systems and Equipment
IEEE 738	Standard for Calculating the Current-Temperature of Bare Overhead Conductors
IEEE 386	Standard for Separable Insulated Connector
	Systems for Power Distribution Systems above 600V
IEEE 998	Direct Lightning Stroke Shielding
IEEE 1299	Connection of Surge Arresters
IEEE 1313.1	Insulation Coordination – Definitions
IEEE 1313.2	Insulation Coordination - Application
IEEE C37.015	Shunt Reactor Switching
IEEE C37.04	Rating Structure HV Circuit Breakers
IEEE C37.301	High Voltage Switchgear - Test Techniques
IEEE C57.12.10	Requirements for Liquid Immersed Transformers
IEEE C62.1	IEEE Standard for Gapped Silicon-Carbide Surge
	Arresters for AC Power Circuits

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220kV SURGE ARRESTERS

IEEE C62.11 Metal-Oxide Surge Arresters for AC Power Circuits

IEEE C62.22 Application of Metal-Oxide Surge Arrestors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA CC1 Power Connectors for Substations

1.2 GENERAL REQUIREMENTS

All equipment shall be manufactured in accordance with the latest edition of applicable IEC-EN or ANSI/IEEE organization standards. Manufacturers may choose to consistently follow IEC or ANSI/IEEE standards based on the manufacturer's usual compliance ratings. Specific standard references from one organization may be substituted by an equivalent standard from another organization for consistency of the manufacturer's compliance ratings. For example, an IEEE standard reference may be substituted by an equivalent IEC standard reference.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted for review and approval as indicated.

SD-03 Product Data
Surge Arrestors (G)

1.4 QUALITY ASSURANCE

1.4.1 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products that have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Provide a product that has been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, provide items that are products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

PART 2 PRODUCTS

2.1 SURGE ARRESTORS

2.1.1 General

Surge arresters for outdoor use shall be furnished in accordance with this section and as indicated on the Specification Table 1.

The surge arresters shall be in compliance with applicable IEC, British or IEEE standards.

Aluminum NEMA 4-hole pads shall be furnished on the line terminals of all arresters.

220kV surge arrestor shall be supplied with one common surge counter per three phase group.

Heavy duty, Zinc-oxide (ZnO)type, station class surge arresters shall be provided with the ratings in the Specification Table 1.

The arrester hardware shall be constructed from corrosion-resistant metal or shall be zinc-coated in accordance with all the latest applicable ASTM standards.

Arrester discharge counters shall be furnished with a built in mA meter with insulating bases if required.

2.1.2 Surge Arrester Housing

2.1.2.1 Porcelain arresters shall be manufactured from a good commercial grade, wet process porcelain. Color of the porcelain shall be as specified in the data sheet.

2.1.2.2 The arrester housing shall be designed to be non-fragmenting in the event of a housing rupture.

2.1.2.3 Appropriate additional creepage shall be added to arresters if installed in areas with extreme natural atmospheric and man-made pollution. Refer to Specification Table 1 for atmospheric classification.

2.1.3 Nameplate

2.1.3.1 The arrester nameplate shall be corrosion resistant. The information on the nameplate shall be applied in a weatherproof, ultraviolet resistant, scratch resistant manner that is permanent for a minimum of 25 years. Silk screened and/or laser etched paint are not acceptable.

2.1.3.2 Nameplate information shall include, at a minimum:

Arrester Classification

Manufacturers Name

Arrester Model and Serial Numbers

Arrester Duty
Cycle Arrester
MCOV Rating Date
of Manufacture

PART 3 EXECUTION

3.1 TESTING

Before shipping, the Manufacturer shall test the equipment per the applicable standard tests in ANSI C29.1. Two (2) copies of the test reports shall be forwarded to the Owner and the Engineer prior to shipping. The Manufacturer shall obtain release from the Owner prior to shipment.

3.2 INSPECTION BY THE ENGINEER/OWNER

The Engineer and/or Owner shall be allowed to witness testing performed by the Seller, as well as inspect the equipment at any time. Inspection by the Engineer / Owner shall not relieve the Seller of his responsibility to inspect the equipment, confirm all requirements of testing, and supply complete equipment which satisfies all requirements of these Specifications.

3.3 SPECIAL SHIPPING REQUIREMENTS

Bidder will supply with his bid approximate gross weights, together with the overall physical dimensions of equipment of subassembly as packed for shipment, and a written proposal describing, briefly, the design, contents and number of shipping units.

3.4 ASSEMBLY

Bid must specify all site assembly requirements.

3.5 APPROVED SUPPLIERS

Approved suppliers of the 220kV surge arresters are Siemens, ABB, Schneider Electric, or Owner approved equal.

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220kV SURGE ARRESTERS

Specification Table 1

DESCRIPTION UNIT		REQUIRED VALUE
Quantity Required	Each	18 (Eighteen)
Type		Station Duty
Nominal Voltage	kV	220kV
Maximum Voltage	kV	245kV
Rated Insulation Level		1,200kV (peak)
Rated Frequency	Hz	50Hz
Creepage Distance (Minimum)		25mm/kV
Energy Capability Class		2
Nominal Discharge Current	kA	10kA
High Current Withstand Crest	kA	65kA
Maximum Continuous Operating Voltage (MCOV)		Minimum 140kV
Front-of-Wave Discharge Voltage (0.5 µs @ 10kA)		2.19-2.36 kV
System Grounding (Solidly, Ungrounded, Resistively)		Solid
Pollution Class (Light, Medium, Heavy, Very Heavy)		Heavy
Seismic Zone (IBC)		Moderate hazard – Zone 2
Ambient Temperature Range		-40°C to 40°C
Radial Ice Build-up	mm	13mm
Elevation Above Sea Level		3,500m (11,500ft)
Wind Speed/NESC Loading District		High
Mounting (Upright or Suspended)		Upright
Color		Gray

--- END OF SECTION ---

Appendix G – 220kV Current Transformers

SECTION 33 75 00.00 40_Rev 2

220kV Current Transformers

PART 1 GENERAL

This specification describes the technical features and details for:

Description: 220kV, 50 Hz, station duty, free-standing, current transformer.

Quantity: Type I, Nine (9) complete units, and Type II, Six (6) complete units as defined in Specification Table 1.

1.1 REFERENCES

The design, manufacture and performance of equipment covered by this specification shall conform to the latest relevant British, IEC, or American Standards.

The equipment shall conform to one of the following sets of standards.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 44 Instrument Transformers

IEC 185 Current Transformers

IEC 186 Potential Transformers

IEC 255 Electrical Relays

IEC 1036 Static Meters

IEC 60481 Coupling devices for power line carrier systems

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std C57.12.10 Requirements for Liquid Immersed Transformers

IEEE Std C57.12.90 Test Code for Liquid-Immersed Transformers

IEEE Std C57.13 Instrument Transformers

IEEE Std 57.19.01 Outdoor Apparatus Bushings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C37.32 Schedules of Preferred Ratings

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA SG-4 AC HV Circuit Breakers

1.2 GENERAL REQUIPMENTS

All equipment shall be manufactured in accordance with the latest edition of applicable IEC-EN or ANSI/IEEE organization standards. Manufacturers may choose to consistently follow IEC or ANSI/IEEE standards based on the manufacturer's usual compliance ratings. Specific standard references from one organization may be substituted by an equivalent standard from another organization for consistency of the manufacturer's compliance ratings. For example, an IEEE standard reference may be substituted by an equivalent IEC standard reference.

1.3 SCOPE OF WORK

This Specification defines a metering/relaying accuracy current transformer (CT) to be designed and manufactured for installation and satisfactory operation outdoors under the conditions set forth below. The current transformer is to be furnished complete except for the stand. The current transformer furnished under these specifications shall be in accordance with all the requirements of applicable ANSI, ASTM, NEMA, or IEEE standards.

1.4 SUBMITTALS

The manufacture shall supply the following preliminary drawings for the acceptance of the preliminary design:

a) Outdoor instrumentation equipment control wiring termination blocks

b) Equipment cut sheets

PART 2 PRODUCTS

2.1 FREE-STANDING CURRENT TRANSFORMERS

a) General

Free-standing current transformers shall be furnished in accordance with this section and as indicated on the drawings. The manufacturer shall provide a standard design for the items within the scope of the specification. All materials and equipment shall be standard product of a manufacturer regularly engaged in the manufacture of the product and shall be in accordance with accepted industry practices for electrical power transmission.

The requirements of the Free-Standing Current Transformers Specification Data Sheet and drawings shall govern should conflicts occur between them and the written text of these specifications.

b) Codes and Standards

All equipment supplied under this specification shall conform to the applicable standards listed in Section 1.1 above.

c) Equipment Required

The manufacturer shall furnish current transformers as specified on the Specification Data Sheet included at the end of this section. Current transformers furnished shall be complete with all accessories ready for mounting, assembly, connection, and immediate service.

The quantity and types of current transformers furnished shall be as indicated in Specification Table 1. All Current Transformers shall meet the requirements here in, with the only difference between Type I and Type II being the required ratios, as defined in Specification Table 1.

d) Ratings

The current transformers shall be rated as indicated on the Specification Data Sheet.

Total burden shall load the secondary winding of a current transformer between 25% and 75% of rated burden.

The current transformers shall be suitable for operation at the altitude specified on the Specification Data Sheet.

e) Construction Details

Each current transformer shall be designed and fabricated in accordance with the latest revisions of the applicable codes and standards.

Current transformers shall be furnished with all field connection hardware for field mounting on supports described in these specifications. All hardware shall be hot-dip galvanized.

Each current transformer assembly shall include line connectors and base support assembly.

The current transformers shall be furnished with the following accessories:

1) Primary terminals - aluminum or tin-plated bronze, 4-hole spade type, NEMA standard.
2) Oil level indicator
3) Oil drain and filling valves.
4) Lifting eyes in base.

Porcelain color shall be in accordance with the Specification Data Sheet.

The number of cores shall be as indicated on the Specification Data Sheet.

f) CT Base Assembly

The assembly shall be an outdoor, weatherproof enclosure designed and fabricated to support and house the following equipment:

Grounding terminal, tinned bronze, bolted clamp type suitable for a 95 mm² to 240 mm² copper ground cable.

Secondary termination box, weatherproof with threaded conduit hubs.

g) Free standing current transformers shall be multi-ratio furnished in accordance with Specification Table 1.

PART 3 EXECUTION

3.1 TESTING

Before shipping, the Manufacturer shall test the equipment per the applicable standard tests in IEEE C57.13. Two (2) copies of the test reports shall be forwarded to the Owner and the Engineer prior to shipping. The Manufacturer shall obtain release from the Owner prior to shipment.

3.2 INSPECTION BY THE ENGINEER/OWNER

The Engineer and/or Owner shall be allowed to witness testing performed by the Seller, as well as inspect the equipment at any time. Inspection by the Engineer / Owner shall not relieve the Seller of his responsibility to inspect the equipment, confirm all requirements of testing, and supply complete equipment which satisfies all requirements of these Specifications.

3.3 SPECIAL SHIPPING REQUIREMENTS

Bidder will supply with his bid approximate gross weights, together with the overall physical dimensions of equipment of subassembly as packed for shipment, and a written proposal describing, briefly, the design, contents and number of shipping units.

3.4 ASSEMBLY

Bid must specify all site assembly requirements.

3.5 APPROVED SUPPLIERS

Approved suppliers of the 220kV current transformers are Siemens, ABB, Schneider Electric, or Owner approved equal.

Specification Table 1

DESCRIPTION	UNIT	REQUIRED VALUE
Quantity Required – Type I	Each	9 (nine)
Quantity Required – Type II	Each	6 (six)
Type		Station duty, free-standing
Rated Voltage	kV	242kV
Insulation level	kV	1,200kV
Lightning impulse withstand voltage (peak)	kV	1,200kV
Frequency	Hz	50Hz
Normal Current (Ir min)	A	1,200A
Short-Time Withstand Current		Minimum 40kA
Duration Short Current		3 second
Type I CT Ratios	Ratio	CT #1 – 400:1 CT #2 – 400:1 CT #3 – 400:1 CT #4 – 400:1 CT #5 – 75:1
Type II CT Ratios	Ratio	CT #1 – MR 30:1/60:1 CT #2 – MR 30:1/60:1 CT #3 – 400:1 CT #4 – 400:1 CT #5 – MR 15:1/30:1/60:1
Accuracy Class – All Types	Class	CT #1 – C200 CT #2 – C200 CT #3 – C200 CT #4 – C200 CT #5 – 0.3 @B-0.5
Secondary current	A	1A
Thermal Rating	%	200%
Rated Output	VA	50 (each CT winding)
Porcelain color		Gray
Minimum creepage distance		25mm/kV_{LL}
Current Transformer Type		Single Bushing/Window
Current Transformer Class		Metering and Relaying
Minimum Current Rating	A	1,200A
Seismic Zone (IBC)		Moderate hazard – Zone 2
Ambient Temperature Range		-40°C to 40°C
Radial Ice Build-up	Mm	13mm
Elevation Above Sea Level		3,500m (11,500ft)
Wind Speed/NESC Loading District		High

--- End of Section ---

Appendix H – 220kV Capacitor Voltage Transformers

SECTION 33 75 50_Rev1

220kV CAPACITOR VOLTAGE TRANSFORMERS

PART 1 GENERAL

This specification describes the technical features and details for:

Description: 220kV, 50 Hz, station duty, free-standing, capacitor coupled voltage transformer (CVT).

Quantity: Twelve (12) complete units.

1.1 REFERENCES

The design, manufacture and performance of equipment covered by this specification shall conform to the latest relevant British, IEC, or American Standards.

The equipment shall conform to the following standards in particular.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 44	Instrument Transformers
IEC 185	Current Transformers
IEC 186	Potential Transformers
IEC 255	Electrical Relays
IEC 1036	Static Meters
IEC 60481	Coupling devices for power line carrier systems

ANSI/IEEE STANDARDS

IEEE Std 4	High Voltage Testing
IEEE Std 693	Seismic Design of Substations
IEEE Std C57.13.5	Instrument Transformers over 115kV
IEEE Std 57.19.01	Outdoor Apparatus Bushings
IEEE Std C57.106	Maintenance of Insulating Oil
ANSI C29.1	Power Insulators - Test Methods
ANSI C29.9	Wet-Process Porcelain Insulators
ANSI C93	Requirements for Power Line Carrier Coupling Capacitors and Coupling Capacitor Voltage Transformers

ASTM INTERNATIONAL (ASTM)

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220kV CAPACITOR VOLTAGE TRANSFORMERS

ASTM A153/153M Zinc Coating on Iron and Steel Hardware

ASTM D1499 Operating Light and Water Exposure

ASTM D2565 Xenon Arc Exposure of Plastics

ASTM G154 UV Exposure

ASTM D1275-06 Test Method for Corrosive Sulphur in Oils

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 107 Methods for Measuring RIV

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 107 Methods for Measuring RIV

1.2 GENERAL REQUIREMENTS

All equipment shall be manufactured in accordance with the latest edition of applicable IEC-EN or ANSI/IEEE organization standards. Manufacturers may choose to consistently follow IEC or ANSI/IEEE standards based on the manufacturer’s usual compliance ratings. Specific standard references from one organization may be substituted by an equivalent standard from another organization for consistency of the manufacturer’s compliance ratings. For example, an IEEE standard reference may be substituted by an equivalent IEC standard reference.

1.3 SCOPE OF WORK

This Specification defines a relaying accuracy Capacitor Voltage Transformer (CVT) as specified herein. The CVT is to be furnished complete except for the stand. Capacitor voltage transformers furnished under this specification shall be in accordance with all of the requirements of applicable ANSI, NEMA, or IEEE standards.

1.4 SUBMITTALS

The manufacture shall supply the following preliminary drawings for the acceptance of the preliminary design:

a) Outdoor instrumentation equipment control wiring termination blocks
b) Equipment cut sheets

SECTION 33 75 50_Rev1

220kV CAPACITOR VOLTAGE TRANSFORMERS

PART 2 PRODUCTS

2.1 VOLTAGE TRANSFORMERS (CVTs)

a) General

Voltage transformers (CVTs) shall be furnished in accordance with this section and as indicated on Specification Table 1. The Manufacturer shall provide a standard design for the items within the scope of the specification, but which are not covered in detail by these specifications.

The standard design shall be in accordance with accepted industry practices for electrical power transmission.

The requirements of Specification Table 1 and drawings shall govern should conflicts occur between them and the written text of these specifications.

b) Codes and Standards

All equipment supplied under this specification shall conform to the applicable standards of the European Standard (EN), International Electrotechnical Commission (IEC), or ANSI/IEEE.

CVT shall be designed, fabricated, and tested in accordance with IEC60044-2 and these specifications.

c) Equipment Required

The Manufacturer shall furnish CVTs as specified on Specification Table 1 at the end of this section. CVTs furnished shall be complete with all accessories ready for mounting, assembly, connection, and immediate service.

The quantity and types of CVTs furnished shall be as indicated on Specification Table 1.

d) Ratings

All CVTs shall be suitable for operation at the altitude and rating indicated on the Specification Table 1. Total burden shall not load the secondary winding of voltage transformer (CVT) more than 75% of rated burden.

e) Details of Construction

Each CVT shall be designed and fabricated in accordance with the latest revisions of the applicable codes and standards.

Each CVT assembly shall include line connectors, coupling capacitor units, and base support assembly. Each CVT shall be factory adjusted and designed and fabricated in accordance with IEC 60044-5.

Each CVT shall be furnished with a 100 mm wide, 4-hole line terminal pad(s) NEMA standard, unless otherwise indicated on Specification Table 1.

CVTs shall be furnished with all field connection hardware for field mounting on steel supports described in these specifications. All hardware shall be hot-dip galvanized.

The CVTs shall be furnished with the following accessories:

- Primary terminal in accordance with the Specification Table 1.
- Lifting eyes in base.

- Oil level indicator.
- Oil drain and filling valves.
- The number of bushings shall be as indicated in the Specification Table 1.

f) Base Support Assembly

The base support assembly shall be an outdoor, weatherproof, welded enclosure designed and fabricated to support and mount the coupling capacitors specified above and house the following equipment:

- Voltage transformer network factory adjusted with main and auxiliary secondary windings, each rated in accordance with the Specification Table 1.
- Space heater sized to prevent moisture from condensing on internal components, with the voltage rating specified on the Specification Table 1.
- Grounding terminal, tinned bronze, bolted clamp type, for 95 mm² to 240 mm² copper ground cable.
- Terminal box, weatherproof rated IP65, with threaded conduit hubs.

g) Specification Table 1

Voltage transformers (CVTs) shall be furnished in accordance with the requirements shown in Specification Table 1.

PART 3 EXECUTION

3.1 TESTING

Before shipping, the Manufacturer shall test the equipment per the applicable standard tests in IEEE C57.13. Two (2) copies of the test reports shall be forwarded to the Owner and the Engineer prior to shipping. The Manufacturer shall obtain release from the Owner prior to shipment.

3.2 INSPECTION BY THE ENGINEER/OWNER

The Engineer and/or Owner shall be allowed to witness testing performed by the Seller, as well as inspect the equipment at any time. Inspection by the Engineer / Owner shall not relieve the Seller of his responsibility to inspect the equipment, confirm all requirements of testing, and supply complete equipment which satisfies all requirements of these Specifications.

3.3 SPECIAL SHIPPING REQUIREMENTS

Bidder will supply with his bid approximate gross weights, together with the overall physical dimensions of equipment of subassembly as packed for shipment, and a written proposal describing, briefly, the design, contents and number of shipping units.

3.4 ASSEMBLY

Bid must specify all site assembly requirements.

3.5 APPROVED SUPPLIERS

Approved suppliers of the 220kV CVTs are Siemens, ABB, Schneider Electric, or Owner approved equal.

SECTION 33 75 50_Rev1

220kV CAPACITOR VOLTAGE TRANSFORMERS

Specification Table 1

DESCRIPTION	UNIT	REQUIRED VALUE
Quantity Required	Each	12 (Twelve)
Type		Station duty, free-standing
System Nominal Voltage Rating	kV	220kV
Voltage factor (phase to earth,continuous)		1.2
Voltage factor (phase to earth,30 seconds)		1.5
System Maximum Rated Voltage	kV	245kV
Lightning impulse withstandvoltage (BIL peak)	kV	1,200kV
Frequency	Hz	50Hz
1 minute power-frequencywithstand voltage (RMS)	kV	50kV
Short-Time Withstand Current		Minimum 40kA
Peak Withstand Current		Minimum 100kA
Duration of Current		3 seconds
Nominal Voltage (line to line)	kV	220kV
Secondary Voltage	V	110/√3
Accuracy Class		5P
Rated Thermal Limit Output	VA	500VA
Number of bushings		1 (one)
Space Heater Voltage		230VAC
Color		Gray
Minimum Creepage Distance		25mm/kV
Terminal Pad		4-hole spade type NEMA standard
Power Line Coupling Required		No
Nominal Capacitance		Standard ±10%
Maximum Burden Per Winding	VA	100VA
Seismic Zone (IBC)		Moderate hazard – Zone 2
Ambient Temperature Range		-40°C to 40°C
Radial Ice Build-up	mm	13mm
Elevation Above Sea Level		3,500m (11,500ft)
Wind Speed/NESC Loading District		High
Number of Secondary Windings		5 (five)

--- End of Section ---

Appendix I – Medium Voltage Switchgear

SECTION 33 75 10_Rev 2

MEDIUM VOLTAGE SWITCHGEAR

PART 1 GENERAL

This specification describes the technical features and details for:

MV (20kV), 50 Hz, indoor class, dead front, multi section, double Bus with tie breaker, PTs, CTs, Surge arrestors, fuses , switches ,protection relays ,control devices, meters and Breakers as described below, metal-clad switchgear.

Quantity: One (1) complete switchgear unit.

1.1 REFERENCES

The switchgear assemblies shall comply with the following codes and standards:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI):

ANSI C29.1	Power Insulators -Test Methods
ANSI C29.9	Wet-Process Porcelain Insulators
ANSI C37.32	Schedules of Preferred Ratings
ANSI C37.34	Test Code for HV Switches
ANSI C37.85	AC High Voltage Vacuum Interrupters
ANSI C39.1	Requirements for Electrical Analog Indicating Instruments
ANSI C63.2	Electromagnetic Noise and Field Strength
ANSI MG 1	Motors and Generators
ANSI 60529	Protection Provided by Enclosures

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC):

IEC 62271-1	High-voltage switchgear and control gear – Part 1: Common specifications
IEC 62271-200	High Voltage Switchgear and Control Gear
IEC 62271-100	High-voltage switchgear and control gear -Part 100: Alternating current circuit-breakers
IEC 62271-103	High-voltage switchgear and control gear -Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
IEC 60071-2	Insulation co-ordination – Part 2: Application guide

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MEDIUM VOLTAGE SWITCHGEAR

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE):

IEEE C37.06	AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities.
IEEE C37.09	IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.20.2	IEEE Standard for Metal-Clad Switchgear
IEEE C37.121	American National Standard for Switchgear -Unit Substations -Requirements
IEEE C37.04	IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers
IEEE C37.90	IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.13	IEEE Standard Requirements for Instrument Transformers
IEEE C37.100.1	Common Requirements for HV Switchgear
IEEE 1	Temperature Limits in Rating Electrical Equipment
IEEE 4	High Voltage Testing
IEEE 693	Seismic Design of Substations
IEEE 1125	Moisture Measurement in SF6 Equipment
IEEE 1291	Partial Discharge Measurement
IEEE 1313.1	Insulation Coordination – Definitions
IEEE 1313.2	Insulation Coordination – Application
IEEE C37.010	Application Guide for AC Circuit Breakers
IEEE Std C37.24	Effect of Solar Radiation on Outdoor Metal Gear
IEEE Std C37.81	Seismic Qualification for Metal Enclosed Gear
IEEE Std C37.90.1	Surge Withstand Capacity Test

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION (NEMA):

NEMA SG4	Power Circuit Breakers
NEMA SG5	Power Switchgear Assemblies
NEMA SG 6	Power Switching Equipment
NEMA 107	Methods for Measuring RIV
NEMA CC1	Power Connectors for Substations

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MEDIUM VOLTAGE SWITCHGEAR

NEMA MG 1 Motors and Generators

ASTM INTERNATIONAL (ASTM):

ASTM A153/153M Zinc Coating on Iron and Steel Hardware

ASTM D 2472 Specification for Sulfur Hexafluoride

ASTM D1499 Operating Light and Water Exposure

ASTM D2565 Xenon Arc Exposure of Plastics

ASTM G154 UV Exposure

1.2 REQUIREMENTS

a) The Supplier shall furnish and test a dead-front, medium voltage (20KV), metal-clad switchgear as specified herein and indicated on the drawings, and Specification Table 1.

b) The switchgear shall have vacuum power circuit breakers with draw-out circuit breaker elements.

c) The switchgear line-up shall contain main breakers, tie breaker, and feeder breakers, metering equipment, protective relays, current limiting fuses, manual switches, control devices, Potential transformers, Current transformers, surge arrestors and all accessories as specified herein, and as indicated on the Drawings, and as required and necessary to result in a complete and operable power distribution, control and protection equipment assembly.

d) The Supplier shall obtain the switchgear from a manufacturer who manufactures the structure and the major switchgear equipment components, which includes, but is not limited to, assemblies of circuit breakers and auxiliary housing, draw out type vacuum circuit breakers, meters, relays and controls.

e) All equipment shall be manufactured in accordance with the latest editions of applicable and pertinent IEC or ANSI/IEEE/NEMA/ASTM organization standards. Manufacturers may choose to consistently follow IEC or ANSI/IEEE standards based on the manufacturer’s usual compliance ratings. Specific standard references from one organization may be substituted by an equivalent standard from another organization for consistency of the manufacturer’s compliance ratings. For example, an IEEE standard reference may be substituted by an equivalent IEC standard reference.

f) Circuit breaker control and relaying/metering circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Circuit breaker pistol grip control switch shall be remote located in control panel which will be provided by others. Provide all wiring to terminal strips to accommodate field installation for remote control.

g) The switchgear shall interface with external control panel (by others) as per Terminal Interface Table 1 below.

Terminal Interface Table 1

Interface to Control Panel			
Equipment	**Function**	**Terminals**	**Cable Entry**
52M1	Open Command	2	TOP
52M1	Close Command	2	TOP
52M1 Relay	Trip Command	2	TOP
52M1 Trip	Alarm/Light	2	TOP
52M1-25	Sync Check = OK	2	TOP
52M1	Aux "a" #1	2	TOP
52M1	Aux "a" #2	2	TOP
52M1	Aux "a" #3	2	TOP
52M1	Aux "a" #4	2	TOP
52M1	Aux "a" #5	2	TOP
52M1	Aux "a" #6	2	TOP
52M1	Aux "a" #7	2	TOP
52M1	Aux "a" #8	2	TOP
52M1	Aux "a" #9	2	TOP
52M1	Aux "a" #10	2	TOP
52M1	Aux "b" #1	2	TOP
52M1	Aux "b" #2	2	TOP
52M1	Aux "b" #3	2	TOP
52M1	Aux "b" #4	2	TOP
52M1	Aux "b" #5	2	TOP
52M1	Aux "b" #6	2	TOP
52M1	Aux "b" #7	2	TOP
52M1	Aux "b" #8	2	TOP
52M1	Aux "b" #9	2	TOP
52M1	Aux "b" #10	2	TOP
52M2	Open Command	2	TOP
52M2	Close Command	2	TOP
52M2 Relay	Trip Command	2	TOP
52M2 Trip	Alarm/Light	2	TOP
52M2-25	Sync Check = OK	2	TOP
52M2	Aux "a" #1	2	TOP
52M2	Aux "a" #2	2	TOP
52M2	Aux "a" #3	2	TOP
52M2	Aux "a" #4	2	TOP
52M2	Aux "a" #5	2	TOP
52M2	Aux "a" #6	2	TOP
52M2	Aux "a" #7	2	TOP
52M2	Aux "a" #8	2	TOP
52M2	Aux "a" #9	2	TOP
52M2	Aux "a" #10	2	TOP
52M2	Aux "b" #1	2	TOP
52M2	Aux "b" #2	2	TOP
52M2	Aux "b" #3	2	TOP
52M2	Aux "b" #4	2	TOP
52M2	Aux "b" #5	2	TOP
52M2	Aux "b" #6	2	TOP
52M2	Aux "b" #7	2	TOP

Terminal Interface Table 1 Continued

Interface to Control Panel			
Equipment	**Function**	**Terminals**	**Cable Entry**
52M2	Aux "b" #8	2	TOP
52M2	Aux "b" #9	2	TOP
52M2	Aux "b" #10	2	TOP
52F1	Open Command	2	TOP
52F1	Close Command	2	TOP
52F1 Relay	Trip Command	2	TOP
52F1 Trip	Alarm/Light	2	TOP
52F1	Aux "a" #1	2	TOP
52F1	Aux "a" #2	2	TOP
52F1	Aux "a" #3	2	TOP
52F1	Aux "a" #4	2	TOP
52F1	Aux "a" #5	2	TOP
52F1	Aux "a" #6	2	TOP
52F1	Aux "a" #7	2	TOP
52F1	Aux "a" #8	2	TOP
52F1	Aux "a" #9	2	TOP
52F1	Aux "a" #10	2	TOP
52F1	Aux "b" #1	2	TOP
52F1	Aux "b" #2	2	TOP
52F1	Aux "b" #3	2	TOP
52F1	Aux "b" #4	2	TOP
52F1	Aux "b" #5	2	TOP
52F1	Aux "b" #6	2	TOP
52F1	Aux "b" #7	2	TOP
52F1	Aux "b" #8	2	TOP
52F1	Aux "b" #9	2	TOP
52F1	Aux "b" #10	2	TOP
52F2	Open Command	2	TOP
52F2	Close Command	2	TOP
52F2 Relay	Trip Command	2	TOP
52F2 Trip	Alarm/Light	2	TOP
52F2	Aux "a" #1	2	TOP
52F2	Aux "a" #2	2	TOP
52F2	Aux "a" #3	2	TOP
52F2	Aux "a" #4	2	TOP
52F2	Aux "a" #5	2	TOP
52F2	Aux "a" #6	2	TOP
52F2	Aux "a" #7	2	TOP
52F2	Aux "a" #8	2	TOP
52F2	Aux "a" #9	2	TOP
52F2	Aux "a" #10	2	TOP
52F2	Aux "b" #1	2	TOP
52F2	Aux "b" #2	2	TOP
52F2	Aux "b" #3	2	TOP
52F2	Aux "b" #4	2	TOP
52F2	Aux "b" #5	2	TOP
52F2	Aux "b" #6	2	TOP
52F2	Aux "b" #7	2	TOP
52F2	Aux "b" #8	2	TOP
52F2	Aux "b" #9	2	TOP

Terminal Interface Table 1 Continued

Interface to Control Panel			
Equipment	**Function**	**Terminals**	**Cable Entry**
52F2	Aux "b" #10	2	TOP
52F3	Open Command	2	TOP
52F3	Close Command	2	TOP
52F3 Relay	Trip Command	2	TOP
52F3 Trip	Alarm/Light	2	TOP
52F3	Aux "a" #1	2	TOP
52F3	Aux "a" #2	2	TOP
52F3	Aux "a" #3	2	TOP
52F3	Aux "a" #4	2	TOP
52F3	Aux "a" #5	2	TOP
52F3	Aux "a" #6	2	TOP
52F3	Aux "a" #7	2	TOP
52F3	Aux "a" #8	2	TOP
52F3	Aux "a" #9	2	TOP
52F3	Aux "a" #10	2	TOP
52F3	Aux "b" #1	2	TOP
52F3	Aux "b" #2	2	TOP
52F3	Aux "b" #3	2	TOP
52F3	Aux "b" #4	2	TOP
52F3	Aux "b" #5	2	TOP
52F3	Aux "b" #6	2	TOP
52F3	Aux "b" #7	2	TOP
52F3	Aux "b" #8	2	TOP
52F3	Aux "b" #9	2	TOP
52F3	Aux "b" #10	2	TOP
52F4	Open Command	2	TOP
52F4	Close Command	2	TOP
52F4 Relay	Trip Command	2	TOP
52F4 Trip	Alarm/Light	2	TOP
52F4	Aux "a" #1	2	TOP
52F4	Aux "a" #2	2	TOP
52F4	Aux "a" #3	2	TOP
52F4	Aux "a" #4	2	TOP
52F4	Aux "a" #5	2	TOP
52F4	Aux "a" #6	2	TOP
52F4	Aux "a" #7	2	TOP
52F4	Aux "a" #8	2	TOP
52F4	Aux "a" #9	2	TOP
52F4	Aux "a" #10	2	TOP
52F4	Aux "b" #1	2	TOP
52F4	Aux "b" #2	2	TOP
52F4	Aux "b" #3	2	TOP
52F4	Aux "b" #4	2	TOP
52F4	Aux "b" #5	2	TOP
52F4	Aux "b" #6	2	TOP
52F4	Aux "b" #7	2	TOP
52F4	Aux "b" #8	2	TOP
52F4	Aux "b" #9	2	TOP
52F4	Aux "b" #10	2	TOP
52BC	Open Command	2	TOP

Terminal Interface Table 1 Continued

Interface to Control Panel			
Equipment	**Function**	**Terminals**	**Cable Entry**
52BC	Close Command	2	TOP
52BC Relay	Trip Command	2	TOP
52BC Trip	Alarm/Light	2	TOP
52BC-25	Sync Check = OK	2	TOP
52BC	Aux "a" #1	2	TOP
52BC	Aux "a" #2	2	TOP
52BC	Aux "a" #3	2	TOP
52BC	Aux "a" #4	2	TOP
52BC	Aux "a" #5	2	TOP
52BC	Aux "a" #6	2	TOP
52BC	Aux "a" #7	2	TOP
52BC	Aux "a" #8	2	TOP
52BC	Aux "a" #9	2	TOP
52BC	Aux "a" #10	2	TOP
52BC	Aux "b" #1	2	TOP
52BC	Aux "b" #2	2	TOP
52BC	Aux "b" #3	2	TOP
52BC	Aux "b" #4	2	TOP
52BC	Aux "b" #5	2	TOP
52BC	Aux "b" #6	2	TOP
52BC	Aux "b" #7	2	TOP
52BC	Aux "b" #8	2	TOP
52BC	Aux "b" #9	2	TOP
52BC	Aux "b" #10	2	TOP
Bus 1 – 87	Trip	2	TOP
Bus 2 – 87	Trip	2	TOP
Bus 1 – 87 Trip	Alarm/Light	2	TOP
Bus 2 – 87 Trip	Alarm/Light	2	TOP
Bus 1 – Energized	Closed = Hot	2	TOP
Bus 2 – Energized	Closed = Hot	2	TOP
T1 - Energized	Closed = Hot	2	TOP
T2 - Energized	Closed = Hot	2	TOP
DC Power	Panel Control Power	2	TOP
AC Power	Panel Heaters/Lights	2	TOP
SST-1	Aux "a" #1	2	TOP
SST-1	Aux "a" #2	2	TOP
SST-1	Aux "b" #1	2	TOP
SST-1	Aux "b" #2	2	TOP
Bus 1 Potential (Bus 1 PT)	Phase A	1	TOP
Bus 1 Potential (Bus 1 PT)	Phase B	1	TOP
Bus 1 Potential (Bus 1 PT)	Phase C	1	TOP
Bus 1 Potential (Bus 1 PT)	Neutral	1	TOP
Bus 2 Potential (Bus 2 PT)	Phase A	1	TOP
Bus 2 Potential (Bus 2 PT)	Phase B	1	TOP
Bus 2 Potential (Bus 2 PT)	Phase C	1	TOP
Bus 2 Potential (Bus 2 PT)	Neutral	1	TOP
52-M1 CT-2 Current	Phase A	2	TOP
52-M1 CT-2 Current	Phase B	2	TOP
52-M1 CT-2 Current	Phase C	2	TOP
52-M1 CT-3 Current	Phase A	2	TOP

Terminal Interface Table 1 Continued

Interface to Control Panel			
Equipment	**Function**	**Terminals**	**Cable Entry**
52-M1 CT-3 Current	Phase B	2	TOP
52-M1 CT-3 Current	Phase C	2	TOP
SST-2	Aux "a" #1	2	TOP
SST-2	Aux "a" #2	2	TOP
SST-2	Aux "b" #1	2	TOP
SST-2	Aux "b" #2	2	TOP

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted for review and approval as indicated.

The following submittals are required in Electronic format:

a) Shop Drawings

b) Operation and Maintenance Manuals

c) Spare Parts List

d) Special Tools List

e) Proposed Testing Methods and Reports of Certified Shop Tests Each submittal shall be identified by the applicable specification section.

SD-02 SHOP DRAWINGS (G)

Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

Partial, incomplete or illegible submissions will be returned to the Supplier without review for resubmittal.

All shop drawings shall be provided in AutoCAD format

a) Shop drawings for switchgear assembly shall include but not be limited to:

1) Equipment specifications and product data sheets identifying all electrical ratings

2) Complete assembly, layout and installation attached with clearly marked dimensions.

3) Weights of all component parts, assembled weight of units, and approximate total shipping weight.

4) Example equipment nameplate data sheet.

5) Plan, front and side view drawings, including overall dimensions of the switchgear assembly. Identify shipping splits and show conduit entry/exit locations on the drawings.

6) Internal wiring diagram of each medium voltage switchgear cell. Each wiring diagram shall include wire identification and terminal numbers. Internal wiring diagrams of each low voltage metering compartment including wire identification and terminal numbers.

7) Internal switchgear cell-to-cell interconnection wiring diagrams including wiring identification and terminal numbers.

8) Complete one-line diagram of the switchgear line-up and complete three line diagrams for each switchgear cell. These drawings shall indicate devices comprising the switchgear assembly including, but not limited to, circuit breakers, control power and instrument transformers, meters, relays, and control devices. Clearly indicate the electrical ratings of all devices.

9) Bill of material list for the switchgear assembly including each switchgear cell.

10) Nameplate schedule for each cell.

11) Manufacturer's installation instructions.

12) Manufacturer's standard warranty.

13) Cable terminal sizes.

The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Supplier intends to provide are acceptable and shall be submitted.

SD-03 Product Data

Conductors (G)

SD-10 OPERATIONS AND MAINTENANCE MANUALS (G)

The manuals shall include:

a) Instruction books, descriptive bulletins, technical bulletins, application data booklets and other applicable instructional information.

b) Recommended spare parts list.

c) Final as-built construction drawings included in the shop drawings incorporating all changes made in the manufacturing process.

1.4 QUALITY ASSURANCE

SECTION 33 75 10_Rev 2

MEDIUM VOLTAGE SWITCHGEAR

1.4.1 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Provide products that have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size. Provide a product that has been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, provide items that are products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

PART 2 PRODUCTS

2.1 MANUFACTURERS

The equipment covered by these specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.2 MEDIUM VOLTAGE METAL-CLAD SWITCHGEAR

2.2.1 General

1) Switchgear shall be suitable for use as service entrance equipment.

2) The switchgear described in this specification shall be designed for operation on a 20 kV, three-phase, three-wire solidly grounded, 50 hertz system.

2.2.2 Ratings

1) All ratings shall be in accordance with Specification Table 1.

2) Rate complete switchgear assembly to withstand mechanical forces exerted during short circuit conditions of Specification Table 1.

3) All ratings shall be tested to the requirements of IEC 62271-200 or ANSI C37.04, C37.06, C37.09 and C37.20.2.

4) The switchgear assembly shall be suitable and rated for indoor construction with suitable IP rating.

2.2.3 Stationary Structure

1) The switchgear structure shall be of "one-high" breaker construction and constructed of formed sections of specially smooth and leveled steel, welded and bolted together and reinforced where necessary with formed steel members. The sides shall be covered with removable bolt on covers. The resulting structure shall be rigid and self-supporting. Structural steel channel sills with end covers shall be furnished for mounting and aligning the separate elements of the structure.

2) The rear of structure shall be covered with individual, bolt-on steel panels for access to buses, connections, and other equipment

mounted within each cell. The ends of the structure shall be closed with removable steel panels. All panels shall be held in place with slotted head bolts or concealed screws.

3) Secondary control devices and associated wiring shall be isolated from all high voltage primary devices by grounded metal barriers. Primary circuits such as circuit breakers, transformers, and buses shall also be isolated from each other and from personnel by grounded metal barriers.

4) The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to Supplier provided floor sills to be set level in concrete per manufacturer's instructions. Provisions shall be made for jacking of shipping groups for removal of skids or insertion of equipment rollers. Base of assembly shall be suitable for rolling directly on pipes without skids.

5) Each vertical steel section forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument cells, a centralized main bus compartment, and a rear cabling compartment. Each individual circuit breaker compartment or cell shall be segregated from adjacent compartments and sections, including the bus compartment, by means of grounded steel barriers. It shall be equipped with draw-out rails and primary and secondary disconnecting contacts. Current transformers for circuit protection and instrumentation shall be located within the appropriate breaker cells.

6) The stationary part of the primary disconnecting devices for each vacuum power circuit breaker shall consist of a set of contacts extending to the rear through glass polyester insulating support barrier; corresponding moving finger contacts suitably spaced shall be furnished on the power circuit breaker studs which engage in only the CONNECTED position. The assembly shall provide multiple silver-to-silver full floating high pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit shall include the necessary three-phase bus connections between the section bus and the breaker line side studs. Load studs shall be equipped with insulated copper load extension busses terminating in solder less type terminals in the rear cable compartment of each structure. Bus extensions shall be silver-plated where outgoing terminals are attached.

7) The primary insulated bushings shall be suitable for mounting two (2) current transformers on each side (line and load) for a minimum total of four (4) sets of current transformers. The Main Breakers shall have three (3) sets on Bus side as shown in the drawings. Actual number of current transformers supplied shall be as shown in drawings.

8) The secondary disconnecting devices shall consist of a plug mounted on the removable unit and engaging a socket mounted in the compartment. The secondary disconnecting devices shall be silver-plated and sliding contact engagement shall be maintained in the CONNECTED and TEST positions.

9) The removable vacuum power circuit breaker element shall be

equipped with disconnecting contacts, wheels, and interlocks for draw-out application. It shall have four positions, CONNECTED,TEST, DISCONNECTED and REMOVE all of which permit closing the compartment door. The breaker draw-out element shall contain a worm gear levering "in" and "out" mechanism with removable lever crank. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering "in" and "out" of the cell. The breaker shall include a provision for padlocking. The padlocking shall secure the breaker in the CONNECTED, TEST, or DISCONNECTED position by preventing levering.

10) Hinged doors with removable hinge pins shall be provided for the fronts of the draw-out vacuum power circuit breaker compartments.

11) Hinged panels shall be provided for mounting of meters, protective relays, and other devices. Doors and panels shall be equipped with concealed hinges and suitable latches. Doors and panels shall have 25 mm (1 inch) deep formed edges with double returns where necessary to assure stiffness.

12) A steel safety shutter shall be furnished to automatically cover the bus stabs in the circuit breaker compartment when the circuit breaker unit is moved to the TEST, DISCONNECTED, or REMOVE position.

13) Provide a rear compartment steel barrier between the cable compartment and main bus to protect against inadvertent contact with the main bus. Provide full height and depth metal barriers between adjacent vertical structures in the cable compartment. Provide a full height and depth glass polyester barrier with appropriate slots for the main bus between adjacent vertical structures in the bus compartment.

14) The withdrawal type units and the stationary sections for these units shall be assembled in jigs which accurately locate the contacts, holding devices, and interlocks. One removable unit of each type and rating shall be tried in each stationary compartment of same type and rating. Each stationary compartment shall be checked with its own removable unit to insure interchangeability.

15) Where specified herein or shown on the Drawings, provide a separate barriered-off utility metering compartment or structure complete with hinged sealable door. Provide utility metering grade potential and current transformers as indicated on the Drawings.

16) Equip each incoming line main circuit breaker cell with distribution class metal oxide surge arresters. The surge arresters shall be suitable for the application with a maximum continuous operating voltage (MCOV) rating based on higher switchgear ambient (55C) conditions. The arresters shall be designed, tested, selected, and installed in accordance with ANSIC62-Guides and Standards for Surge Protection.

Each feeder circuit breaker cell shall also be furnished with distribution class surge arresters as indicated on the Drawings.

2.2.4 Bus

1) Buses and main connections shall consist of flat copper bars.

2) The main bus shall be fully insulated for its entire length with aflame-retardant and track-resistant epoxy coating installed by the fluidized bed process. Provide the 3 phase bus of each unit with insulation to completely encase each bar, except provide removable, insulating boots at bus joints.

3) The bus shall be braced to withstand fault currents equal to the close and latch (momentary) rating of circuit breakers.

4) Access to the main bus compartment shall be from the rear of the structure after removing the steel barrier.

5) Bus supports between units shall be cycloaliphatic epoxy. All bus joints shall be silver plated and be insulated with easily installed boots. The bolted bus joints shall use constant pressure washers for positive contact.

6) An un-insulated ground bus of adequate capacity shall be furnished and installed throughout the switchgear structure. Each stationary unit shall be effectively connected to this ground bus. A substantial ground contact shall be provided between each breaker and removable element and the ground bus, which shall automatically be made before the primary contacts touch. Contact engagement to the ground bus shall be maintained in the CONNECTED and TEST positions.

7) The un-insulated ground bus shall be tin-plated copper bar. Ground each housing directly to this bus. Ground relay panels with a 15mm2 insulated copper wire to the ground bus.

8) All main and ground buses shall be extended through the entire length of the switchgear assembly. All busses shall have provisions for future extension.

2.2.5 Removable Element

1) The removable element of each circuit breaker unit shall consist of a 3-pole vacuum circuit breaker with trip-free stored-energy mechanism, positive mechanical interlock, primary and secondary disconnecting devices, auxiliary switches, position indicator, and control wiring. The removable element shall have four positions: CONNECTED, TEST, DISCONNECTED, and REMOVE, all of which permit closing of the compartment door.

2) Provide for padlocking of the removable element in the TEST and DISCONNECTED position. Lock shall not interfere with operation of the breaker and its mechanism.

3) Provide an interlock on each circuit breaker unit to prevent the circuit breaker from being removed while breaker is closed and to prevent breaker from being placed in the CONNECTED position unless the breaker is open. If the circuit breaker is closed, the interlock shall trip the breaker before it can be placed in the CONNECTED position.

4) Interlocks shall be provided to prevent the circuit breaker between the CONNECTED and TEST positions, to trip breakers upon insertion or removal from the housing, and to discharge the stored energy mechanisms upon insertion or removal of the circuit breaker from the housing. The circuit breaker shall be secured positively in the housing between and including the CONNECTED and TEST positions.

5) The disconnect switches and related 20KV fuses for service station transformers feeds shall mounted on draw-out assemblies.

2.2.6 Circuit Breakers

1) Each draw-out vacuum power circuit breaker shall be capable of being withdrawn on rails and shall be enclosed in a separate metal compartment. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper.

2) Vacuum circuit breakers shall meet the ratings listed in Specification Table 1.

3) Circuit breakers shall be suitable for application in their enclosures for 100 percent of their continuous current rating.

4) Circuit breakers of equal rating shall be completely interchangeable.

5) Equip each circuit breaker with silver-plated secondary disconnecting contacts to automatically engage in the CONNECTED position and manually engage in the TEST position to complete circuits as required.

6) Provide a means for racking the circuit breaker in and out of the cell and between positions.

7) Provide a means for holding the circuit breaker in the cell in all positions.

8) Provide interlocking to prevent a closed circuit breaker from racking to or from any position. Provide an additional interlock to assure automatic discharging of the closing springs upon insertion or removal of the breaker into or out of the cell.

9) Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit which can be removed easily. The vacuum interrupter pole units hall be mounted on cycloaliphatic supports. A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the breaker is removed from its cell. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.

10) A TEST position for each vacuum power circuit breaker shall be provided and so interlocked to insure proper sequence and safe operation.

11) Each main, tie, feeder circuit breaker and the SST feed switches shall be provided with "a" and "b" auxiliary contacts as indicated in the Specification Table 1 which will open or close when the breaker is open or closed. Each breaker shall also be provided with an alarm switch or contact to indicate that the breaker has tripped. All of these contacts shall be wired to terminals in each cell for use in indicating breaker status.

12) The vacuum power circuit breakers shall be electrically operated by a 220 volt DC close and 220 volt DC trip.

13) The control voltage shall be derived from the DC control voltage system specific herein.

2.2.7 Direct Current Battery System for Switchgear Control

1) Furnish complete battery system as specified herein, to operate breaker mechanisms and protective relays.

2) The battery system shall be capable of operating 100% of the circuit breakers simultaneously. One minute discharge rate down to final 1.14 volt/cell shall be equal to trip current drawn by 50% of breakers tripping simultaneously.

3) Batteries shall be sealed pocket plate Lead Acid type, cabled to produce a 220VDC output.

(a) Each switchgear cubicle shall have a fused direct current circuit. Provide batteries with a rack assembly to house the batteries and charger.

(b) Furnish a current limiting battery charger to automatically recharge the batteries. The charger to float at 2.10 volts per cell and equalize at 2.20 volts per cell. Include overload protection, silicon diode full wave rectifiers, voltage surge suppressors, direct current ammeter, and fused alternating current output. Amperage output to be not less than 20 amperes.

4) Minimum battery system ratings shall be as required by the switchgear manufacturer plus 25% spare capacity. Additionally, battery system shall be sized to operate five 220kV SF6 circuit breakers and twelve (12) 220kV motor operated disconnect switches in the switchyard.

5) The battery charging system shall include an insulation monitoring device. The device, as a minimum, shall close a type “a” contact (for remote indication) when either positive or negative battery terminals measure 20k Ohms or less to ground. The system shall also have local alarm indication of an indicating light and horn. The alarm horn shall have a local “silence” pushbutton. The monitoring device shall constantly monitor the battery insulation condition. Upon return to a normal resistance level the device shall be self-resetting.

2.2.8 Current Transformers

1) Locate the current transformers on the bus side and line side of the circuit breaker units to be front accessible to permit adding or changing transformers without removing high voltage insulation connections.

2) Secondary wiring from current transformers shall be routed in suitable wiring trough or conduit to proper short-circuiting type terminal blocks for connection to protective relays, instruments, and other devices.

3) Identify the current transformers for polarity with standard marking or symbols. The transformers shall be capable of carrying rated primary current continuously without damage.

4) Current transformers shall be rated in accordance with ANSI Standard C57.13, with accuracy of the current transformers suitable for B0.5 metering accuracy at rated burden. The current transformers shall be sized for the necessary burden for the required devices, minimum.

5) Ring type current transformers shall be furnished as specified herein and indicated on the Drawings attached. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers.

2.2.9 Potential Transformers

1) Potential transformers shall be indoor dry type, single-phase, 50 hertz.

2) Potential transformers shall have an accuracy classification determined according to ANSI Standards. The potential transformers shall be suitable for metering accuracy, the burden to be served for the required devices plus 20 percent, and shall meet the following minimum requirements:

3) Identify polarity with standard markings or symbols. Connect windings to voltage buses as required. Protect potential transformers with primary and secondary fuses. Protect the primary side with current-limiting fuses.

4) Potential transformers shall be mounted in draw-out drawers contained in an enclosed auxiliary compartment. Rails shall be provided (see Accessories) to permit easy inspection, testing, and fuse replacement. Automatic shutters shall be furnished to isolate primary bus stabs when the drawers are withdrawn from the cell.

2.2.10 Station Service Transformers

1) Station service transformers (SST) will be remote located and provided by others. Protect primary side with current limiting fuses and manual switch as indicated in the drawing.

2) Station power transformers primary fuses shall be fixed mounted in draw-out drawers. Rails shall be provided (see Accessories) to permit easy inspection, testing, and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn.

3) An interlock shall be provided to require the related disconnect switch to be open before the SST primary fuse drawer can be withdrawn.

2.2.11 Control Wiring

1) Wire and factory test switchgear to satisfy the requirements of the operation described or necessary.

2) Switchgear secondary wiring shall be NEC Type SIS, single-conductor, stranded copper, rated 600 volts, 90C bundled and secured with nylon ties. Provide flexible stranding for swinging

doors and panels. Minimum wire size shall be 2.5 mm2 for voltage transformer and control circuits. For current transformer circuits, minimum wire size shall be 4mm^2 to decrease resistance as required.

3) Route outgoing control wires or outgoing or "cell-to-cell" interconnecting wiring to the master terminal blocks with suitable numbering strips numbered in agreement with the manufacturer's detailed wiring diagrams.

4) Terminate control wiring in molded terminal blocks acceptable to Engineer. Provide a minimum of 10 percent (10%) spare terminal blocks for each circuit breaker and auxiliary compartment. Compression type terminal blocks are not acceptable. Terminal blocks shall be States Company sliding link Type NT or as accepted by Engineer.

5) Number wiring with shrink-type tag devices at both ends consistent with the manufacturer's detailed wiring diagrams. Duplication of wire numbers and terminal block numbers is not acceptable.

6) One control circuit cut-out device shall be furnished in each circuit breaker housing.

2.2.12 Instruments, Meters, Protective Relays and Control Devices

1) The switchgear manufacturer shall furnish and install in the switchgear instruments, meters, protective relays, and control devices complete with devices and associated circuitry necessary to perform the required functions specified herein and indicated on the Drawings. Relays and controls are listed to describe system operating requirements. Other multi-function electronic modules will be considered where equivalent relay operating characteristics can be provided as approved by the Owner or Owner’s Engineer. Any material not specifically listed or shown but necessary to perform required functions shall be furnished.

2) Mount instruments and relays on the hinged doors secured to the stationary structure. Devices shall have enclosing cases, dull black finish, and mounted semi-flush. Provide nameplates.

3) Panel mounted protective relays shall be switchgear draw-out type with (if available) built-in testing facilities. Contacts shall be self-aligning and visible to permit ready inspection. All protective relays shall have the capability to be interfaced with remotely via SCADA system.

4) Instrument and control switches shall be rotary operated type with means for maintaining contact position. Contacts shall be silver - to-silver, enclosed in easily removable protective covers. Provide indicating lights for circuit breakers with low voltage indicating lamps. Lamps shall be easily removable from front of panel and shall be LED type. Indicating lights shall be NEMA rated, 22.5 mm with chrome bezel.

5) Furnish wiring, potential bus, necessary fuses, and terminal blocks within each cell. Shield secondary and control wiring within the high voltage cell in a protective metal covering.

6) Requirements for items mounted on hinged doors or panels are as follows:

(a) Semi-flush mounting unless otherwise noted.

(b) Items specified as draw-out case type shall be removable-chassis

construction providing for removal of the relay from the case without disconnecting the leads or removing the case from the panel. The associated current-transformer secondaries shall automatically short-circuit at the case when the relay is removed from its case. Furnish built-in test facilities and visible self-aligning contacts.

(c) Instruments shall be in accordance with ANSI C39.1, 1 percent accuracy class, 4-1/2 inch nominal square, with 250 degrees scale unless otherwise noted.

(d) Terminal blocks, wire ways, wiring, device mounting brackets, and other miscellaneous items shall be provided as required.

2.2.13 Nameplates

1) Provide engraved plastic nameplates to identify switchgear units, door mounted devices, and internal components

2) Label the switchgear per the requirements of ANSI C37.20.2.

3) Provide a master nameplate giving switchgear designation, voltage-ampere rating, short circuit rating, manufacturer's name, general order number and item number.

4) Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.2.14 Switchgear Equipment

1) Furnish and equip the circuit breaker compartments and auxiliary compartments as previously specified and as follows:

(a) Vacuum circuit breaker unit including 1 set of primary disconnecting devices and current transformers, and, where specified or required, potential transformers with fuses.

(b) Vacuum circuit breaker faceplate with a breaker open/close position indicator, closing spring charged/discharged indicator, push-to-trip button, push-to-close button, operation counter, breaker latch, and manual spring charging access.

(c) Door-mounted circuit breaker red (closed) and green (open) indicating lights to indicate breaker contact position. The switchgear shall provide remote controlled 86 lock out relay functionality which will be provided by others. Additionally, synch check ok contacts shall be provided for remote indication. Energized bus status contacts shall also be supplied.

(d) Bottom-Rear entry shall be provided for all power cables.

(e) A bottom-rear compartment bare ground bus shall extend the full length of the switchgear. Provide lugs at each end of the bus and in each compartment for ground cable terminations.

(f) Auxiliary contacts, auxiliary relays, and interposing contactors as required to provide remote interlocking and indicating functions specified herein and indicated on the Drawings attached. Provide 2 spare normally open and 2 spare normally closed contacts per auxiliary relay, contactor, and similar equipment.

SECTION 33 75 10_Rev 2

MEDIUM VOLTAGE SWITCHGEAR

2.2.15 Description of Sections

1) In addition to the specified basic equipment common to all switchgear sections, equip the various individual sections with instruments, protective relays, and control devices as described below. Arrange the equipped sections side by side to form continuous switchgear lineups as indicated on the Drawings attached.

2) The detailed descriptions which follow are intended to describe basic features of the equipment required and are not intended to specify all devices and materials necessary. It shall be the manufacturer's responsibility to provide and install, as required, all auxiliary relays, auxiliary transformers, terminal strips and such devices and materials required to provide complete units ready for installation and operation.

(a) The main circuit breaker sections and bus tie section and respective instrument compartment shall contain the following:

i. 630 ampere frame circuit breaker, electrical close and trip.

ii. Circuit breaker control switch will be remote located and provided by others.

iii. Three (3) current transformers: With Ratios as indicated in the Single Line Diagram with one (1)ampere rated secondary output.

(b) Metering

i. Draw-out potential transformers specified herein.

(c) Each feeder breaker section shall contain the following:

i. 630 ampere frame circuit breaker, electrical close and trip

ii. Three (3) current transformers: Ratio as required with one (1)ampere secondary output.

2.2.16 Warning Signs

1) Provide a minimum of two (2) warning signs on the front of the switchgear lineup and two (2) on the back.

(a)Red laminated plastic engraved with white letters approximately1/2 inch high.

(b)Signs shall read "DANGER HIGH VOLTAGE"

2) All signs shall be printed in English and local languages.

2.2.17 Source Quality Control

1) Completely assemble, wire, and test the switchgear at the factory. Detailed inspections before and after assembly shall assure correctness of design and workmanship. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.

2) After assembly, provide the switchgear with lifting channel shaving eyebolts for attachment of crane slings to facilitate lifting and handling each shipping-assembly unit. These lifting channels shall be removable after equipment is placed on permanent foundations.

2.2.18 Accessories

1) Switchgear accessories shall be provided by the switchgear manufacturer for test, inspection, maintenance, and operation as follows:

(a) One (1) maintenance tool for manually charging the breaker closing spring and manually opening the shutter

(b) One (1) levering crank for moving the breaker between the TEST and CONNECTED positions

(c) One (1) test jumper for electrically operating the breaker while out of its cell

(d) One (1) breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails

(e) One (1) set of rail extensions and rail clamps

(f) One (1) portable lifting device for lifting the breaker on or off the rails

(g) One (1) "dockable" transport dolly for moving breaker about outside its compartment

(h) One (1) ramp for rolling breaker directly onto the floor.

(i) One (1) test cabinet for testing electrically operated breakers outside the cell

(j) Secondary couplers for operating a circuit breaker in the DISCONNECTED position.

2.2.19 Indoor Enclosure

1) The enclosure shall be provided with side and rear removable panels, and front hinged doors. Ventilating openings shall be provided complete with replaceable fiberglass air filters. Provide necessary space heaters thermostatically controlled for breakers, bus, and cable compartments of adequate wattage to prevent the accumulation of moisture within the compartments.

2) Power for any fans, space heaters, lights, receptacles or auxiliary equipment, shall be obtained from an externally mounted station service transformers. Supply voltage to the loads shall be 220 volts AC.

2.2.20 Finish

The switchgear finish shall consist of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray.

2.2.21 Tools, Supplies, and Spare Parts

The switchgear shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment and all spare parts as recommended by the equipment manufacturer.

The Supplier shall furnish the following minimum spare parts for each switchgear assembly:

NO. REQUIRED	DESCRIPTION
1 set	Power and control fuses of each size provided
1	Control power transformer of each size provided
5	Lamps and lenses for indicating lights, each color

The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

Spare parts shall be delivered at the same time as the equipment to which they pertain. The Supplier shall properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to the Owner.

Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

2.2.22 Identification

A nameplate shall be securely affixed in a conspicuous place on each switchgear assembly.

PART 3 EXECUTION

3.1 TESTING

Before shipping, the Manufacturer shall test the equipment per the applicable tests in pertinent standards, and as detailed below. The testing and inspection procedures shall demonstrate that the equipment conforms to the requirements specified and shall be approved by the Owner or Owner’s representative. At least 30 days notice shall be given the Owner prior to such tests and inspection dates. Two (2) copies of the test reports shall be forwarded to the Owner and the Engineer prior to shipping. The Manufacturer shall obtain release from the Owner prior to shipment.

3.1.1 Certified Shop Tests and Reports

1) Submit description of proposed testing methods, procedures, and apparatus.

2) Submit certified copies of all factory test reports.

3) As a minimum, the entire switchgear assembly shall go through a quality inspection before shipment. This inspection shall include, but is not limited to, the following:

(a) Physical inspection of the structure and the electrical conductors including bussing, general wiring, and cells.

(b) General electrical tests including power circuit phasing, control circuit wiring, instrument transformers, meters, ground fault system, and device electrical operation.

(c) AC dielectric tests of the power circuits and control circuits.

(d) Markings/labels, including instructional type, and inspector's stamps.

4) The following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in test with master cell to verify all interfaces and interchangeability.

(a) Alignment test with master cell to verify all interfaces and interchangeability.

(b) General electrical tests including power circuit phasing, control circuit wiring, instrument transformers, meters, ground fault system, and device electrical operation.

(c) AC dielectric tests of the power circuits and control circuits.

(d) Markings/labels, including instructional type, and inspector's stamps.

5) The following production test shall be performed on each breaker housing.

(a) Alignment test with master breaker to verify interfaces.

(b) One-minute dielectric test per ANSI standards on primary and secondary circuits.

(c) Operation of wiring, relays, and other devices verified by an operational sequence test.

(d) Final inspection and quality check.

6) The manufacturer shall use integral quality control checks throughout the manufacturing process to maintain the correctness of the switchgear.

3.2 INSPECTION BY THE ENGINEER/OWNER

The Engineer and/or Owner shall be allowed to witness testing performed by the Seller, as well as inspect the equipment at any time. Inspection by the Engineer / Owner shall not relieve the Seller of his responsibility to inspect the equipment, confirm all requirements of testing, and supply complete equipment which satisfies all requirements of these Specifications.

3.3 SPECIAL SHIPPING REQUIREMENTS

Bidder will supply with his bid approximate gross weights, together with the overall physical dimensions of equipment of subassembly as packed for shipment, and a written proposal describing, briefly, the design, contents and number of shipping units.

3.4 ASSEMBLY

Bid must specify all site assembly requirements.

3.5 APPROVED VENDORS

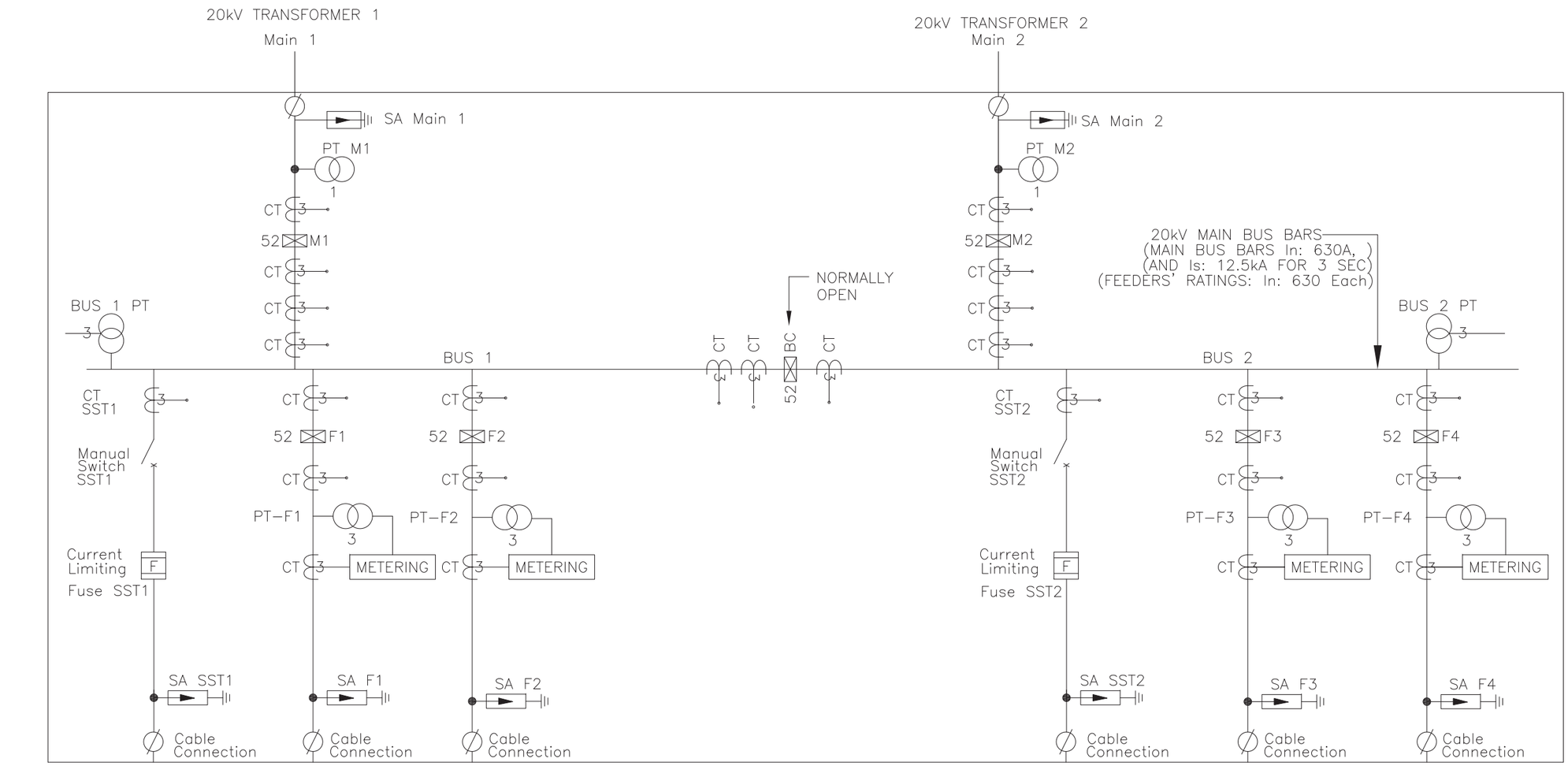
The switchgear shall be Vac\Clad-W as manufactured by Cutler Hammer/Westinghouse Electric Corporation, or PV System 27 as manufactured by Powell Electrical Manufacturing Company, or ABB UniGear ZS1, or Siemens NXAIR M, or Owner approved equal.

SECTION 33 75 10_Rev 2

MEDIUM VOLTAGE SWITCHGEAR

4.0 20kV SWITCHGEAR ELECTRICAL DRAWINGS

E-103 SWITCHGEAR SINGLE LINE DIAGRAM
E-104 20KV FEEDER BREAKERS
E-105 STATION SERVICE FEEDER
E-106 20KV BREAKERS
E-107 20KV BUS DIFFERENTIAL



SWITCHGEAR
SINGLE LINE DIAGRAM

LEGEND

DEVICE	52– AC CIRCUIT BREAKER
ABBREVIATION	CT– CURRENT TRANSFORMER SST– STATION SERVICE TRANSFORMER SA– SURGE ARRESTOR PT– POTENTIAL TRANSFORMER SA– SURGE ARRESTOR

ONE–LINE LEGEND

- CURRENT TRANSFORMER QUANTITY = #
- POTENTIAL TRANSFORMER QUANTITY = #
- SURGE ARRESTOR (SA) / QUANTITY = 3
- XX — PROTECTIVE RELAY (ELECTRONIC RELAY OR ELECTROMECHANICAL) / METERING EQUIPMENT XX DEDICATED (IEEE) FUNCTION NUMBER
- F — 20 kV Current Limiting Fuse
- 20 kV SWITCHGEAR CIRCUIT BREAKER
- 20 kV CABLE CONNECTION
- 20 kV MANUAL CUT OFF SWITCH

NOTES:

1. THIS IS A PRELIMINARY DESIGN ONLY. CONTRACTOR /SUPPLIER SHALL SUBMIT CONSTRUCTION/ASSEMBLY DRAWINGS TO THE ASSIGNED OWNER'S REPRESENTATIVE FOR THEIR APPROVAL. THE CONSTRUCTION/ASSEMBLY DRAWINGS SHALL SATISFY DABS AND THE OWNER'S REPRESENTATIVES.
2. ALL SWITCHGEAR BUS BARS SHALL BE FULLY RATED.
3. SEE SHEET E–206 AND E–207 FOR PROTECTIVE RELAY FUNCTIONS AND CONNECTIONS.

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FINAL DESIGN SUBMITTAL

SYMB	DESCRIPTION	DATE	APR
B	Removed SS transformers from the switchgear	12/06/2013	NF
A	Concept Design Submittal	07/09/13	KF
	SUBMITTAL/REVISION		

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: NF
DATE: 07/09/13
SUBMITTED BY: Tetra Tech
CAD FILE NAME: LT0063-E-103

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GOWARAH, AFGHANISTAN
20KV SWITCHGEAR
SINGLE LINE DIAGRAM

SHEET REFERENCE NUMBER:
E–103

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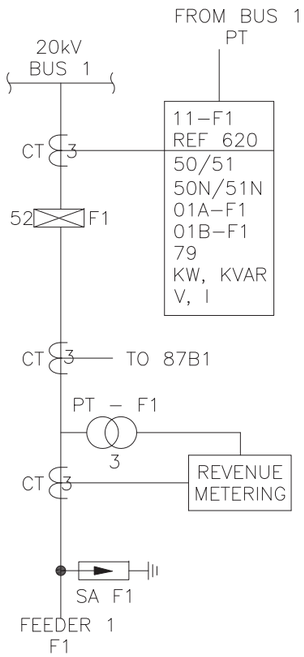
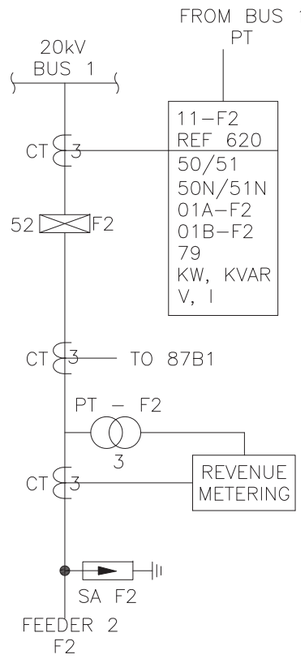
24 OF 30



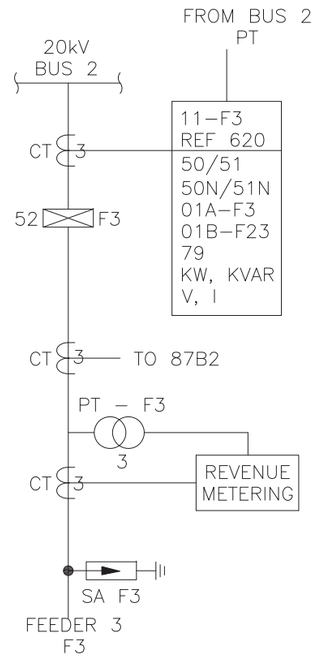
NOTES:

1. 01A–F1 IS LOCAL CONTROLLER HMI IN 11–F1 CONTROLLING 52–F1.
2. 01B–F1 IS SCADA CONTROL OF 52–F1 THROUGH 11–F1.



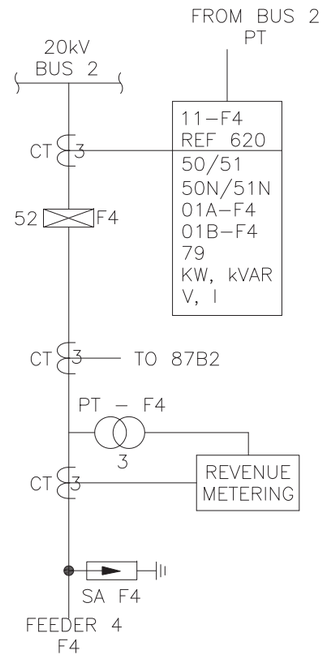
NOTES:

1. 01A–F2 IS LOCAL CONTROLLER HMI IN 11–F2 CONTROLLING 52–F2.
2. 01B–F2 IS SCADA CONTROL OF 52–F2 THROUGH 11–F2.



NOTES:

1. 01A–F3 IS LOCAL CONTROLLER HMI IN 11–F3 CONTROLLING 52–F3.
2. 01B–F3 IS SCADA CONTROL OF 52–F3 THROUGH 11–F3.



NOTES:

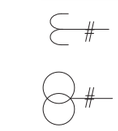
1. 01A–F4 IS LOCAL CONTROLLER HMI IN 11–F4 CONTROLLING 52–F4.
2. 01B–F4 IS SCADA CONTROL OF 52–F4 THROUGH 11–F4.

20kV SWITCHGEAR FEEDER BREAKERS
SINGLE LINE DIAGRAMS

LEGEND

ID	RELAY FUNCTIONS
1	MASTER ELEMENT (TRIP/CLOSED)
11	MULTI–FUNCTIONS RELAY DEVICE
50	INSTANTANEOUS OVERCURRENT
51	AC INVERSE TIME OVERCURRENT
52	AC CIRCUIT BREAKER
79	AC RECLOSING
87B	BUS DIFFERENTIAL PROTECTION

ONE–LINE LEGEND



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CONCEPT DESIGN SUBMITTAL

SYMB	SUBMITTAL/REVISION DESCRIPTION	DATE	APR
B	Replaced switches with breakers	11/15/2013	RC
A	Concept Design Submittal	07/09/13	KF

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: NF
DATE: 07/09/13
SUBMITTED BY: Tetra Tech
CAD FILE NAME: LT0063-E-104

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SALANG TUNNEL SUBSTATION
GOWARAH, AFGHANISTAN
20kV SWITCHGEAR FEEDER BREAKERS
SINGLE LINE DIAGRAMS

SHEET REFERENCE NUMBER:
E104

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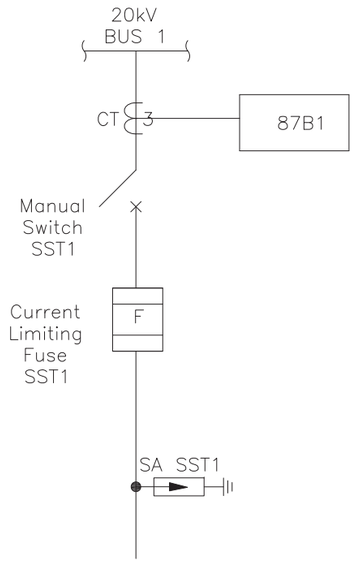
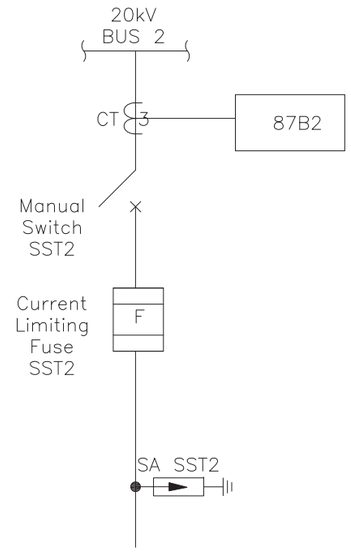


TO
SUB STATION TRANSFORMER 1



TO
SUB STATION TRANSFORMER 2

20kV STATION SERVICE TRANSFORMERS FEEDERS
SINGLE LINE DIAGRAMS

LEGEND

ID	FUNCTION
87B	BUS DIFFERENTIAL PROTECTIVE

ONE-LINE LEGEND

- # — CURRENT TRANSFORMER QUANTITY = #
- SURGE ARRESTOR (SA) QUANTITY = 3
- F — 20KV Current Limiting Fuse

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FINAL DESIGN SUBMITTAL

SYMB	SUBMITTAL/REVISION DESCRIPTION	DATE	APR
B	Removed Relays , CTs and Notes:	12/06/2013	RC
A	Concept Design Submittal	07/09/13	KF

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: NF
DATE: 07/09/13
SUBMITTED BY: Tetra Tech
CAD FILE NAME: LT0063 - E - 105

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GOWARAH, AFGHNISTAN

STATION SERVICE FEEDERS
SINGLE LINE DIAGRAMS

SHEET REFERENCE NUMBER:
E-105

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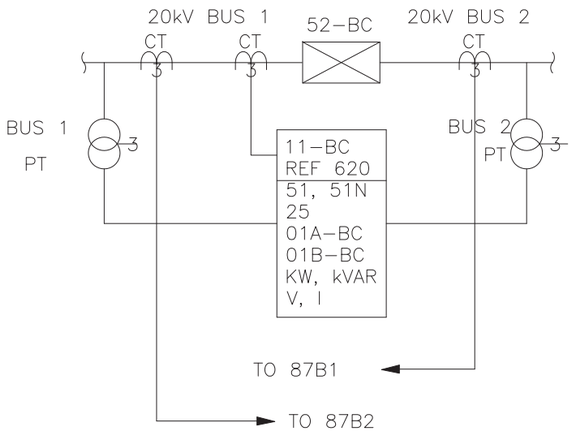
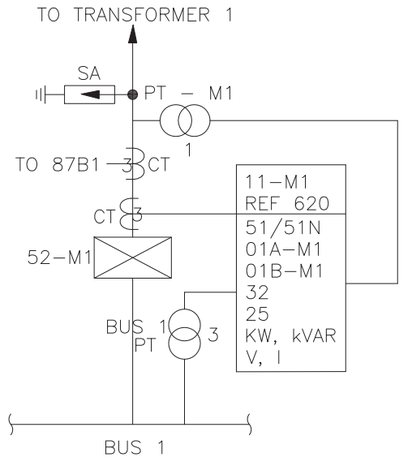


NOTES:

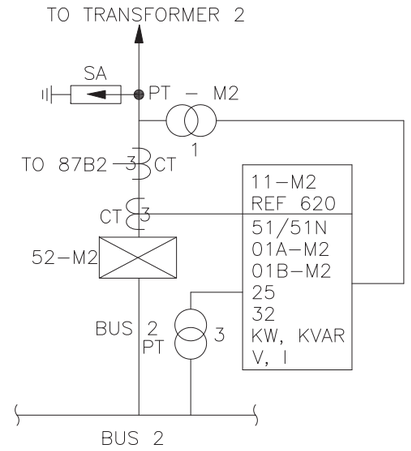
1. 01A–BC IS LOCAL CONTROLLER HMI IN 11–BC CONTROLLING 52–BC.
2. 01B–BC IS SCADA CONTROL OF 52–BC THROUGH 11–BC.

20kV LT TIE BREAKER
SINGLE LINE DIAGRAMS



NOTES:

1. 01A–M1 IS LOCAL CONTROLLER HMI IN 11–M1 CONTROLLING 52–M1.
2. 01B–M1 IS SCADA CONTROL OF 52–M1 THROUGH 11–M1.



NOTES:

1. 01A–M2 IS LOCAL CONTROLLER HMI IN 11–M2 CONTROLLING 52–M2.
2. 01B–M2 IS SCADA CONTROL OF 52–M2 THROUGH 11–M2.

20kV LT MAIN BREAKERS
SINGLE LINE DIAGRAMS

LEGEND

ID	FUNCTION
1	MASTER ELEMENT
11	MULTI–FUNCTION DEVICE
50	INSTANTANEOUS OVERCURRENT RELAY
51	AC INVERSE TIME OVERCURRENT RELAY
52	AC CIRCUIT BREAKER
87B	BUS DIFFERENTIAL PROTECTIVE
32	REVERSE POWER

ONE–LINE LEGEND

NOTE: A3 SIZE REDUCED TO HALF SCALE

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FINAL DESIGN SUBMITTAL

SYMB	SUBMITTAL/REVISION DESCRIPTION	DATE	APR
B	Replaced switches with breakers	11/15/13	RC
A	Concept Design Submittal	07/09/13	KF

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: NF
DATE: 07/09/2013
SUBMITTED BY: Tetra Tech
CAD FILE NAME: LT0063 – E – 106

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GOWARAH, AFGHANISTAN

20kV SWITCHGEAR MAIN BREAKERS
SINGLE LINE DIAGRAMS

SHEET REFERENCE NUMBER:
E–106

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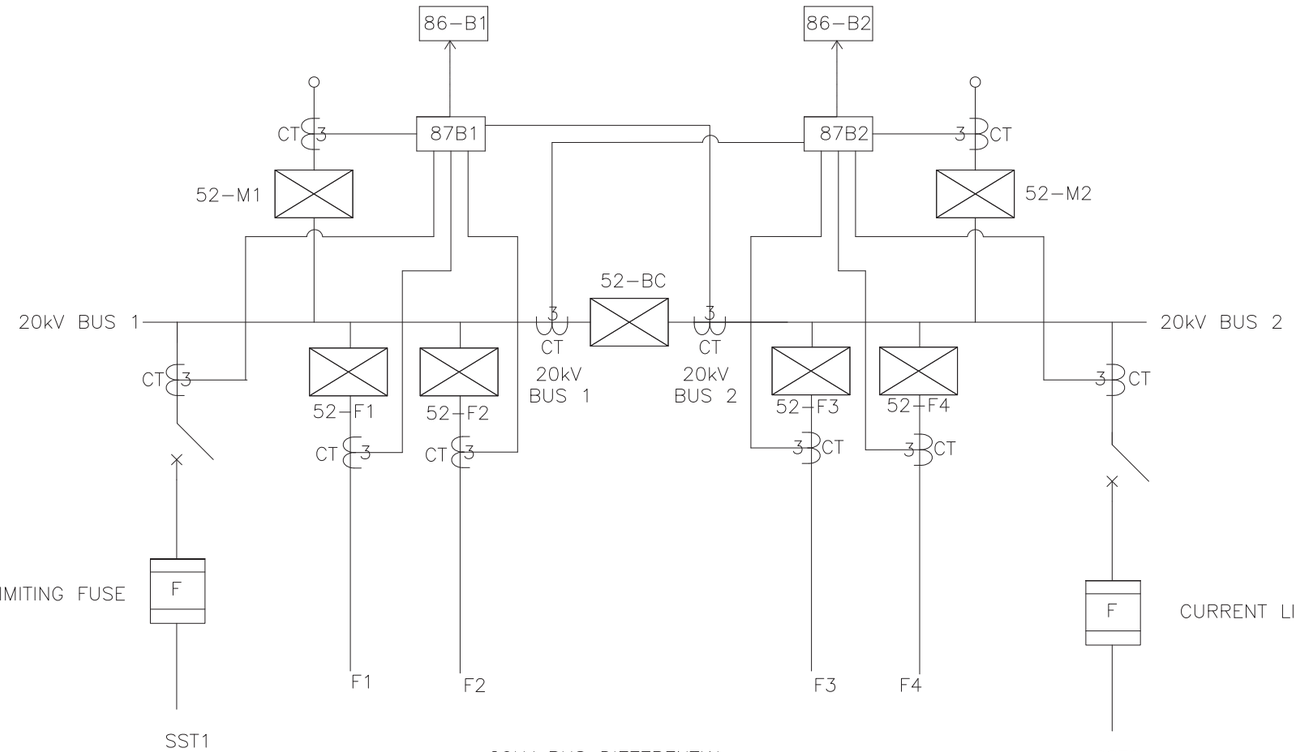

20kV BUS DIFFERENTIAL SINGLE LINE DIAGRAMS

LEGEND

ID	RELAY FUNCTIONS
52	AC CIRCUIT BREAKER
79	AC RECLOSING RELAY
87B	BUS DIFFERENTIAL PROTECTIVE RELAY
86	LOCK OUT RELAY

ONE-LINE LEGEND

- CURRENT TRANSFORMER, QUANTITY = #
- 20KV SWITCHGEAR CIRCUIT BREAKER
- SURGE ARRESTOR (SA) / QUANTITY = 3
- 20KV MANUAL SWITCH
- 20KV CURRENT LIMITING FUSE

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FINAL DESIGN SUBMITTAL

SYMB	SUBMITTAL/REVISION DESCRIPTION	DATE	APR
B	Replaced switches with breakers	11/15/13	RC
A	Concept Design Submittal	07/09/13	KF

DESIGNED BY: RC
DRAWN BY: KF
CHECKED BY: NF
DATE:
SUBMITTED BY: Tetra Tech
CAD FILE NAME: LT006- E-107

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GOWARAH, AFGHANISTAN

20kV SWITCHGEAR BUS DIFFERENTIAL SINGLE LINE DIAGRAMS

SHEET REFERENCE NUMBER:
E-107

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SECTION 33 75 10_Rev 2

MEDIUM VOLTAGE SWITCHGEAR

SPECIFICATION TABLE 1

DESCRIPTION	UNIT	REQUIRED VALUE
Quantity Required	Each	1 (One) unit
Type		Indoor Class, Metal-Clad, MV, Draw-out VAC. power breakers, Dead Front, double bus, multi section,50Hz
Switchgear		
Nominal System Voltage	kV	20kV
Maximum Nominal System Voltage	kV	24kV
BIL rated	kV	150kV
Continuous current (feeder breakers)	A	630A
Continuous current (main & tie breakers)	A	630A
Continuous current Bus	A	630A
Short circuit current interrupt(Symmetrical) at rated max. kV	kA	25kA
Closing and latching capability(Making)	kA	43kA
Three-second rating	kA	25kA
Enclosure Type		NEMA 1, Indoor
Nominal three-phase MVA class	MVA	1,100 MVA
Rated interrupting time	m.sec	100 m. sec.
Surge Arrester	KV&C	15.3KV$_{LG}$ @ 55°C
Potential Transformers		
BIL	kV	150kV
Primary Voltage	kV	20kV/√3 kV (±2.5%, 5 Taps)
Secondary Voltage	V	110/√3 V
Transformer Type		Dry type or epoxy enclosed
Metering Accuracy Class		.3 at rated burden
Station Service Transformer Feeder Switch		
SST Feeder Switch Rating		25A (Min)
Switch Type		Load Break
Phases		3 (Three)
Primary Nominal Voltage	kV	20kV
Auxiliary Contacts		2 "a" & 2 "b"
Circuit Breakers		
Continuous current (feeder breakers)	A	630A
Continuous current (main & tie breakers)	A	630A
Type		Vacuum
Charge Motor Voltage	VDC	220 V$_{DC}$
Control Voltage	VDC	220V$_{DC}$
Auxiliary Contacts		10a & 10b

SPECIFICATION TABLE 1 Continued

DESCRIPTION	UNIT	REQUIRED VALUE
Battery System		
Nominal output Voltage	VDC	220VDC
Cell Type		VRLA (Valve regulated Lead Acid)
Number of Cells		110
Terminal position & Type		Front, copper alloy with post protector
Ambient Temperature	C (F)	18° C (65° F)
Charger Current (Min)	ADC	20 ADC
Battery Float phase Voltage	VDC	2.10 VPCMax (231VDC Max. output)
Current Transformers		
Primary Current	A	MR 300:600
Secondary Current	A	1
Thermal Rating	%	200%
Burden	VA	50
ACCURACY (ANSI CLASS)		C200

--- End of Section ---

Appendix J – Relay and Control Panels

SECTION 33 75 00.00 40
Relay and Control Panels

PART 1 GENERAL

This specification includes requirements for 220/20kV relay, metering, control panels and the associated equipment mounted therein. These panels shall be provided for the Salang Tunnel Substation as specified herein and indicated on the Elementary Control Panel Single Line Diagram for the site.

Description: Substation Relay and Control Panel

Quantity: 1

1.1 REFERENCES

The design, manufacture and performance of equipment covered by this specification shall conform to the relevant British, IEC, or American Standards.

The equipment shall conform to the following codes and standards:

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 44 Instrument Transformers

IEC 185 Current Transformers

IEC 186 Potential Transformers

IEC 255 Electrical Relays

IEC 1036 Static Meters

IEC 60481 Coupling devices for power line carrier systems

1.2 GENERAL REQUIREMENTS

All equipment shall be manufactured in accordance with the latest edition of applicable IEC-EN or ANSI/IEEE organization standards. Manufacturers may choose to consistently follow IEC or ANSI/IEEE standards based on the manufacturer’s usual compliance ratings. Specific standard references from one organization may be substituted by an equivalent standard from another organization for consistency of the manufacturer’s compliance ratings. For example, an IEEE standard reference may be substituted by an equivalent IEC standard reference.

1.3 SCOPE OF WORK

The scope of design, manufacture, testing, and supply of equipment covered under this specification shall include, but not be limited to, the following:

a) Design, engineering, and fabrication of panels as per the specifications and drawings included.

b) Supply and mounting of all the equipment and auxiliary equipment like instruments, etc. necessary for satisfactory functioning of the control and protection system.

c) The protection system shall be provided with additional auxiliary contacts to integrate the system with the existing SCADA system. The Control Panel shall have all provisions & electronic equipment required for operation of a fiber-optic based SCADA system. All equipment necessary to interface and communicate with the existing transmission line and connected substations SCADA devices shall be provided. Meters shall have the facility for interrogation via modem and the SCADA/CSCS and shall provide pulsed outputs to the metering data processors. The Control Panel shall provide all hardware necessary for termination of the SCADA system to a minimum of 40 fiber-optic incoming circuits.

d) All internal wiring between all equipment up to the terminal blocks and the inter-panel wiring.

e) Prepare all data/drawings/documents as per the specifications. These include AC Three Lines, DC Protection and Control Ladder Diagram Schematics.

f) Provide testing results from manufacturing facility of the panels and the mounted equipment.

1.4 SUBMITTALS

The manufacture shall supply the following preliminary drawings for the acceptance of the preliminary design:

a) AC Three line diagrams

b) DC schematics

c) Panel wiring termination and interface blocks

d) Outdoor instrumentation equipment control wiring termination blocks

e) Equipment cut sheets

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENT

a) Constructional Features

1. All enclosures shall be sheet steel enclosed dust and vermin proof type. Enclosures shall be floor mounted, free standing, formed on a framework of standard sections. The enclosure shall be of cold rolled sheet of 3mm thickness for front and back and 2.5mm thick for rest. Enclosure supporting structure shall be so designed to form a rigid structure.

2. The boards shall be made of sheet steel of at least 2mm thickness and be of vermin-proof design IP 43 according to IEC - British 60529.

3. All doors and openings shall be provided with neoprene gaskets.

4. The enclosures shall be suitable to be installed on a base frame supplied in one piece along with foundation bolts. Amply dimensioned oblong holes shall be provided at the bottom of all panels for their installation on base frame. In addition, the panels shall have an additional base channel at the bottom with smooth surface. Anti-vibration type mounting shall be provided.

5. Boards shall be wired at the Contractor's workshop before delivery to Site. To facilitate transportation, the boards should be assembled in convenient sections before delivery.

6. All boards shall have a maximum height of 2,300mm.

7. The boards shall be equipped with a master key locking system.

8. Each board shall have internal lighting that is switched on when the door of the cubicle is opened.

9. Suitable removable undrilled steel gland plate shall be provided for interface cable entry from top of marshalling cabinet. The floor of marshalling cabinet shall be open to allow conduit & cable entry to substation yard equipment.

10. The degree of ingress protection for the enclosure shall be IP54.

11. Boards and marshalling boxes and equipment installed in them shall be of satisfactory corrosion proof design.

12. All box openings shall be screened for protection against vermin, and be so arranged that entry of water is prevented. For screening of the holes, netting with at least one mesh per mm shall be used.

13. All marshalling boxes shall be placed at normal working height and shall be sufficiently spacious to facilitate the connection of leads. They shall be so designed as to make markings easily legible.

b) Mounting

1. All instruments, control switches, and relays shall be mounted on the front of the enclosure. The low voltage switches for the AC boards shall be of Utilization Category AC 23 and DC 23 respectively. The switches shall be front-operated and have distinct ON-OFF markings and have provision for locking. Switches on the main boards shall be of plug-in type.

2. All equipment shall be flush or semi-flush type.

3. Checking and removal of components shall be possible without disturbing the adjacent equipment. It shall be possible to set all the measuring relays "in-situ." All mounted equipment inside the enclosures shall have Identification Tags and shall be Stainless Steel screwed.

4. The mounting of terminal blocks and any other auxiliary equipment such as transducers, interposing CTs, etc. shall be done in such a way so as to be readily accessible, but without impeding the access to internal wiring and components.

5. The center line of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The center line of relays, meters, and recorders shall not be less than 450mm from bottom of the panel. All switches, push buttons, indicating lamps, relays, etc. shall be neatly arranged in a matching manner.

6. Switch disconnections shall be of utilization category AC 23 (DC 23). Switch disconnections shall be operated from the front of the box and have distinct OFF-ON markings with possibility for locking with padlock in OFF position.

7. The control panels shall be matched with other panels in dimension, color and mimic.

8. Table 1 lists the minimum terminal interface functions to be provided. The functions listed are available for use by the supplier as necessary for complete operation of the control panel. At least 20% spare terminals shall be provided.

Table 1. Interface Cable Functions			
Equipment	**Function**	**Terminals**	**Cable Entry**
Generator Running	Alarm/Light	2	TOP
Generator Fail	Alarm/Light	2	TOP
Generator Fuel Low	Alarm/Light	2	TOP
220 kV Bus 1 - 87 Trip	Alarm/Light	2	TOP
220 kV Bus 2 - 87 Trip	Alarm/Light	2	TOP
220 kV Line 1 Fail	Alarm/Light	2	TOP
220 kV Line 2 Fail	Alarm/Light	2	TOP
AC Control Power Fail	Alarm/Light	2	TOP
DC Control Power Ground Fault	Alarm/Light	2	TOP
Interface to 20kV SWITCHGEAR			
Equipment	**Function**	**Terminals**	**Cable Entry**
52M1	Open Command	2	TOP
52M1	Close Command	2	TOP
52M1 Relay	Trip Command	2	TOP
52M1 Trip	Alarm/Light	2	TOP
52M1-25	Sync Check = OK	2	TOP
52M1	Aux "a" #1	2	TOP
52M1	Aux "a" #2	2	TOP

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
52M1	Aux "a" #3	2	TOP
52M1	Aux "a" #4	2	TOP
52M1	Aux "a" #5	2	TOP
52M1	Aux "a" #6	2	TOP
52M1	Aux "a" #7	2	TOP
52M1	Aux "a" #8	2	TOP
52M1	Aux "a" #9	2	TOP
52M1	Aux "a" #10	2	TOP
52M1	Aux "b" #1	2	TOP
52M1	Aux "b" #2	2	TOP
52M1	Aux "b" #3	2	TOP
52M1	Aux "b" #4	2	TOP
52M1	Aux "b" #5	2	TOP
52M1	Aux "b" #6	2	TOP
52M1	Aux "b" #7	2	TOP
52M1	Aux "b" #8	2	TOP
52M1	Aux "b" #9	2	TOP
52M1	Aux "b" #10	2	TOP
52M2	Open Command	2	TOP
52M2	Close Command	2	TOP
52M2 Relay	Trip Command	2	TOP
52M2 Trip	Alarm/Light	2	TOP
52M2-25	Sync Check = OK	2	TOP
52M2	Aux "a" #1	2	TOP
52M2	Aux "a" #2	2	TOP
52M2	Aux "a" #3	2	TOP
52M2	Aux "a" #4	2	TOP
52M2	Aux "a" #5	2	TOP
52M2	Aux "a" #6	2	TOP
52M2	Aux "a" #7	2	TOP
52M2	Aux "a" #8	2	TOP
52M2	Aux "a" #9	2	TOP
52M2	Aux "a" #10	2	TOP
52M2	Aux "b" #1	2	TOP
52M2	Aux "b" #2	2	TOP
52M2	Aux "b" #3	2	TOP
52M2	Aux "b" #4	2	TOP
52M2	Aux "b" #5	2	TOP
52M2	Aux "b" #6	2	TOP
52M2	Aux "b" #7	2	TOP
52M2	Aux "b" #8	2	TOP
52M2	Aux "b" #9	2	TOP
52M2	Aux "b" #10	2	TOP
52F1	Open Command	2	TOP
52F1	Close Command	2	TOP
52F1 Relay	Trip Command	2	TOP
52F1 Trip	Alarm/Light	2	TOP
52F1	Aux "a" #1	2	TOP
52F1	Aux "a" #2	2	TOP
52F1	Aux "a" #3	2	TOP
52F1	Aux "a" #4	2	TOP
52F1	Aux "a" #5	2	TOP
52F1	Aux "a" #6	2	TOP
52F1	Aux "a" #7	2	TOP
52F1	Aux "a" #8	2	TOP

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
52F1	Aux "a" #9	2	TOP
52F1	Aux "a" #10	2	TOP
52F1	Aux "b" #1	2	TOP
52F1	Aux "b" #2	2	TOP
52F1	Aux "b" #3	2	TOP
52F1	Aux "b" #4	2	TOP
52F1	Aux "b" #5	2	TOP
52F1	Aux "b" #6	2	TOP
52F1	Aux "b" #7	2	TOP
52F1	Aux "b" #8	2	TOP
52F1	Aux "b" #9	2	TOP
52F1	Aux "b" #10	2	TOP
52F2	Open Command	2	TOP
52F2	Close Command	2	TOP
52F2 Relay	Trip Command	2	TOP
52F2 Trip	Alarm/Light	2	TOP
52F2	Aux "a" #1	2	TOP
52F2	Aux "a" #2	2	TOP
52F2	Aux "a" #3	2	TOP
52F2	Aux "a" #4	2	TOP
52F2	Aux "a" #5	2	TOP
52F2	Aux "a" #6	2	TOP
52F2	Aux "a" #7	2	TOP
52F2	Aux "a" #8	2	TOP
52F2	Aux "a" #9	2	TOP
52F2	Aux "a" #10	2	TOP
52F2	Aux "b" #1	2	TOP
52F2	Aux "b" #2	2	TOP
52F2	Aux "b" #3	2	TOP
52F2	Aux "b" #4	2	TOP
52F2	Aux "b" #5	2	TOP
52F2	Aux "b" #6	2	TOP
52F2	Aux "b" #7	2	TOP
52F2	Aux "b" #8	2	TOP
52F2	Aux "b" #9	2	TOP
52F2	Aux "b" #10	2	TOP
52F3	Open Command	2	TOP
52F3	Close Command	2	TOP
52F3 Relay	Trip Command	2	TOP
52F3 Trip	Alarm/Light	2	TOP
52F3	Aux "a" #1	2	TOP
52F3	Aux "a" #2	2	TOP
52F3	Aux "a" #3	2	TOP
52F3	Aux "a" #4	2	TOP
52F3	Aux "a" #5	2	TOP
52F3	Aux "a" #6	2	TOP
52F3	Aux "a" #7	2	TOP
52F3	Aux "a" #8	2	TOP
52F3	Aux "a" #9	2	TOP
52F3	Aux "a" #10	2	TOP
52F3	Aux "b" #1	2	TOP
52F3	Aux "b" #2	2	TOP
52F3	Aux "b" #3	2	TOP
52F3	Aux "b" #4	2	TOP
52F3	Aux "b" #5	2	TOP

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
52F3	Aux "b" #6	2	TOP
52F3	Aux "b" #7	2	TOP
52F3	Aux "b" #8	2	TOP
52F3	Aux "b" #9	2	TOP
52F3	Aux "b" #10	2	TOP
52F4	Open Command	2	TOP
52F4	Close Command	2	TOP
52F4 Relay	Trip Command	2	TOP
52F4 Trip	Alarm/Light	2	TOP
52F4	Aux "a" #1	2	TOP
52F4	Aux "a" #2	2	TOP
52F4	Aux "a" #3	2	TOP
52F4	Aux "a" #4	2	TOP
52F4	Aux "a" #5	2	TOP
52F4	Aux "a" #6	2	TOP
52F4	Aux "a" #7	2	TOP
52F4	Aux "a" #8	2	TOP
52F4	Aux "a" #9	2	TOP
52F4	Aux "a" #10	2	TOP
52F4	Aux "b" #1	2	TOP
52F4	Aux "b" #2	2	TOP
52F4	Aux "b" #3	2	TOP
52F4	Aux "b" #4	2	TOP
52F4	Aux "b" #5	2	TOP
52F4	Aux "b" #6	2	TOP
52F4	Aux "b" #7	2	TOP
52F4	Aux "b" #8	2	TOP
52F4	Aux "b" #9	2	TOP
52F4	Aux "b" #10	2	TOP
52BC	Open Command	2	TOP
52BC	Close Command	2	TOP
52BC Relay	Trip Command	2	TOP
52BC Trip	Alarm/Light	2	TOP
52BC-25	Sync Check = OK	2	TOP
52BC	Aux "a" #1	2	TOP
52BC	Aux "a" #2	2	TOP
52BC	Aux "a" #3	2	TOP
52BC	Aux "a" #4	2	TOP
52BC	Aux "a" #5	2	TOP
52BC	Aux "a" #6	2	TOP
52BC	Aux "a" #7	2	TOP
52BC	Aux "a" #8	2	TOP
52BC	Aux "a" #9	2	TOP
52BC	Aux "a" #10	2	TOP
52BC	Aux "b" #1	2	TOP
52BC	Aux "b" #2	2	TOP
52BC	Aux "b" #3	2	TOP
52BC	Aux "b" #4	2	TOP
52BC	Aux "b" #5	2	TOP
52BC	Aux "b" #6	2	TOP
52BC	Aux "b" #7	2	TOP
52BC	Aux "b" #8	2	TOP
52BC	Aux "b" #9	2	TOP
52BC	Aux "b" #10	2	TOP
Bus 1 - 87	Trip	2	TOP

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
Bus 2 - 87	Trip	2	TOP
Bus 1 - 87 Trip	Alarm/Light	2	TOP
Bus 2 - 87 Trip	Alarm/Light	2	TOP
Bus 1 - Energized	Closed = Hot	2	TOP
Bus 2 - Energized	Closed = Hot	2	TOP
T1 - Energized	Closed = Hot	2	TOP
T2 - Energized	Closed = Hot	2	TOP
DC Power	Panel Control Power	2	TOP
AC Power	Panel Heaters/Lights	2	TOP
SST-1	Aux "a" #1	2	TOP
SST-1	Aux "a" #2	2	TOP
SST-1	Aux "b" #1	2	TOP
SST-1	Aux "b" #2	2	TOP
Bus 1 Potential (Bus 1 PT)	Phase A	1	TOP
Bus 1 Potential (Bus 1 PT)	Phase B	1	TOP
Bus 1 Potential (Bus 1 PT)	Phase C	1	TOP
Bus 1 Potential (Bus 1 PT)	Neutral	1	TOP
Bus 2 Potential (Bus 2 PT)	Phase A	1	TOP
Bus 2 Potential (Bus 2 PT)	Phase B	1	TOP
Bus 2 Potential (Bus 2 PT)	Phase C	1	TOP
Bus 2 Potential (Bus 2 PT)	Neutral	1	TOP
52-M1 CT-2 Current	Phase A	2	TOP
52-M1 CT-2 Current	Phase B	2	TOP
52-M1 CT-2 Current	Phase C	2	TOP
52-M1 CT-3 Current	Phase A	2	TOP
52-M1 CT-3 Current	Phase B	2	TOP
52-M1 CT-3 Current	Phase C	2	TOP
SST-2	Aux "a" #1	2	TOP
SST-2	Aux "a" #2	2	TOP
SST-2	Aux "b" #1	2	TOP
SST-2	Aux "b" #2	2	TOP
Interface to DC PANEL			
Equipment	**Function**	**Terminals**	**Cable Entry**
201-89L DC Power	Control Power	2	TOP
203-89L DC Power	Control Power	2	TOP
201-89M1 DC Power	Control Power	2	TOP
201-89M2 DC Power	Control Power	2	TOP
203-89M1 DC Power	Control Power	2	TOP
203-89M2 DC Power	Control Power	2	TOP
208-89M1 DC Power	Control Power	2	TOP
208-89M2 DC Power	Control Power	2	TOP
209-89M1 DC Power	Control Power	2	TOP
209-89M2 DC Power	Control Power	2	TOP
215-89M1 DC Power	Control Power	2	TOP
215-89M2 DC Power	Control Power	2	TOP
201-52	Control Power	2	TOP
203-52	Control Power	2	TOP
208-52	Control Power	2	TOP
209-52	Control Power	2	TOP
215-52 Bus Coupler	Control Power	2	TOP
T1 DC Power	Control Power	2	TOP
T2 DC Power	Control Power	2	TOP

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
SWGR DC Power	Control Power	2	TOP
Control Panel DC	Control Power	2	TOP
Interface to AC PANEL			
Equipment	**Function**	**Terminals**	**Cable Entry**
201-89L AC Power	Heaters/Lights	2	TOP
201-89M1 AC Power	Heaters/Lights	2	TOP
201-89M2 AC Power	Heaters/Lights	2	TOP
203-89L AC Power	Heaters/Lights	2	TOP
203-89M1 AC Power	Heaters/Lights	2	TOP
203-89M2 AC Power	Heaters/Lights	2	TOP
208-89M1 AC Power	Heaters/Lights	2	TOP
208-89M2 AC Power	Heaters/Lights	2	TOP
209-89M1 AC Power	Heaters/Lights	2	TOP
209-89M2 AC Power	Heaters/Lights	2	TOP
215-89M1 AC Power	Heaters/Lights	2	TOP
215-89M2 AC Power	Heaters/Lights	2	TOP
201-52	Heaters/Lights	2	TOP
203-52	Heaters/Lights	2	TOP
208-52	Heaters/Lights	2	TOP
209-52	Heaters/Lights	2	TOP
215-52 Bus Coupler	Heaters/Lights	2	TOP
CVT-201-1	Heaters	2	TOP
CVT-203-1	Heaters	2	TOP
CVT-BUS-1	Heaters	2	TOP
CVT-BUS-2	Heaters	2	TOP
CT-201-1	Heaters	2	TOP
CT-203-1	Heaters	2	TOP
CT-208-1	Heaters	2	TOP
CT-209-1	Heaters	2	TOP
CT-215-1	Heaters	2	TOP
T1 AC Power	Heaters/Lights	2	TOP
T2 AC Power	Heaters/Lights	2	TOP
SWGR AC Power	Heaters/Lights	2	TOP
Control Panel AC	Heaters/Lights	2	TOP
Yard Lights 1	Heaters/Lights	2	TOP
Yard Lights 2	Heaters/Lights	2	TOP
Interface to SWITCHYARD			
Equipment	**Function**	**Terminals**	**Cable Entry**
CVT-201-1	Core 1	2	BOTTOM
CVT-201-1	Core 2	2	BOTTOM
CVT-201-1	Core 3	2	BOTTOM
CVT-201-1	Heater	2	BOTTOM
201-89L	Aux “a” #1	2	BOTTOM
201-89L	Aux “a” #2	2	BOTTOM
201-89L	Aux “a” #3	2	BOTTOM
201-89L	Aux “a” #4	2	BOTTOM
201-89L	Aux “a” #5	2	BOTTOM
201-89L	Aux “a” #6	2	BOTTOM
201-89L	Aux “a” #7	2	BOTTOM
201-89L	Aux “a” #8	2	BOTTOM
201-89L	Aux “a” #9	2	BOTTOM
201-89L	Aux “a” #10	2	BOTTOM

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
201-89L	Aux "b" #1	2	BOTTOM
201-89L	Aux "b" #2	2	BOTTOM
201-89L	Aux "b" #3	2	BOTTOM
201-89L	Aux "b" #4	2	BOTTOM
201-89L	Aux "b" #5	2	BOTTOM
201-89L	Aux "b" #6	2	BOTTOM
201-89L	Aux "b" #7	2	BOTTOM
201-89L	Aux "b" #8	2	BOTTOM
201-89L	Aux "b" #9	2	BOTTOM
201-89L	Aux "b" #10	2	BOTTOM
201-89L DC Power	Control Power	2	BOTTOM
201-89L AC Power	Heaters/Lights	2	BOTTOM
CT-201-1	Core 1	2	BOTTOM
CT-201-1	Core 2	2	BOTTOM
CT-201-1	Core 3	2	BOTTOM
CT-201-1	Core 4	2	BOTTOM
CT-201-1	Core 5	2	BOTTOM
CT-201-1	Heater	2	BOTTOM
201-52	Heaters/Lights	2	BOTTOM
201-52	Control Power	2	BOTTOM
201-52	Open Command	2	BOTTOM
201-52	Close Command	2	BOTTOM
201-52	Aux "a" #1	2	BOTTOM
201-52	Aux "a" #2	2	BOTTOM
201-52	Aux "a" #3	2	BOTTOM
201-52	Aux "a" #4	2	BOTTOM
201-52	Aux "a" #5	2	BOTTOM
201-52	Aux "a" #6	2	BOTTOM
201-52	Aux "a" #7	2	BOTTOM
201-52	Aux "a" #8	2	BOTTOM
201-52	Aux "a" #9	2	BOTTOM
201-52	Aux "a" #10	2	BOTTOM
201-52	Aux "b" #1	2	BOTTOM
201-52	Aux "b" #2	2	BOTTOM
201-52	Aux "b" #3	2	BOTTOM
201-52	Aux "b" #4	2	BOTTOM
201-52	Aux "b" #5	2	BOTTOM
201-52	Aux "b" #6	2	BOTTOM
201-52	Aux "b" #7	2	BOTTOM
201-52	Aux "b" #8	2	BOTTOM
201-52	Aux "b" #9	2	BOTTOM
201-52	Aux "b" #10	2	BOTTOM
201-52 Summary Alarm	Alarm = Closed	2	BOTTOM
201-89M1	Aux "a" #1	2	BOTTOM
201-89M1	Aux "a" #2	2	BOTTOM
201-89M1	Aux "a" #3	2	BOTTOM
201-89M1	Aux "a" #4	2	BOTTOM
201-89M1	Aux "a" #5	2	BOTTOM
201-89M1	Aux "a" #6	2	BOTTOM
201-89M1	Aux "a" #7	2	BOTTOM
201-89M1	Aux "a" #8	2	BOTTOM
201-89M1	Aux "a" #9	2	BOTTOM
201-89M1	Aux "a" #10	2	BOTTOM
201-89M1	Aux "b" #1	2	BOTTOM
201-89M1	Aux "b" #2	2	BOTTOM

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
201-89M1	Aux "b" #3	2	BOTTOM
201-89M1	Aux "b" #4	2	BOTTOM
201-89M1	Aux "b" #5	2	BOTTOM
201-89M1	Aux "b" #6	2	BOTTOM
201-89M1	Aux "b" #7	2	BOTTOM
201-89M1	Aux "b" #8	2	BOTTOM
201-89M1	Aux "b" #9	2	BOTTOM
201-89M1	Aux "b" #10	2	BOTTOM
201-89M1 DC Power	Control Power	2	BOTTOM
201-89M1 AC Power	Heaters/Lights	2	BOTTOM
201-89M2	Aux "a" #1	2	BOTTOM
201-89M2	Aux "a" #2	2	BOTTOM
201-89M2	Aux "a" #3	2	BOTTOM
201-89M2	Aux "a" #4	2	BOTTOM
201-89M2	Aux "a" #5	2	BOTTOM
201-89M2	Aux "a" #6	2	BOTTOM
201-89M2	Aux "a" #7	2	BOTTOM
201-89M2	Aux "a" #8	2	BOTTOM
201-89M2	Aux "a" #9	2	BOTTOM
201-89M2	Aux "a" #10	2	BOTTOM
201-89M2	Aux "b" #1	2	BOTTOM
201-89M2	Aux "b" #2	2	BOTTOM
201-89M2	Aux "b" #3	2	BOTTOM
201-89M2	Aux "b" #4	2	BOTTOM
201-89M2	Aux "b" #5	2	BOTTOM
201-89M2	Aux "b" #6	2	BOTTOM
201-89M2	Aux "b" #7	2	BOTTOM
201-89M2	Aux "b" #8	2	BOTTOM
201-89M2	Aux "b" #9	2	BOTTOM
201-89M2	Aux "b" #10	2	BOTTOM
201-89M2 DC Power	Control Power	2	BOTTOM
201-89M2 AC Power	Heaters/Lights	2	BOTTOM
CVT-203-1	Core 1	2	BOTTOM
CVT-203-1	Core 2	2	BOTTOM
CVT-203-1	Core 3	2	BOTTOM
CVT-203-1	Heater	2	BOTTOM
203-89L	Aux "a" #1	2	BOTTOM
203-89L	Aux "a" #2	2	BOTTOM
203-89L	Aux "a" #3	2	BOTTOM
203-89L	Aux "a" #4	2	BOTTOM
203-89L	Aux "a" #5	2	BOTTOM
203-89L	Aux "a" #6	2	BOTTOM
203-89L	Aux "a" #7	2	BOTTOM
203-89L	Aux "a" #8	2	BOTTOM
203-89L	Aux "a" #9	2	BOTTOM
203-89L	Aux "a" #10	2	BOTTOM
203-89L	Aux "b" #1	2	BOTTOM
203-89L	Aux "b" #2	2	BOTTOM
203-89L	Aux "b" #3	2	BOTTOM
203-89L	Aux "b" #4	2	BOTTOM
203-89L	Aux "b" #5	2	BOTTOM
203-89L	Aux "b" #6	2	BOTTOM
203-89L	Aux "b" #7	2	BOTTOM
203-89L	Aux "b" #8	2	BOTTOM
203-89L	Aux "b" #9	2	BOTTOM

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
203-89L	Aux "b" #10	2	BOTTOM
203-89L DC Power	Control Power	2	BOTTOM
203-89L AC Power	Heaters/Lights	2	BOTTOM
CT-203-1	Core 1	2	BOTTOM
CT-203-1	Core 2	2	BOTTOM
CT-203-1	Core 3	2	BOTTOM
CT-203-1	Core 4	2	BOTTOM
CT-203-1	Core 5	2	BOTTOM
CT-203-1	Heater	2	BOTTOM
203-52	Heaters/Lights	2	BOTTOM
203-52	Control Power	2	BOTTOM
203-52	Open Command	2	BOTTOM
203-52	Close Command	2	BOTTOM
203-52	Aux "a" #1	2	BOTTOM
203-52	Aux "a" #2	2	BOTTOM
203-52	Aux "a" #3	2	BOTTOM
203-52	Aux "a" #4	2	BOTTOM
203-52	Aux "a" #5	2	BOTTOM
203-52	Aux "a" #6	2	BOTTOM
203-52	Aux "a" #7	2	BOTTOM
203-52	Aux "a" #8	2	BOTTOM
203-52	Aux "a" #9	2	BOTTOM
203-52	Aux "a" #10	2	BOTTOM
203-52	Aux "b" #1	2	BOTTOM
203-52	Aux "b" #2	2	BOTTOM
203-52	Aux "b" #3	2	BOTTOM
203-52	Aux "b" #4	2	BOTTOM
203-52	Aux "b" #5	2	BOTTOM
203-52	Aux "b" #6	2	BOTTOM
203-52	Aux "b" #7	2	BOTTOM
203-52	Aux "b" #8	2	BOTTOM
203-52	Aux "b" #9	2	BOTTOM
203-52	Aux "b" #10	2	BOTTOM
203-52 Summary Alarm	Alarm = Closed	2	BOTTOM
203-89M1	Aux "a" #1	2	BOTTOM
203-89M1	Aux "a" #2	2	BOTTOM
203-89M1	Aux "a" #3	2	BOTTOM
203-89M1	Aux "a" #4	2	BOTTOM
203-89M1	Aux "a" #5	2	BOTTOM
203-89M1	Aux "a" #6	2	BOTTOM
203-89M1	Aux "a" #7	2	BOTTOM
203-89M1	Aux "a" #8	2	BOTTOM
203-89M1	Aux "a" #9	2	BOTTOM
203-89M1	Aux "a" #10	2	BOTTOM
203-89M1	Aux "b" #1	2	BOTTOM
203-89M1	Aux "b" #2	2	BOTTOM
203-89M1	Aux "b" #3	2	BOTTOM
203-89M1	Aux "b" #4	2	BOTTOM
203-89M1	Aux "b" #5	2	BOTTOM
203-89M1	Aux "b" #6	2	BOTTOM
203-89M1	Aux "b" #7	2	BOTTOM
203-89M1	Aux "b" #8	2	BOTTOM
203-89M1	Aux "b" #9	2	BOTTOM
203-89M1	Aux "b" #10	2	BOTTOM
203-89M1 DC Power	Control Power	2	BOTTOM

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
203-89M1 AC Power	Heaters/Lights	2	BOTTOM
203-89M2	Aux "a" #1	2	BOTTOM
203-89M2	Aux "a" #2	2	BOTTOM
203-89M2	Aux "a" #3	2	BOTTOM
203-89M2	Aux "a" #4	2	BOTTOM
203-89M2	Aux "a" #5	2	BOTTOM
203-89M2	Aux "a" #6	2	BOTTOM
203-89M2	Aux "a" #7	2	BOTTOM
203-89M2	Aux "a" #8	2	BOTTOM
203-89M2	Aux "a" #9	2	BOTTOM
203-89M2	Aux "a" #10	2	BOTTOM
203-89M2	Aux "b" #1	2	BOTTOM
203-89M2	Aux "b" #2	2	BOTTOM
203-89M2	Aux "b" #3	2	BOTTOM
203-89M2	Aux "b" #4	2	BOTTOM
203-89M2	Aux "b" #5	2	BOTTOM
203-89M2	Aux "b" #6	2	BOTTOM
203-89M2	Aux "b" #7	2	BOTTOM
203-89M2	Aux "b" #8	2	BOTTOM
203-89M2	Aux "b" #9	2	BOTTOM
203-89M2	Aux "b" #10	2	BOTTOM
203-89M2 DC Power	Control Power	2	BOTTOM
203-89M2 AC Power	Heaters/Lights	2	BOTTOM
208-89M1	Aux "a" #1	2	BOTTOM
208-89M1	Aux "a" #2	2	BOTTOM
208-89M1	Aux "a" #3	2	BOTTOM
208-89M1	Aux "a" #4	2	BOTTOM
208-89M1	Aux "a" #5	2	BOTTOM
208-89M1	Aux "a" #6	2	BOTTOM
208-89M1	Aux "a" #7	2	BOTTOM
208-89M1	Aux "a" #8	2	BOTTOM
208-89M1	Aux "a" #9	2	BOTTOM
208-89M1	Aux "a" #10	2	BOTTOM
208-89M1	Aux "b" #1	2	BOTTOM
208-89M1	Aux "b" #2	2	BOTTOM
208-89M1	Aux "b" #3	2	BOTTOM
208-89M1	Aux "b" #4	2	BOTTOM
208-89M1	Aux "b" #5	2	BOTTOM
208-89M1	Aux "b" #6	2	BOTTOM
208-89M1	Aux "b" #7	2	BOTTOM
208-89M1	Aux "b" #8	2	BOTTOM
208-89M1	Aux "b" #9	2	BOTTOM
208-89M1	Aux "b" #10	2	BOTTOM
208-89M1 DC Power	Control Power	2	BOTTOM
208-89M1 AC Power	Heaters/Lights	2	BOTTOM
208-89M2	Aux "a" #1	2	BOTTOM
208-89M2	Aux "a" #2	2	BOTTOM
208-89M2	Aux "a" #3	2	BOTTOM
208-89M2	Aux "a" #4	2	BOTTOM
208-89M2	Aux "a" #5	2	BOTTOM
208-89M2	Aux "a" #6	2	BOTTOM
208-89M2	Aux "a" #7	2	BOTTOM
208-89M2	Aux "a" #8	2	BOTTOM
208-89M2	Aux "a" #9	2	BOTTOM
208-89M2	Aux "a" #10	2	BOTTOM

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
208-89M2	Aux "b" #1	2	BOTTOM
208-89M2	Aux "b" #2	2	BOTTOM
208-89M2	Aux "b" #3	2	BOTTOM
208-89M2	Aux "b" #4	2	BOTTOM
208-89M2	Aux "b" #5	2	BOTTOM
208-89M2	Aux "b" #6	2	BOTTOM
208-89M2	Aux "b" #7	2	BOTTOM
208-89M2	Aux "b" #8	2	BOTTOM
208-89M2	Aux "b" #9	2	BOTTOM
208-89M2	Aux "b" #10	2	BOTTOM
208-89M2 DC Power	Control Power	2	BOTTOM
208-89M2 AC Power	Heaters/Lights	2	BOTTOM
208-52	Heaters/Lights	2	BOTTOM
208-52	Control Power	2	BOTTOM
208-52	Open Command	2	BOTTOM
208-52	Close Command	2	BOTTOM
208-52	Aux "a" #1	2	BOTTOM
208-52	Aux "a" #2	2	BOTTOM
208-52	Aux "a" #3	2	BOTTOM
208-52	Aux "a" #4	2	BOTTOM
208-52	Aux "a" #5	2	BOTTOM
208-52	Aux "a" #6	2	BOTTOM
208-52	Aux "a" #7	2	BOTTOM
208-52	Aux "a" #8	2	BOTTOM
208-52	Aux "a" #9	2	BOTTOM
208-52	Aux "a" #10	2	BOTTOM
208-52	Aux "b" #1	2	BOTTOM
208-52	Aux "b" #2	2	BOTTOM
208-52	Aux "b" #3	2	BOTTOM
208-52	Aux "b" #4	2	BOTTOM
208-52	Aux "b" #5	2	BOTTOM
208-52	Aux "b" #6	2	BOTTOM
208-52	Aux "b" #7	2	BOTTOM
208-52	Aux "b" #8	2	BOTTOM
208-52	Aux "b" #9	2	BOTTOM
208-52	Aux "b" #10	2	BOTTOM
208-52 Summary Alarm	Alarm/Light	2	BOTTOM
CT-208-1	Core 1	2	BOTTOM
CT-208-1	Core 2	2	BOTTOM
CT-208-1	Core 3	2	BOTTOM
CT-208-1	Core 4	2	BOTTOM
CT-208-1	Core 5	2	BOTTOM
CT-208-1	Heaters/Lights	2	BOTTOM
201-89L	Operation Inhibit	2	BOTTOM
201-89M1	Operation Inhibit	2	BOTTOM
201-89M2	Operation Inhibit	2	BOTTOM
203-89L	Operation Inhibit	2	BOTTOM
203-89M1	Operation Inhibit	2	BOTTOM
203-89M2	Operation Inhibit	2	BOTTOM
208-89M1	Operation Inhibit	2	BOTTOM
208-89M2	Operation Inhibit	2	BOTTOM
209-89M1	Operation Inhibit	2	BOTTOM
209-89M2	Operation Inhibit	2	BOTTOM
215-89M1	Operation Inhibit	2	BOTTOM
215-89M2	Operation Inhibit	2	BOTTOM

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
T1 DC Power	Control Power	2	BOTTOM
T1 AC Power	Heaters/Lights	2	BOTTOM
T1 High Temp	Alarm	2	BOTTOM
T1 Low Temp	Alarm/Light	2	BOTTOM
T1 Fault Pressure	Alarm/Light	2	BOTTOM
T1 Pressure Relief	Alarm/Light	2	BOTTOM
T1 LTC Manual Operation	Alarm/Light	2	BOTTOM
T1 Oil Level	Alarm/Light	2	BOTTOM
T1 LTC Position Bit 1	Position Indicator	1	BOTTOM
T1 LTC Position Bit 2	Position Indicator	1	BOTTOM
T1 LTC Position Bit 3	Position Indicator	1	BOTTOM
T1 LTC Position Bit 4	Position Indicator	1	BOTTOM
T1 LTC Position Common	Position Indicator	1	BOTTOM
T1 Neutral CT	Relay RET-670	2	BOTTOM
CVT-BUS-1	Core 1	2	BOTTOM
CVT-BUS-1	Core 2	2	BOTTOM
CVT-BUS-1	Core 3	2	BOTTOM
CVT-BUS-1	Heaters/Lights	2	BOTTOM
209-89M1	Aux “a” #1	2	BOTTOM
209-89M1	Aux “a” #2	2	BOTTOM
209-89M1	Aux “a” #3	2	BOTTOM
209-89M1	Aux “a” #4	2	BOTTOM
209-89M1	Aux “a” #5	2	BOTTOM
209-89M1	Aux “a” #6	2	BOTTOM
209-89M1	Aux “a” #7	2	BOTTOM
209-89M1	Aux “a” #8	2	BOTTOM
209-89M1	Aux “a” #9	2	BOTTOM
209-89M1	Aux “a” #10	2	BOTTOM
209-89M1	Aux “b” #1	2	BOTTOM
209-89M1	Aux “b” #2	2	BOTTOM
209-89M1	Aux “b” #3	2	BOTTOM
209-89M1	Aux “b” #4	2	BOTTOM
209-89M1	Aux “b” #5	2	BOTTOM
209-89M1	Aux “b” #6	2	BOTTOM
209-89M1	Aux “b” #7	2	BOTTOM
209-89M1	Aux “b” #8	2	BOTTOM
209-89M1	Aux “b” #9	2	BOTTOM
209-89M1	Aux “b” #10	2	BOTTOM
209-89M1 DC Power	Control Power	2	BOTTOM
209-89M1 AC Power	Heaters/Lights	2	BOTTOM
209-89M2	Aux “a” #1	2	BOTTOM
209-89M2	Aux “a” #2	2	BOTTOM
209-89M2	Aux “a” #3	2	BOTTOM
209-89M2	Aux “a” #4	2	BOTTOM
209-89M2	Aux “a” #5	2	BOTTOM
209-89M2	Aux “a” #6	2	BOTTOM
209-89M2	Aux “a” #7	2	BOTTOM
209-89M2	Aux “a” #8	2	BOTTOM
209-89M2	Aux “a” #9	2	BOTTOM
209-89M2	Aux “a” #10	2	BOTTOM
209-89M2	Aux “b” #1	2	BOTTOM
209-89M2	Aux “b” #2	2	BOTTOM
209-89M2	Aux “b” #3	2	BOTTOM
209-89M2	Aux “b” #4	2	BOTTOM
209-89M2	Aux “b” #5	2	BOTTOM

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
209-89M2	Aux "b" #6	2	BOTTOM
209-89M2	Aux "b" #7	2	BOTTOM
209-89M2	Aux "b" #8	2	BOTTOM
209-89M2	Aux "b" #9	2	BOTTOM
209-89M2	Aux "b" #10	2	BOTTOM
209-89M2 DC Power	Control Power	2	BOTTOM
209-89M2 AC Power	Heaters/Lights	2	BOTTOM
209-52	Heaters/Lights	2	BOTTOM
209-52	Control Power	2	BOTTOM
209-52	Open Command	2	BOTTOM
209-52	Close Command	2	BOTTOM
209-52	Aux "a" #1	2	BOTTOM
209-52	Aux "a" #2	2	BOTTOM
209-52	Aux "a" #3	2	BOTTOM
209-52	Aux "a" #4	2	BOTTOM
209-52	Aux "a" #5	2	BOTTOM
209-52	Aux "a" #6	2	BOTTOM
209-52	Aux "a" #7	2	BOTTOM
209-52	Aux "a" #8	2	BOTTOM
209-52	Aux "a" #9	2	BOTTOM
209-52	Aux "a" #10	2	BOTTOM
209-52	Aux "b" #1	2	BOTTOM
209-52	Aux "b" #2	2	BOTTOM
209-52	Aux "b" #3	2	BOTTOM
209-52	Aux "b" #4	2	BOTTOM
209-52	Aux "b" #5	2	BOTTOM
209-52	Aux "b" #6	2	BOTTOM
209-52	Aux "b" #7	2	BOTTOM
209-52	Aux "b" #8	2	BOTTOM
209-52	Aux "b" #9	2	BOTTOM
209-52	Aux "b" #10	2	BOTTOM
209-52 Summary Alarm	Alarm/Light	2	BOTTOM
CT-209-1	Core 1	2	BOTTOM
CT-209-1	Core 2	2	BOTTOM
CT-209-1	Core 3	2	BOTTOM
CT-209-1	Core 4	2	BOTTOM
CT-209-1	Core 5	2	BOTTOM
CT-209-1	Heaters/Lights	2	BOTTOM
T2 DC Power	Control Power	2	BOTTOM
T2 AC Power	Heaters/Lights	2	BOTTOM
T2 High Temp	Alarm/Light	2	BOTTOM
T2 Low Temp	Alarm/Light	2	BOTTOM
T2 Fault Pressure	Alarm/Light	2	BOTTOM
T2 Pressure Relief	Alarm/Light	2	BOTTOM
T2 LTC Manual Operation	Alarm/Light	2	BOTTOM
T2 Oil Level	Alarm/Light	2	BOTTOM
T2 LTC Position Bit 1	Position Indicator	1	BOTTOM
T2 LTC Position Bit 2	Position Indicator	1	BOTTOM
T2 LTC Position Bit 3	Position Indicator	1	BOTTOM
T2 LTC Position Bit 4	Position Indicator	1	BOTTOM
T2 LTC Position Common	Position Indicator	1	BOTTOM
T2 Neutral CT	Relay RET-670	2	BOTTOM
CVT-BUS-2	Core 1	2	BOTTOM
CVT-BUS-2	Core 2	2	BOTTOM
CVT-BUS-2	Core 3	2	BOTTOM

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
CVT-BUS-2	Heaters/Lights	2	BOTTOM
215-89M1	Aux "a" #1	2	BOTTOM
215-89M1	Aux "a" #2	2	BOTTOM
215-89M1	Aux "a" #3	2	BOTTOM
215-89M1	Aux "a" #4	2	BOTTOM
215-89M1	Aux "a" #5	2	BOTTOM
215-89M1	Aux "a" #6	2	BOTTOM
215-89M1	Aux "a" #7	2	BOTTOM
215-89M1	Aux "a" #8	2	BOTTOM
215-89M1	Aux "a" #9	2	BOTTOM
215-89M1	Aux "a" #10	2	BOTTOM
215-89M1	Aux "b" #1	2	BOTTOM
215-89M1	Aux "b" #2	2	BOTTOM
215-89M1	Aux "b" #3	2	BOTTOM
215-89M1	Aux "b" #4	2	BOTTOM
215-89M1	Aux "b" #5	2	BOTTOM
215-89M1	Aux "b" #6	2	BOTTOM
215-89M1	Aux "b" #7	2	BOTTOM
215-89M1	Aux "b" #8	2	BOTTOM
215-89M1	Aux "b" #9	2	BOTTOM
215-89M1	Aux "b" #10	2	BOTTOM
215-89M1 DC Power	Control Power	2	BOTTOM
215-89M1 AC Power	Heaters/Lights	2	BOTTOM
215-89M2	Aux "a" #1	2	BOTTOM
215-89M2	Aux "a" #2	2	BOTTOM
215-89M2	Aux "a" #3	2	BOTTOM
215-89M2	Aux "a" #4	2	BOTTOM
215-89M2	Aux "a" #5	2	BOTTOM
215-89M2	Aux "a" #6	2	BOTTOM
215-89M2	Aux "a" #7	2	BOTTOM
215-89M2	Aux "a" #8	2	BOTTOM
215-89M2	Aux "a" #9	2	BOTTOM
215-89M2	Aux "a" #10	2	BOTTOM
215-89M2	Aux "b" #1	2	BOTTOM
215-89M2	Aux "b" #2	2	BOTTOM
215-89M2	Aux "b" #3	2	BOTTOM
215-89M2	Aux "b" #4	2	BOTTOM
215-89M2	Aux "b" #5	2	BOTTOM
215-89M2	Aux "b" #6	2	BOTTOM
215-89M2	Aux "b" #7	2	BOTTOM
215-89M2	Aux "b" #8	2	BOTTOM
215-89M2	Aux "b" #9	2	BOTTOM
215-89M2	Aux "b" #10	2	BOTTOM
215-89M2 DC Power	Control Power	2	BOTTOM
215-89M2 AC Power	Heaters/Lights	2	BOTTOM
CT-215-1	Core 1	2	BOTTOM
CT-215-1	Core 2	2	BOTTOM
CT-215-1	Core 3	2	BOTTOM
CT-215-1	Core 4	2	BOTTOM
CT-215-1	Core 5	2	BOTTOM
CT-215-1	Heaters/Lights	2	BOTTOM
215-52 Bus Coupler	Heaters/Lights	2	BOTTOM
215-52 Bus Coupler	Control Power	2	BOTTOM
215-52 Bus Coupler	Open Command	2	BOTTOM
215-52 Bus Coupler	Close Command	2	BOTTOM

Table 1. Interface Cable Functions-Continued			
Equipment	**Function**	**Terminals**	**Cable Entry**
215-52 BC Summary Alarm	Alarm/Light	2	BOTTOM
Yard Lights 1	Lights	2	BOTTOM
Yard Lights 2	Lights	2	BOTTOM
SCADA Cables	Fiber-Optic Type Communication Interface	40 Fibers, min.	BOTTOM

c) Wiring

1. All wiring shall be done with PVC insulated, 650V, single-core multi-strands (minimum 3 strands) annealed copper conductors suitable for temperature and humidity specified.

2. The cables and wires with accessories shall be continuously rated and suitable for service under the actual climatic conditions.

3. The cables shall withstand all electrical, thermal and mechanical stresses under the stated service conditions, and at a voltage of 10% above the rated value. The insulation level shall be 1kV. Special mechanical protection of the cables shall be provided where required. The cables shall be protected against the short circuit current and earth fault current by fuses, with exception of use in current measuring circuits. Cables shall be protected against direct sunshine.

4. Cables shall be marked with designation according to the cable list.

5. The minimum requirement for cable joints and cable terminations are that they after installation shall withstand the environmental and climatic conditions as the cable itself. They shall also fulfill the same electrical standards as the cables regarding insulation and current rating.

6. Jointing shall be avoided. If jointing is anyway deemed necessary by the Contractor, he shall obtain approval of the Contracting Officer. The jointing of conductor ends shall be done by pressing or screwing technique. The insulation may be restored by taping, molding or shrinking techniques.

7. Connection of low voltage cables to distribution boards, contactor cubicles, motors, etc., shall be carried out by removal of the insulation to the required length of the conductors and by connecting the ends to the terminals. The terminals shall be of screw-joint type. Special cable terminations shall not be required. Control cables shall be of multi-core type, PVC insulated, with screen and copper conductors.

8. The cross section of the wires for voltage, current, and control circuits shall be 2.5 mm^2 and that for the alarm circuits shall be 1.5 mm^2. The wires shall be vermin proof and shall be laid in plastic troughs. Respective phase color shall be used for PT & CT circuits. Black color shall be used for auxiliary AC supply and neutral of CT & PT circuits and gray color shall be used for DC control circuits. Control cable color coding shall comply with IEC

standards and also a printed label-legend in color format inside each main enclosure door.

9. Each wire shall be identified at both ends with wire numbers by means of PVC ferrules. Color coding for the wires shall be as per IEC. Each cable shall be identified with aluminum tags.

10. Minimum 20% spare terminals shall be provided on all panels.

11. The terminals shall be suitable to receive crimped wires to give positive connection. All terminals shall be properly shrouded against accidental contact. Sufficient terminals shall be provided so that not more than one wire is connected to each terminal.

12. All terminal blocks shall be equipped with visible isolating arrangements for testing purposes. They shall be provided with sockets for banana plugs, at both sides. The terminal blocks shall be insulated for 500 V and shall have provisions for marking. The terminal blocks shall be mounted to give easy access to wires, terminations and ferrules. The terminal blocks shall also give a clear view of the arrangement of the cable tails. Terminals connected to 400/230 V shall be properly protected and separated from control circuits.

13. Auxiliary conductors in apparatus cubicles such as control and relay cubicles, etc. shall be stranded PVC cables with a minimum area of 1.5 mm^2.

14. Conductors within cubicles and between terminal blocks and apparatus shall be laid in plastic ducts or covered with plastic bands.

15. Conductor ends not connected to compression-type terminal blocks shall be provided with approved claw washers, which neatly retain all strands.

16. All jointing and tying of wires shall be carried out only at the terminal points.

17. Spare cores, if any, shall be connected to terminal blocks in cubicles and marshalling boxes.

18. The cables shall be mounted so that they are protected against damage and vibrations.

19. All cables shall be connected to the boards with terminal blocks of approved type located near the cable entry.

20. Cables with large cross-section areas are permitted to be connected directly to the apparatus.

21. Not more than two cores shall be connected to each side of a terminal block.

22. Terminal blocks for the CT and PT secondary leads shall be provided with test links and isolation facilities. Also CT secondary leads shall be provided with short circuiting and earthling links. Test terminal blocks shall be provided in Tri-vector metering (TVM) / KWH circuits.

23. Medium voltage, low voltage and control cables shall be laid in separate pipes.

24. Cables shall have conductors of tin coated stranded copper wires and screen of aluminum foil and copper wires (Electronic cables).

25. Cables containing more than 10 cores shall be so dimensioned that at least 25% of the cores will serve as standby cores.

26. As a protective jacket the cable shall have an extruded sheath of grey or white PVC in waterproof color marked with the following: name of manufacturer, year of manufacture, cross-section area of phase-conductors and number of cores.

27. The cables shall be delivered in full lengths and, consequently, no joints are permitted. Cable terminations are normally not needed for these types of cables; however, all cable terminations shall be provided with cable glands.

28. Auxiliary cables shall be PVC-insulated for a test voltage of 2 kV, 50 Hz and shall be screened or metal-sheathed. The conductors, screens and metal sheaths shall be made of copper.

29. All cables shall be connected to the boards with terminal blocks of approved type located near the cable entry.

30. The auxiliary cables shall be designed for a maximum voltage drop from voltage transformers to instrument and meters of 0.1%, and to relays 1.0%.

31. The cables shall fulfill the system data listed in the Specification Table.

d) Painting

All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structure shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under surface shall be made free from all imperfections before undertaking finishing coat.

After preparation of the under surface, the relay and control panel shall be spray painted with two coats of final paint. Color shade of final paint shall be pebble / flint grey, shade RAL 7032 with glossy finish and shall be approved by the Purchaser before final painting is done. The finished panel shall be dried in a stoving oven in a dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run off paint, etc.

All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust corrosion. All hinges shall be greased.

e) Earthing

A continuous 25 mm x 3 mm copper (tinned) earth bus shall be provided running along the full length of the enclosures. The earthing bus shall be provided with pre-drilled 12mm holes for connection of earthing lug and wire. Earthing lugs between cabinets shall be provided.

Each enclosure and associated equipment shall be securely connected to the earth bus. For this purpose, the earth wire shall be looped thru all electrically connected equipment within the enclosure.

The earth wire system shall be of stranded copper wire designed for the maximum prospective fault current.

The shield of control cables in connection with the outdoor switchgear shall generally be earthed at the marshalling cabinet end. All other cables shall generally be earthed at one end only. Sufficient earthing terminals shall be provided in the marshalling cabinet to terminate yard cables.

Each board and box, etc., shall be connected to the station earth system by a copper wire with a minimum area of 25 mm^2.

f) Space Heaters

Panel space heaters shall operate off 240V AC and shall be supplied complete with on/off switch, fuse and thermostat. A common thermostat shall be provided for the entire enclosure. The thermostat shall maintain the internal temperature above 20 degrees centigrade.

g) Mimic

1. The front panel mimic diagram shall be provided on panels. Mimic diagram shall be screwed onto the panels and shall be made of anodized aluminum or plastic of approved color. The mimic shall be 10mm wide for horizontal run and 5mm wide for vertical run. Mimic shall match the one-line diagrams indicated on the drawings and as specified herein.

2. Semaphore indicators (push-to-test type) shall be provided for the Operator and indications as listed in Table 2.

3. Each breaker control switch shall be paired with a control switch selector. The selector will place related breaker switch into local (control panel) control or remote (SCADA) control. All necessary interface wiring to SCADA equipment to supply this function shall be provided.

4. Blue indicators shall be provided for energized indication of bus or line sections. The indicators shall be located in the related section of the mimic bus. Any mimic bus section over 500mm in length shall have multiple indicators evenly placed in mimic section.

5. White Sync OK indicators shall be provided for all breakers except the 20kV feeders as shown in Table 2. These indicators shall illuminate when the respective breaker synchronization relay allows closure. All close signals (local and/or SCADA) shall be inhibited when related synchronization relay is not satisfied.

6. Control Panel wiring logic shall be provided to inhibit all operations (contact signal to switch operator) of 220kV disconnect switches if respective 220kV breaker is closed.

7. Control Panel wiring logic shall be provided to inhibit simultaneous closure of: 201-89M1 & 201-89M2; 203-89M1 & 209-89M2; 208-89M1 & 208-89M2; or 209-89M1 & 209-89M2.

8. Control Panel wiring logic shall be provided to automatically select proper current transformers for bus differential relaying during all possible switching schemes provided through the above disconnect switch positions.

9. Control Panel wiring logic shall be provided to automatically select proper voltage transformers for sync check (25) relaying during all possible switching schemes provided through the above disconnect switch positions.

10. The colors for various voltages in the mimic diagram shall be as below.

	Voltage Level	Mimic Color
a.	20 kV	Canary Yellow
b.	220 kV	Signal Red

Table 2. Operators & Indicators

Control Panel Device	Device Function	Related Indicators
201-01 Operator	201-52 Operator Local/SCADA Selector	None
201-52 Operator	201-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed White=Sync OK
201-89L Indication	201-89L Disconnect Switch Position	Green=Open Red=Closed
201-89M1 Indication	201-89M2 Disconnect Switch Position	Green=Open Red=Closed
201-89M2 Indication	201-89M2 Disconnect Switch Position	Green=Open Red=Closed
203-01 Operator	203-52 Operator Local/SCADA Selector	None
203-52 Operator	203-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed White=Sync OK
203-89L Indication	203-89L Disconnect Switch Position	Green=Open Red=Closed
203-89M1 Indication	203-89M2 Disconnect Switch Position	Green=Open Red=Closed
203-89M2 Indication	203-89M2 Disconnect Switch Position	Green=Open Red=Closed
208-01 Operator	208-52 Operator Local/SCADA Selector	None
208-52 Operator	208-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed White=Sync OK
208-89M1 Indication	208-89M2 Disconnect Switch Position	Green=Open Red=Closed
208-89M2 Indication	208-89M2 Disconnect Switch Position	Green=Open Red=Closed

Table 2. Operators & Indicators-Continued		
Control Panel Device	**Device Function**	**Related Indicators**
209-01 Operator	209-52 Operator Local/SCADA Selector	None
209-52 Operator	209-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed White=Sync OK
209-89M1 Indication	209-89M2 Disconnect Switch Position	Green=Open Red=Closed
209-89M2 Indication	209-89M2 Disconnect Switch Position	Green=Open Red=Closed
215-01 Operator	215-52 Operator Local/SCADA Selector	None
215-52 Operator	215-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed White=Sync OK
215-89M1 Indication	215-89M2 Disconnect Switch Position	Green=Open Red=Closed
215-89M2 Indication	215-89M2 Disconnect Switch Position	Green=Open Red=Closed
M1-01 Operator	M1-52 Operator Local/SCADA Selector	None
M1-52 Operator	M1-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed White=Sync OK
M2-01 Operator	M2-52 Operator Local/SCADA Selector	None
M2-52 Operator	M2-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed White=Sync OK
BC-01 Operator	BC-52 Operator Local/SCADA Selector	None
BC-52 Operator	BC-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed White=Sync OK
F1-01 Operator	F1-52 Operator Local/SCADA Selector	None
F1-52 Operator	F1-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed
F2-01 Operator	F2-52 Operator Local/SCADA Selector	None
F2-52 Operator	F2-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed
F3-01 Operator	F3-52 Operator Local/SCADA Selector	None
F3-52 Operator	F3-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed
F4-01 Operator	F4-52 Operator Local/SCADA Selector	None
F4-52 Operator	F4-52 Local Close/Trip Switch & Position Indication	Green=Open Red=Closed
Bus I-86 Operator	220kV Bus I Differential Lockout	None

Table 2. Operators & Indicators-Continued		
Control Panel Device	**Device Function**	**Related Indicators**
Bus II-86 Operator	220kV Bus II Differential Lockout	None
Bus 1-86 Operator	20kV Bus 1 Differential Lockout	None
Bus 2-86 Operator	20kV Bus 2 Differential Lockout	None
T1-86 Operator	Transformer 1 Differential Lockout	None
T2-86 Operator	Transformer 2 Differential Lockout	None
Line 1 Indicator	220kV Line 1 (CVT-201) is Energized	Blue=Energized
Line 2 Indicator	220kV Line 2 (CVT-203) is Energized	Blue=Energized
Bus I Indicator	220kV Bus I (CVT-Bus I) is Energized	Blue=Energized
Bus II Indicator	220kV Bus II (CVT-Bus II) is Energized	Blue=Energized
Transformer 1 Indicator	T1 20kV (PT-M1) is Energized	Blue=Energized
Transformer 2 Indicator	T2 20kV (PT-M2) is Energized	Blue=Energized
Bus 1 Indicator	20kV Bus 1 (PT-Bus 1) is Energized	Blue=Energized
Bus 2 Indicator	20kV Bus 2 (PT-Bus 2) is Energized	Blue=Energized
Feeder 1 Indicator	20kV Feeder 1 (PT-F1) is Energized	Blue=Energized
Feeder 2 Indicator	20kV Feeder 2 (PT-F2) is Energized	Blue=Energized
Feeder 3 Indicator	20kV Feeder 3 (PT-F3) is Energized	Blue=Energized
Feeder 4 Indicator	20kV Feeder 4 (PT-F4) is Energized	Blue=Energized
Switch SST-1	Disconnect Switch SST-1 Position	Green=Open Red=Closed
Switch SST-2	Disconnect Switch SST-2 Position	Green=Open Red=Closed

2.2 CONTROL PANEL EQUIPMENT

a) Instruments

1. The supplier shall provide all, relays, switches, and all other associated equipment as required for a fully functional substation control system, and as listed in Table 3.

Table 3. 220kV Metering	
Panel	**220kV**
Line/Feeder Bay	3 x V and 3 x I
Transformer Bay	3 x I, 3 x PF, 3-phase MW, 3-phase MVAR
Bus Coupler	3 x V

2. All instruments shall be switchboard type, back connected, flush mounted, and dust tight.

3. They shall be of square pattern and shall be of accuracy class 1.0.

4. They shall have 90 degree scale range.

5. All power measuring meters/transducers shall be suitable for measuring import and export parameters.

6. Zero adjustment for analog pointers shall be accessible from the front of the instruments.

7. All auxiliary equipment such as shunts, transducers, etc. that are required shall be included in the scope of supply.

8. All instruments shall be subjected to an applied potentials test of 2.0 kV for one minute.

b) Metering Equipment

Meters installed for monitoring of energy consumption shall be kWh delivered and kWh received and four quadrants for KVARh (MVARh).

Accuracy class for meters shall be 0.2 for active energy and 0.5 minimum for reactive energy. Meters shall have the facility for remote interrogation via modem and the SCADA/CSCS and shall provide pulsed outputs to the metering data processors. Two data processors (main and backup) shall be supplied for recording and totaling metering pulses, with programmable 20- or 30- minute printout facilities and 20 inputs minimum for each processor.

Integrating meters of the Tri-vector or equivalent types capable of indicating kWh, kVARh, kVAh directly shall be provided for measuring and recording grid parameters. Meters shall be suitable for measuring import as well as export parameters, including ‘lag’ and ‘lead’ functions for reactive kVARH for import and export.

The transformer control and protection and OLTC panels shall include control and indication of the power transformers. The control switches for the circuit breakers and disconnectors and indicating instruments shall be installed directly on the front of the control panel.

They should be suitable for 3 phases (poles), 4 wire 50 Hz circuits with unbalanced loading and with three elements connected to current and potential transformers of specified ratio.

The tri-vector meters for tariff purposes shall be of digital type, class 0.5 accuracy with RS485 communication port.

Test terminal blocks (TTB) shall be provided in the panels, wherever the tri-vector meters are installed.

Wherever specified, digital meters shall be provided to indicate frequency and power factor parameters.

1. Frequency Meters shall be long range and calibrated for 45, 50, & 55 Hz.

2. Ammeters, Voltmeters, KVAR meters, KVA meters

Voltmeters and ammeters shall have dimensions 96 mm x 96 mm and be flush-mounted. The indication instruments shall be of square type with 240° scales. Indication errors shall not exceed ±1.5% of the full scale value. The instrument scales shall have a white background and the same design of figures and gradation. The indicated values shall be given directly without constants such as 10x and like.

(a) These meters shall be of three phase digital type and have three individual LED displays built into them. With the use of pushbuttons, they will have the ability to scroll through Amps, Volts, KVAR and KVA indications.
(b) These meters will be equipped with RS-485 communication port.

3. Power Factor Meters

(a) These meters shall be digital and the range of PF meters shall be 0.5 - 1 – (-0.5).
(b) These shall operate on 110V PT secondary.
(c) These meters shall be suitable for measuring PF in four quadrants.

c) Indicating Lamps

These shall be switchboard type of low power consumption, LED cluster type lamps and shall be supplied with necessary resistors. Lamps shall be provided with screwed translucent covers to diffuse light. The lamp covers shall be unbreakable, molded, heat resistant material and shall be provided with chromium plated bezels. All lamp fixtures shall provide push-to-test functions.

d) Control Switches

All control switches shall be rotary, back connected type, having cam operation contact mechanism. Phosphor bronze contacts shall be used on switches.

Control switches shall be designed for 10A and be marked OFF-AUTO-ON, etc. Control switches shall be operated from the front of the cubicles.

The handle of control switches used for circuit breaker operation shall turn clockwise for closing and counter-clockwise for tripping and shall be spring return to center from close / trip with lost motion device.

Function 86 lockout devices shall be rotary electromechanical type. Trip coil shall be 220VDC activated. Normal position shall be vertical; trip shall be minimum 45° clockwise.

e) Control Devices

All control devices shall be of miniature circuit breaker (MCB) type, MCBs shall generally be mounted on the top half of the panels. All MCBs shall be provided with suitable identification labels.

Circuit breakers shall be capable of breaking short-circuit power.

Power fuses shall be of blade type according to IEC - British 60269 - 2A Section I. Fuses maximum 25 A may be of screw type D11 (IEC - British 60341). The fuses shall have a visible indication device. For small apparatuses, miniature fuses 5x20 mm (IEC - British 60127) may be used.

f) Annunciator

The substation annunciator shall be for local indication of substation equipment trouble and alarms. The annunciator shall be supplied with acknowledge, rest, and test buttons and a horn.

An alarm annunciator shall audibly and visually identify the source and type of alarm. There is no requirement for a remote fault signal system.

The input contacts shall be field configurable to accommodate either normally open or normally closed inputs. The annunciator shall be supplied with blank user configurable labels.

Basic annunciator functions are shown in Table 4. The supplier shall provide all internal control panel wiring to provide these functions. A quantity of 100% spare blank user configurable labels shall be supplied. The annunciator shall be sized for the ultimate arrangement of the substation, with minimum window sizes of 36mm square.

Table 4. Annunciator Functions
AC Control Power Fail
DC Control Power Failure
DC Control Power Ground Fault
220kV Line-1 Fail
220kV Line-2 Fail
220kV Main Breaker 201 Trip
220kV Main Breaker 203 Trip
220kV Bus Coupler Breaker 215 Trip
220kV Bus-1 87 Trip
220kV Bus-2 87 Trip
Transformer-1 Breaker 208 Trip
Transformer-2 Breaker 209 Trip
20kV Main Breaker M1 Trip

Table 4. Annunciator Functions-Continued
20kV Main Breaker M2 Trip
20kV Tie Breaker Trip
20kV Feeder-1 Breaker F1 Trip
20kV Feeder-2 Breaker F2 Trip
20kV Feeder-3 Breaker F3 Trip
20kV Feeder-4 Breaker F4 Trip
20kV Bus-1 87 Trip
20kV Bus-2 87 Trip
Generator Running
Generator Fail
Generator Fuel Low
T1 High Temp
T1 Low Temp
T1 Fault Pressure
T1 Pressure Relief Device
T1 LTC Manual Operation
T1 Oil Level
T2 High Temp
T2 Low Temp
T2 Fault Pressure
T2 Pressure Relief Device
T2 LTC Manual Operation
T2 Oil Level

Fascia type microprocessor based annunciators shall be provided on the control panels for all alarm/trip functions of the system as specified in the I/O list and indicated on the drawings.

One common audible alarm, one common acknowledge push button, one reset push button, and one “all lamp test” push button shall be provided common to all annunciators.

Indicator windows shall initially flash with alarm sound. After “acknowledge” push button operation the alarm shall silence and the window light remain steady. Upon return of the alarm condition to normal status the window indicator shall automatically extinguish. All subsequent alarms (including those activated while earlier alarms are still present) shall re-initiate the alarm sequence.

DC supply failure indication shall be provided separately with DC under voltage relays with reverse flag indication. On failure of DC supply to the panel, a lamp and a horn with AC supply shall operate. There shall be provision for canceling AC horn. The DC bell and AC horn shall have distinctly separate tones.

g) Relays

Relays for the 20kV switchgear shall be provided by others. The supplier shall provide all relays for the 220kV yard equipment.

All relays shall be switchboard pattern, back connected draw out type suitable for flush mounting and fitted with dust tight covers. The relays conform to BS 3950 and BS 142.

A set of test block and test lead for necessary secondary injection tests shall be included. All relays in draw out cases shall have suitable spring loaded contacts for inserting test block.

Relays shall be provided with hand / auto reset type contacts and flag indicators. The flag indication shall be suitable for external hand resetting and mechanically interlocked to prevent falling when relays are subjected to vibration. The rating of the auxiliary contacts shall not be less than 5A at 240VAC and 1.5A for 220VDC. Relay coils to be suitable for the specified DC voltage.

Relays for each panel are indicated in the single-line drawings. The relays shall be supplied with the necessary accessories to make the system complete. Test terminal blocks shall be provided with multifunction relays as well as name and identity plates.

All instruments, relays and other electrical devices mounted on the control panel shall be provided with plates bearing the manufacturer’s name, serial number and the electrical rating data.

Plastic plates at least 10 mm wide bearing suitable identification marks shall be fixed in the interior of the switchboard at the test blocks, at the fuse blocks, and at the cable terminals. Similar plates shall be fixed to the exterior of the switchboard in appropriate places to indicate the functions of control switches, push buttons, lamp and other equipment not incorporated in the mimic diagram.

h) Auxiliary Direct Current (DC) system

The 250VDC control battery and charger shall be provided by others. The control panel shall include following DC voltage monitoring system.

DC Supervision

DC supervision of the 250VDC control power system shall be provided and shall as a minimum consist of:

1. Over- and under-voltage supervision in two steps for each function of the floating voltage level
2. Battery circuit supervision
3. Fuse supervision for two remote fuse/CB disconnect (voltage difference detection)

i) Protective Relays

Protective functions shall be as indicated on the drawings. Control and interlocks shall be clearly identified in the submittals.

Microprocessor-based relays shall incorporate such features as a local human-machine interface (HMI), remote interrogation, disturbance recording and sequence-of-events recording, indication metering, and self-checking and shall be flush mounted or rack mounted.

Remote interrogation facilities shall be provided via an external series interface. The relays shall have two independent communications ports. One port shall be dedicated to communicating with the Substation SCADA System and the other port shall be for local interrogation.

The microprocessor based relays shall communicate with the substation SCADA/RTU system using IEC 870-5-103 or IEC 61850 or MODBUS protocol. If the relay does not support one of these protocols, a protocol converter shall be provided.

The settings and records menu structure shall be arranged in such a way that it is easy and convenient for operators to interpret the information stored in the relay. The information in the menu shall be in the form of alphanumeric characters in the English language. No indirect codes or memory addresses are acceptable for this purpose. Events and programming shall be stored in nonvolatile memory.

The relays shall include a real-time clock synchronizable to allow accurate time stamping of events.

The relays shall incorporate a self-checking feature that continuously monitors or automatically checks at regular intervals the condition of the relay and provides a warning of incipient or actual failure by means of an alarm.

All relays shall be password protected and a provision to change the factory default password shall be available at the Jobsite.

A digital fault disturbance recorder (DFR), Device 39 function, shall be provided in the microprocessor relays. The DFR shall meet the following requirements:

1. Record the instantaneous values of analog inputs, such as voltages and currents, in all the three phases, open delta voltage, and neutral current in the primary circuits in the case of a short-circuit (fault) and a disturbance in the power system, in accordance with the required technical parameters.

2. Fault/disturbance logs shall be clearly identified by fault ID, fault date, and time (hour, minutes, seconds, and milliseconds). Time stampings on fault records shall be synchronized with a GPS clock.

3. Acquire the disturbance data for the pre-fault, fault, and post-fault periods. The DFR shall use the same current and voltage inputs the microprocessor relay uses for protection functions.

4. The software for analyzing the fault data shall be available at the substation level. The software shall be capable of the complete analysis of fault data, including the display of RMS/peak envelope of any voltage/current, fundamental power frequency deviation, display of instantaneous values of real power (computed value), reactive power (computed value), power factor angle, etc.

5. Have a built-in distance-to-fault locator function. This function shall be an online function and shall be suitable for circuit breaker operating times of two cycles. The computed distance-to-fault shall be available as a percentage of line length or kilometers without requiring any further calculations. It shall have a provision for mutual zero sequence compensation. It shall have an accuracy of 3 percent or better for all types of faults and fault levels.

6. Sequence-of-events functionality pertaining to the main protection applications shall be provided as a part of the microprocessor relays.

j) Inspections and Tests

Following tests shall be carried out on the control panel in the presence of Purchaser or his authorized representative:

1. Verification of wiring of circuits and continuity

2. Electrical control, interlock and sequential operation test

3. High voltage test 2000 volts to earth for one minute

4. Insulation resistance of the complete wiring with all equipment mounted on the panels

5. Routine tests according to the standards followed by the manufacturer on the instruments, relays and other devices

6. DC tests

Certified copies of all routine test certificates shall be submitted to the Purchaser before dispatch for review by the Purchaser.

k) Drawing and Data

Supplier shall submit for Purchaser's approval the general arrangement drawings showing front, rear and side views, AC / DC power diagrams, detailed bill of materials, interconnection and wiring diagrams, wiring schedules, terminal arrangement drawings as well as other drawings which may be deemed necessary by the Purchaser. Approval of the GA drawing is required before the fabrication of panels begins. Approval of wiring and interconnection drawings is required before the manufacturer proceeds with the panel wiring. Programming listings for numeric type relays and relay setting format for all relays shall also be submitted for approval.

1. Final as-built drawings, catalogues of all relays / meters, O&M manuals and Instructions shall be furnished.

2. All metallic structures within a vicinity of 2000 mm above and 5000 mm below ground shall be bonded to the conductors of lightning protection system.

3. All wiring diagrams, point to point diagrams, panel internal layout, and panel front views shall be provided in native AutoCAD format. Submission of shop drawings without these shall constitute rejection of submittal.

2.3 TRAINING

The Contractor shall provide operational and maintenance training limited and applicable to elements included within this specification to DABS personnel (maximum 6 per substation) for all systems furnished under this Specifications. All such training shall be in the English and Pashto language.

PART 3 EXECUTION

3.1 TESTING

Before shipping, the Manufacturer shall test the equipment per the pertinent standard test. Two (2) copies of the test reports shall be forwarded to the Owner and the Engineer prior to shipping. The Manufacturer shall obtain release from the Owner prior to shipment.

3.2 INSPECTION BY THE ENGINEER/OWNER

The Engineer and/or Owner shall be allowed to witness testing performed by the Seller, as well as inspect the equipment at any time. Inspection by the Engineer / Owner shall not relieve the Seller of his responsibility to inspect the equipment, confirm all requirements of testing, and supply complete equipment which satisfies all requirements of these Specifications.

3.3 SPECIAL SHIPPING REQUIREMENTS

Bidder will supply with his bid approximate gross weights, together with the overall physical dimensions of equipment of subassembly as packed for shipment, and a written proposal describing, briefly, the design, contents and number of shipping units.

3.4 ASSEMBLY

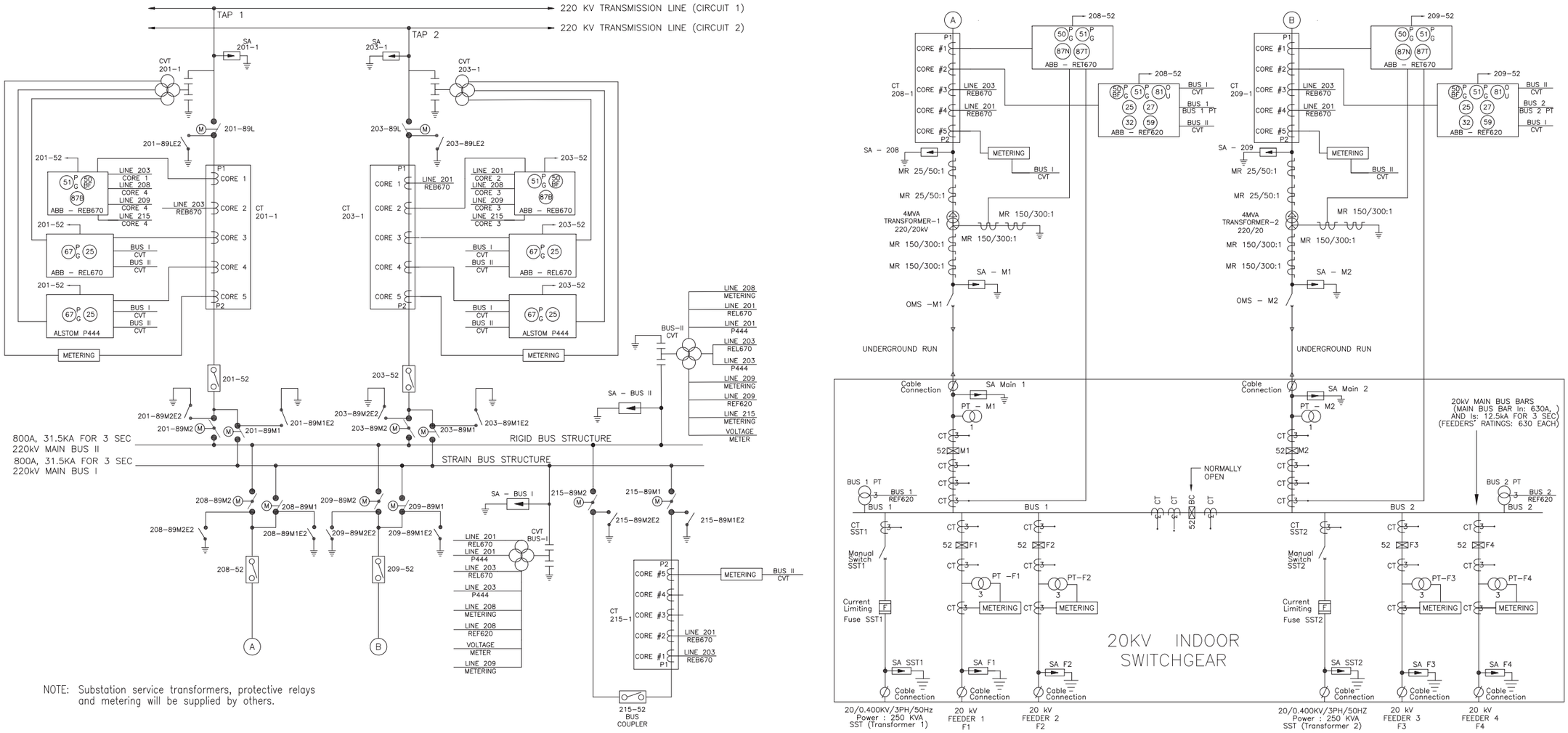
Bid must specify all site assembly requirements.

3.5 APPROVED SUPPLIERS

Approved suppliers of the 220kV circuit breakers are Siemens, ABB, Schneider Electric, or Owner approved equal.

3.6 SPECIFICATION DRAWINGS

a) E-501 Elementary Control Panel Single Line



NOTE: Substation service transformers, protective relays and metering will be supplied by others.

LEGEND

RELAY FUNCTIONS

27–	UNDERVOLTAGE RELAY
25–	SNYCHRONISM CHECK RELAY
32–	DIRECTIONAL POWER RELAY
50–	INSTANTANEOUS OVERCURRENT RELAY
51–	INVERSE–TIME OVERCURRENT RELAY
52–	AC CIRCUIT BREAKER RELAY
50BF–	BREAKER FAILURE RELAY
59–	OVERVOLTAGE RELAY
81–	FREQUENCY RELAY
87B–	BUS DIFFERENTIAL PROTECTIVE RELAY
87T–	TRANSFORMER DIFFERENTIAL PROTECTIVE RELAY
87N–	RESTRICTIVE EARTH FAULT RELAY
89–	LINE SWITCH RELAY

ONE–LINE LEGEND

- CAPACITIVE VOLTAGE TRANSFORMER (CVT)
- CURRENT TRANSFORMER
- HV DISCONNECT (ISOLATOR) MOTOR OPERATED SWITCH 3 POLE/ VERTICAL BREAK GANG SWITCH WITH MANUAL EARTHING SWITCH
- 220KV AC CIRCUIT BREAKER
- OVERHEAD MANUAL SWITCH
- SURGE ARRESTOR (SA)
- POWER TRANSFORMER
- 20KV SWITCHGEAR CIRCUIT BREAKER
- BUSHING MOUNTED CURRENT TRANSFORMER
- HV DISCONNECT (ISOLATOR) MOTOR OPERATED SWITCH 3 POLE/ DOUBLE END BREAK GANG SWITCH WITH MANUAL EARTHING SWITCH
- POTENTIAL TRANSFORMER

CONTROL PANEL SECTIONS

SECTION	NAME	PURPOSE	RELAYS	COMMUNICATION
BD1	BUS DIFFERENTIAL 1	PRIMARY 220KV BUS DIFFERENTIAL	1 X REB670 (PRIMARY)	SCADA/FIBER
BD2	BUS DIFFERENTIAL 2	BACKUP 220KV BUS DIFFERENTIAL	1 X REB670 (BACKUP)	SCADA/FIBER
L1	LINE 201	220KV LINE OVERCURRENT	1 X REL670 (PRIMARY) 1 X P444 (BACKUP)	SCADA/FIBER
L2	LINE 203	220KV LINE OVERCURRENT	1 X REL670 (PRIMARY) 1 X P444 (BACKUP)	SCADA/FIBER
T1	208 TRANSFORMER	TRANSFORMER DIFFERENTIAL	1 X RET670 (PRIMARY) 1 X REF620 (BACKUP)	SCADA/FIBER
T2	209 TRANSFORMER	TRANSFORMER DIFFERENTIAL	1 X RET670 (PRIMARY) 1 X REF620 (BACKUP)	SCADA/FIBER
ANN	ANNUNCIATOR	ANNUNCIATOR AND ALARMS	NONE	SCADA/FIBER
MTR	METERING	METERING	NONE	SCADA/FIBER
SC	SCADA	SCADA	NONE	SCADA/FIBER

This project was made possible by the United States Agency for International Development and the generous support of the American People through USAID Global Architecture and Engineering IQC Contracts.

CURRENT TRANSFORMERS

CT NAME	CORE #	RATIO	CLASS		% THERMAL RATING	PURPOSE
			RATED OUTPUT	IEEE RATING		
201–1	1	SR 400:1	50VA	C200	200%	PROTECTION
	2	SR 400:1	50VA	C200	200%	PROTECTION
	3	SR 400:1	50VA	C200	200%	PROTECTION
	4	SR 400:1	50VA	C200	200%	PROTECTION
	5	SR 75:1	50VA	0.3@B–0.5	200%	METERING
203–1	1	SR 400:1	50VA	C200	200%	PROTECTION
	2	SR 400:1	50VA	C200	200%	PROTECTION
	3	SR 400:1	50VA	C200	200%	PROTECTION
	4	SR 400:1	50VA	C200	200%	PROTECTION
	5	SR 75:1	50VA	0.3@B–0.5	200%	METERING
208–1	1	MR 30:1/60:1	50VA	C200	200%	PROTECTION
	2	MR 30:1/60:1	50VA	C200	200%	PROTECTION
	3	SR 400:1	50VA	C200	200%	PROTECTION
	4	SR 400:1	50VA	C200	200%	PROTECTION
	5	MR 15:1/30:1/60:1	50VA	0.3@B–0.5	200%	METERING
209–1	1	MR 30:1/60:1	50VA	C200	200%	PROTECTION
	2	MR 30:1/60:1	50VA	C200	200%	PROTECTION
	3	SR 400:1	50VA	C200	200%	PROTECTION
	4	SR 400:1	50VA	C200	200%	PROTECTION
	5	MR 15:1/30:1/60:1	50VA	0.3@B–0.5	200%	METERING
215–1	1	SR 400:1	50VA	C200	200%	PROTECTION
	2	SR 400:1	50VA	C200	200%	PROTECTION
	3	SR 400:1	50VA	C200	200%	PROTECTION
	4	SR 400:1	50VA	C200	200%	PROTECTION
	5	SR 75:1	50VA	0.3@B–0.5	200%	METERING
208 – 20KV	1	MR 300:1/600:1	50VA	C200	200%	PROTECTION
	2	MR 300:1/600:1	50VA	C200	200%	PROTECTION
209 – 20KV	1	MR 300:1/600:1	50VA	C200	200%	PROTECTION
	2	MR 300:1/600:1	50VA	C200	200%	PROTECTION

FINAL DESIGN SUBMITTAL

DESCRIPTION	DATE	BY
		APR
		SMB

DESIGNED BY: MAY
DWN BY: MAY
DATE: 11/22/2013
SUBMITTED BY: TETRA TECH
CHK BY: GS
FILE NO.: LT0063–E–102

USAID FROM THE AMERICAN PEOPLE

AESP

220KV/20KV DOUBLE–TAP PRIMARY SELECTIVE SUBSTATION SALANG TUNNEL SUBSTATION

ELEMENTARY CONTROL SINGLE LINE

SHEET REFERENCE NUMBER: E–

SECTION 33 75 00.00 40
Relay and Control Panels

Specification Table

DESCRIPTION	UNIT	REQUIRED VALUE
Quantity Required	Each	1
Type		Indoor
Temperature		0° to 50° C
Humidity		95%
Cable System Data		
Cable	Control	Electronic
Nominal Voltage	250V	0-230 V
Maximum Current	10A	2A
Insulation Level	0.6/1 kV	0.6/1 kV
Frequency	DC or 50Hz	0-1,000 Hz
Power Metering Equipment		
Panel	220kV	20kV
Line/Feeder Bay	kWh delivered, kWh received Four-quadrant kVARh With data access facilities and pulse output, Class 0.2 on 20kV side of Transformer	kWh delivered Four-quadrant kVARh With data access facilities and pulse output, class 0.2
Transformer Bay	kWh delivered, kWh received Four-quadrant kVARh With data access facilities and pulse output, Class 0.2 on 20kV side of Transformer	

--- End of Section ---

AFGHANISTAN ENGINEERING SUPPORT PROGRAM

WO-LT-0063-AMENDMENT 4
SALANG TUNNEL SUBSTATION
PRE-PURCHASE EQUIPMENT SPECIFICATIONS

END OF TECHNICAL SECTION

[redacted]

Dear [redacted]

[redacted] asked me to respond to your request. The RFP document is confirmed to have latest (Revision 2) technical specifications. However, we noticed a small typo that should be corrected prior to release. On Page 40-77 of 150, specification Table 1, the rated voltage of the CT should be 245kV not 242kV.

Best Regards,

[redacted]

[redacted]

[redacted]

Finally, we have received the approval from USAID to issue the RFP. Please confirm if the PDF file has the right technical specifications so that [redacted] could issue the RFP tomorrow.

with regards,

[redacted]

POWER ENGINEERS, INC.

2041 SOUTH COBALT POINT WAY
MERIDIAN, ID 83642 USA

PHONE 208-288-6100
FAX 208-288-6199

MEMORANDUM

DATE: January 20, 2014

TO: [redacted]

[redacted]r
Federal Global Project Manager

SUBJECT: 128473 LT-0063-Correction of Number of Secondary Windings

MESSAGE

It has just come to our attention that LT-63, AMD 4, Capacitor coupled Voltage Transformer Specification contains a technical error. In the last line of Specification Table 1 (end of spec) the "Number of Secondary Windings" should be 3 (three); not 5 (five).