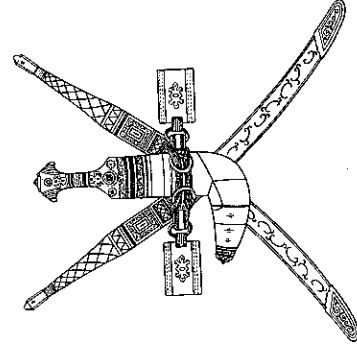


SULTANATE OF OMAN

MINISTRY OF ELECTRICITY & WATER



**SWITCHGEAR & ASSOCIATED
EQUIPMENTS**

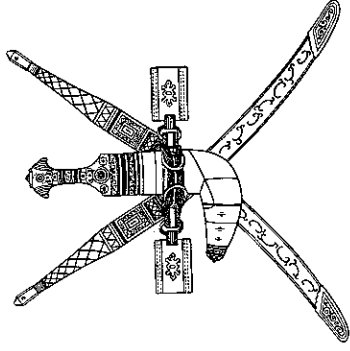
**STANDARDS – OES 12A, 12B,
13, 14, 15, 19, 34 and 35**

BRIEF SPECIFICATIONS

Second Edition : January 1995

SULTANATE OF OMAN

MINISTRY OF ELECTRICITY & WATER



**30V BATTERY SWITCH
TRIPPING UNIT**

STANDARD – OES 12A

BRIEF SPECIFICATIONS

Second Edition : January 1995

SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD : OES - 12A
30V BATTERY SWITCH TRIPPING UNIT

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SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD OES - 12A
SPECIFICATION FOR 30V BATTERY SWITCH TRIPPING UNIT

1.0 GENERAL

The 30V Battery Switch Tripping Units are for installation indoor in 11KV substations and required for tripping, closing spring release, of the breakers and for emergency lighting.

The units shall be self-contained with the battery cells, control and charging gear, instruments, terminal blocks etc. accommodated and mounted in floor standing cabinet of folded steel construction with hinged panels for access to the battery.

2.0 BATTERY

The battery shall comprise 28 (twenty eight) Nickel-Cadmium battery cells in plastic containers, normal cell voltage 1.2 volt and shall have minimum capacity of 100 ampere-hours at 5 hour discharge rate.

The battery cells shall be accommodated in impregnated hardwood trays complete with intercell connectors of plated and annealed copper strip and inter-crate connectors of flexible tinned copper rubber sheathed cable of adequate size and complete with necessary terminal lugs. The battery shall be supplied filled with electrolytic and in a part discharged condition.

3.0 CHARGER

3.1 GENERAL

3.1.1 The battery charger shall be constant voltage type, solid state (silicon) controlled rectifier equipment, designed to provide fully automatic voltage stabilization and current limitation for charging Nickel Cadmium batteries in D.C. systems. It shall also be capable of simultaneously supplying varying load of 10 Amps permanently connected in parallel with the battery.

3.1.2 The charges circuitry shall be of modular design and the printed circuit cards shall have plug-in or slide-in type construction. The silicon rectifier diode and thyristors shall be assembled to one sub-assembly which can be easily exchanged. The Charger shall preferably be divided into the following separate sections, each with its own unique function :

- A.C. input module
- Power module(s)
- Control and alarm module
- D.C. output bay

3.1.3 All components especially the converter transformer and the thyristor stack shall be adequately rated for continuous operation at the maximum output under the specified service conditions and shall normally require no replacement during the life of the Charger.

- 3.1.4 A dry type shielded isolation transformer with copper winding shall be provided for the AC input to the semi controlled SCR bridge.
- 3.1.5 The Battery Charger shall be of manufacturer's proven design and shall meet or exceed the requirements of this specification in all respects.

3.2 PERFORMANCE CHARACTERISTICS AND RATINGS

- 3.2.1 The Charger shall be suitable for operation on single phase, 240V, 50 c/s AC supply.
- 3.2.2 The rated output voltage of the Charger shall be 30V DC.
- 3.2.3 The Battery Charger shall be designed for two charging modes that is, float charging for normal use and Boost charging under discharged battery conditions.
- 3.2.4 The Load output voltage shall be automatically and continuously held constant to within 1% of the voltage setting at any load from no-load to full rated load (0 to 100%), within simultaneous A.C. input voltage variations of + or - 5%. This regulation shall be maintained under both float and Boost operations.
- 3.2.5 The ripple voltage shall not exceed 2.0% peak-to-peak of the nominal DC voltage over the specified input voltage range with battery disconnected.
- 3.2.6 The power factor shall be better than 0.8 lagging at full load with rated mains voltage.
- 3.2.7 The maximum temperature rise of the windings of converter transformer shall not exceed 50°C. The maximum temperature rise for thyristor stack (junction temperature) shall not exceed 65°C. The temperature limitations shall apply under both float and equalize (Boost) operations of the Charger.
- 3.2.8 The Battery Charger shall be operated with an unearthed battery bank.
- 3.2.9 Audible noise, resulting from operation of the rectifier, shall be as minimum as practical so as not to cause any nuisance.

3.3 CONTROLS AND PROTECTION

- 3.3.1 The Charger shall be adequately protected against short circuits by automatic tripping provided at both input and output circuits. The output shall be controlled by current limiting device which will reduce the output DC voltage to safe limits when load exceeds rating with facility to adjust it from 100% to 120% of rated load.
- 3.3.2 Provision shall be made to protect the Charger against accidental reverse polarity connection.
- 3.3.3 The Charger shall have independent individual adjustable float and boost charge circuits. These circuits shall have adjustable manual devices for Nickel cadmium. The range of adjustment for float and boost voltage shall be 1.35 to 1.45 per cell and 1.5 to 1.7 V per cell respectively.
- 3.3.4 Provisions shall be made for the "initiation" and "cut-off" of the boost charging mode automatically as well as manually. A selector switch shall be provided to select the desired mode of operation.

- 3.3.5 The automatic charging system shall be provided with the auto equalize timers equipped with “float reset” and Boost override switches along with respective indicating lights for Flat and Boost modes.
- 3.3.6 Return of Charger from Boost to float voltage after manual initiation, shall be accomplished automatically via automatic timer. The L.E.D. indicating the equalize rate charge shall flash to indicate the discrepancy position of the manual switch. The L.E.D. will turn-off when the manual switch is switched back to normal position.
- 3.3.7 The Charger shall be furnished with a soft start to limit the inrush current upon application of input voltage.
- 3.3.8 The Charger shall be designed to automatically shutdown in the event of high battery voltage. The set point shall be selectable and consistent with the maximum recharging voltage of the particular type of battery.
- 3.3.9 A ground detection circuit shall be furnished with the charger to detect a ground on the batteries. The ground detection relay shall be suitable for local and remote indication. The system shall be equipped with positive and negative ground detection indicating lights along with ground test and lamp test switches.

3.4 STATUS INDICATIONS, ALARMS AND INSTRUMENTATIONS

A) Status	B) Alarm
a) AC Power On (Green)	a) AC Power Fail Alarm
b) Float Mode (Green)	b) Low DC Voltage Alarm
c) Boost Mode (Amber)	c) Separate DC Positive and Negative Ground Detection Alarm
d) Current Limit (Amber)	d) High DC Voltage Instantaneous Shutdown Alarm
	e) DC Current Limit Alarm
	f) End of Discharge Alarm

Audible alarms going off after set time delay will be required since substations are mostly unattended but visual alarm will continue till reset.

Wired terminals shall be provided for the remote indications of alarm functions as described above.

3.5 PANEL MOUNTED EQUIPMENT/INSTRUMENTS

- 3.5.1 The Charger shall have the following components mounted on the front panel. Each component shall be labelled for identification :
- 1) A two position ON/OFF AC main switch for charger input with pilot lamp (Green).

2) A four position DC output selector switch for the following settings :

- Off
- Float
- Boost
- Automatic (Float/Boost)

3) An AC Voltmeter for input AC supply.

4) An AC Ammeter.

5) A DC ammeter with + or - full scale accuracy ranging from 0-150% of maximum output rated current.

6) A DC Voltmeter for output voltage.

7) Controls for the following functions (to be located on the control switch)

- Float voltage adjust
- Boost voltage adjust
- Current limit adjust
- Over voltage trip adjust
- Low voltage alarm adjust

8) Charger output MCBS - 6.

9) Status indications.

10) Alarm indications.

11) A lamp test push-button to test all lamps.

3.6 CONSTRUCTION

3.6.1 The Battery Charger shall be designed as a free standing equipment. All components shall be integrally designed to complete control and monitoring as required.

3.6.2 The Charger enclosure shall be of IP 21 construction and designed for indoor free standing installation. The cabinet enclosure shall be constructed of welded steel material. Material sheet thickness shall be 2.5 mm minimum.

The Panel shall be made completely vermin proof.

3.6.3 Access to the equipment shall be from the front. The door shall have a handle with provision for locking. Entries of cables shall be through suitable cable glands.

3.6.4 Besides AC terminals the Chargers shall have two DC positive terminals (i.e. one for battery and the other for DC load) and one negative terminal on the other side. The positive terminals shall be marked "+B" and "+L" for battery and load respectively and coloured red. The negative terminal shall be marked "-" and coloured black. AC terminals shall be marked "AC" with proper phase marking where three (3) phase is used. AC/DC terminals shall be mounted on separate terminal blocks. All the markings shall be permanent.

3.6.5 The Charger shall be adequately ventilated for self cooling by natural air convection.

3.6.6 Provision shall be made for earthing of the panel and a bolted connector shall be provided to accommodate 75 sq.mm earthing conductor. All bolted parts shall use suitable washers to ensure electrical continuity of the structure.

3.6.7 An approved schematic diagram of the Charger identifying various components and referring to the appropriate drawings and erection instruction in English shall be affixed to the inside of the cubicle access door. The diagram shall be marked on durable non-fading material suitable for the specified climatic conditions.

3.6.8 Appropriate identification in the form of a name plate(s) shall be provided on each Charger component as far as possible. These name plates shall be the visible, engraved type, of appropriate size and attached to the panel by stainless steel screws or rivets.

3.7 WIRING

3.7.1 All wiring used within the Charger shall be installed and tested at the factory unless otherwise specified.

3.7.2 All control wiring shall be PVC insulated multistrand copper and in no case shall be smaller than 1.5 mm². Electronic and low signal wiring shall be manufacturer's standard.

3.7.3 All terminal block, except electronic systems internal terminal blocks, shall be rated 600V minimum, and shall have non-captive pan head screw terminals. Blocks shall be clearly numbered and identified. All wire terminations shall be ring type, or pin type stack-on or equivalent.

3.7.4 Wiring shall be carried in troughs or in neatly formed packs which shall be tied or otherwise secured at frequent intervals to prevent undue stress on equipment or connections. Connections across portions which are movable shall be made with flexible wire formed to distribute the bending motion. No wires shall be jointed between terminal points.

3.7.5 The AC and DC circuit terminals shall be fitted with non-flammable, transparent plastic covers to prevent accidental short circuit/contact with live parts or earthing of the battery.

3.7.6 All printed circuit boards shall be coated with a solderable polyurethane varnish.

3.7.7 All wiring shall be identified by a non-flammable permanent marking at each termination. Markers shall be of material that will not deform or deteriorate, and shall withstand the specified ambient temperatures.

3.8 PAINTING

The Charger cabinet painting shall be in accordance with MEW Standard OES-11.

3.9 NAME PLATE(S)

3.9.1 The Charger shall bear a name plate fixed on the front side of the panel. The plate shall be marked in English and Arabic with the following minimum information :

- 01) The words "BATTERY CHARGER"
- 02) Model Number and Type
- 03) Manufacturer's Name and Trade Mark
- 04) Year of Manufacture
- 05) Manufacturer's Serial Number
- 06) Rated AC Input Voltage
- 07) Rated AC Input Current
- 08) Frequency
- 09) Number of Phases
- 10) Rated DC Output Voltage

- 11) Rated DC Full Load Output Current
- 12) Range of Adjustments for :
 - Float Voltage
 - Boost Voltage
 - Current Limited

3.9.2 The name plate material shall be stainless steel or other non-corrodible material, but shall not include plastic aluminum, and shall fastened to the equipment by stainless steel screws or rivets. The markings shall be imprinted or etched in black, and shall be non-fading.

3.9.3 The rating plates for the sub-assemblies e.g. thyristor stack, converter transformer etc., shall bear the following minimum indications :

- a) Identification Reference/Manufacturer's Type Designation
- b) Serial Number
- c) Number of Input Phases
- d) Rated Input Voltage and Frequency
- e) Rated Input Current
- f) Rated Output Voltage
- g) Rated Output Current

3.10 INSPECTION AND TESTING

Tests

All Standard tests shall be carried out on complete Charger(s) in accordance with IEC or BSS Standards as applicable.

Certified test reports of type tests performed on identical chargers acceptable to MEW may be submitted for review and acceptance in lieu of the required design (type) tests above.

All circuits connected to the AC, DC power control input and output terminals shall be capable of withstanding a test voltage of 2000 volts RMS, 50 Hz, to ground for one (1) minute.

3.11 DATA REQUIREMENTS

General

The English shall be used at all times with respect to documents, drawings and labels procured or prepared by the Vendor pertaining to the work.

Documentation

The following minimum information shall be provided along with offer :

- 1) Overall dimensional drawing showing front, back, side and plan views with door closed and open.
- 2) Details of thyristor stack and associated control units including the information regarding forward and reverse characteristics.

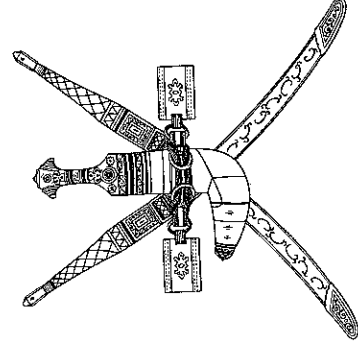
- 3) Details of relays, fuses and circuit breakers etc.
- 4) Method/Details of surge protection, ripple control, voltage regulation, current limitation, automatic equalize system etc.
- 5) Charger sizing calculations.
- 6) Circuit diagram for the complete Charger.
- 7) List of recommended spare parts and special tools (if any) along with prices.
- 8) Dimensional drawing of the Charger unit showing the equipment mounted on front and inside.
- 9) The vendor, upon shipment of the equipment, shall supply four (4) copies of the following approved drawings and other documentation for record purposes :
 - a) One (1) reproducible of each approved drawing.
 - b) Instrumentation manuals covering installation, maintenance and operation of the Charger including trouble shooting. A functionally laid out and directional point-to-point testing sequence shall be described in the instructional manual.
 - c) Certified Test Reports, Certificates, Data and Curves etc.
 - d) A complete list of the component parts along with manufacturer's catalogue parts numbers.

30V BATTERY SWITCH TRIPPING UNIT
TECHNICAL GUARANTEED PARTICULARS

S. No.	Description	Particulars
A) BATTERIES		
01	Manufacturer	
02	Type	
03	Electrolyte	
04	Voltage	V
05	Capacity at 5 hours rate	A.H.
06	Number of cells	
07	Voltage per cell	V
08	Normal charging rate	A
09	Ampere hour efficiency at 5 hour rate	%
10	Dimensions of cells	mm
11	Dimensions of battery	mm
12	Weight of cell complete with electrolyte	Kg
13	Total weight of battery complete	Kg
14	Internal resistance per cell when fully charged	Ohms
15	Battery voltage at end of the duty cycle specified	V
B) CHARGES		
01	Manufacturer	
02	Type	
03	A.C. input to charger	KVA
04	D.C. output to charger	KW
05	Type of D.C. voltage control	V
06	Range of D.C. voltage control	%
07	Regulation	mm
08	Overall dimension	Kg
09	Total weight	
10	Boost charge contactors:	
	a) Manufacturer	A
	b) Maximum current rating	W
	c) Coil rating	
	d) Method of interlocking	
	Alarm relays :	
	a) Manufacturer	
	b) Type of reference	
	c) Power consumption:	
	1) Quiescent	W
	2) Operated	W
11	Number and rating of distribution circuits	
12	Overall dimensions	mm
13	Total weight	Kgs

SULTANATE OF OMAN

MINISTRY OF ELECTRICITY & WATER



**110V BATTERY SWITCH
TRIPPING UNIT**

STANDARD – OES 12B

BRIEF SPECIFICATIONS

Second Edition : January 1995

SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD : OES - 12B
110V BATTERY SWITCH TRIPPING UNIT

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SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD OES - 12A
SPECIFICATION FOR 110V BATTERY SWITCH TRIPPING UNIT

1.0 GENERAL

The 110V Battery Switch Tripping Units are for installation indoor in 33KV substations and required for tripping, closing spring release and for emergency lighting.

The units shall be self-contained with the battery cells, control and charging gear, instruments, terminal blocks etc. accommodated and mounted in floor standing cabinet of folded steel construction with hinged panels for access to the battery.

2.0 BATTERY

The battery shall comprise 92 (Ninety two) Nickel-Cadmium battery cells in plastic containers, normal cell voltage 1.2 volt and shall have minimum capacity of 100 ampere-hours at 5 hour discharge rate.

The battery cells shall be accommodated in impregnated hardwood trays complete with intercell connectors of plated and annealed copper strip and inter-crate connectors of flexible tinned copper rubber sheathed cable of adequate size and complete with necessary terminal lugs. The battery shall be supplied filled with electrolytic and in a part discharged condition.

3.0 CHARGER

3.1 GENERAL

3.1.1 The battery charger shall be constant voltage type, solid state (silicon) controlled rectifier equipment, designed to provide fully automatic voltage stabilization and current limitation for charging Nickel Cadmium batteries in D.C. systems. It shall also be capable of simultaneously supplying varying load of 10 Amps permanently connected in parallel with the battery.

3.1.2 The charges circuitry shall be of modular design and the printed circuit cards shall have plug-in or slide-in type construction. The silicon rectifier diode and thyristors shall be assembled to one sub-assembly which can be easily exchanged. The Charger shall preferably be divided into the following separate sections, each with it's own unique function :

- A.C. input module
- Power module(s)
- Control and alarm module
- D.C. output bay

3.1.3 All components especially the converter transformer and the thyristor stack shall be adequately rated for continuous operation at the maximum output under the specified service conditions and shall normally require no replacement during the life of the Charger.

- 3.1.4 A dry type shielded isolation transformer with copper winding shall be provided for the AC input to the semi controlled SCR bridge.
- 3.1.5 The Battery Charger shall be of manufacturer's proven design and shall meet or exceed the requirements of this specification in all respects.

3.2 PERFORMANCE CHARACTERISTICS AND RATINGS

- 3.2.1 The Charger shall be suitable for operation on single phase, 240V, 50 c/s AC supply.
- 3.2.2 The rated output voltage of the Charger shall be 30V DC.
- 3.2.3 The Battery Charger shall be designed for two charging modes that is, float charging for normal use and Boost charging under discharged battery conditions.
- 3.2.4 The Load output voltage shall be automatically and continuously held constant to within 1% of the voltage setting at any load from no-load to full rated load (0 to 100%), within simultaneous A.C. input voltage variations of + or - 5%. This regulation shall be maintained under both float and Boost operations.
- 3.2.5 The ripple voltage shall not exceed 2.0% peak-to-peak of the nominal DC voltage over the specified input voltage range with battery disconnected.
- 3.2.6 The power factor shall be better than 0.8 lagging at full load with rated mains voltage.
- 3.2.7 The maximum temperature rise of the windings of converter transformer shall not exceed 50°C. The maximum temperature rise for thyristor stack (junction temperature) shall not exceed 65°C. The temperature limitations shall apply under both float and equalize (Boost) operations of the Charger.
- 3.2.8 The Battery Charger shall be operated with an unearthed battery bank.
- 3.2.9 Audible noise, resulting from operation of the rectifier, shall be as minimum as practical so as not to cause any nuisance.

3.3 CONTROLS AND PROTECTION

- 3.3.1 The Charger shall be adequately protected against short circuits by automatic tripping provided at both input and output circuits. The output shall be controlled by current limiting device which will reduce the output DC voltage to safe limits when load exceeds rating with facility to adjust it from 100% to 120% of rated load.
- 3.3.2 Provision shall be made to protect the Charger against accidental reverse polarity connection.
- 3.3.3 The Charger shall have independent individual adjustable float and boost charge circuits. These circuits shall have adjustable manual devices for Nickel cadmium. The range of adjustment for float and boost voltage shall be 1.35 to 1.45 per cell and 1.5 to 1.7 V per cell respectively.
- 3.3.4 Provisions shall be made for the "initiation" and "cut-off" of the boost charging mode automatically as well as manually. A selector switch shall be provided to select the desired mode of operation.

- 3.3.5 The automatic charging system shall be provided with the auto equalize timers equipped with “float reset” and Boost override switches along with respective indicating lights for flat and Boost modes.
- 3.3.6 Return of Charger from Boost to float voltage after manual initiation, shall be accomplished automatically via automatic timer. The L.E.D. indicating the equalize rate charge shall flash to indicate the discrepancy position of the manual switch. The L.E.D. will turn-off when the manual switch is switched back to normal position.
- 3.3.7 The Charger shall be furnished with a soft start to limit the inrush current upon application of input voltage.
- 3.3.8 The Charger shall be designed to automatically shutdown in the event of high battery voltage. The set point shall be selectable and consistent with the maximum recharging voltage of the particular type of battery.
- 3.3.9 A ground detection circuit shall be furnished with the charger to detect a ground on the batteries. The ground detection relay shall be suitable for local and remote indication. The system shall be equipped with positive and negative ground detection indicating lights along with ground test and lamp test switches.

3.4 STATUS INDICATIONS, ALARMS AND INSTRUMENTATIONS

A) Status	B) Alarm
a) AC Power On (Green)	a) AC Power Fail Alarm
b) Float Mode (Green)	b) Low DC Voltage Alarm
c) Boost Mode (Amber)	c) Separate DC Positive and Negative Ground Detection Alarm
d) Current Limit (Amber)	d) High DC Voltage Instantaneous Shutdown Alarm
	e) DC Current Limit Alarm
	f) End of Discharge Alarm

Audible alarms going off after set time delay will be required since substations are mostly unattended but visual alarm will continue till reset.

Wired terminals shall be provided for the remote indications of alarm functions as described above.

3.5 PANEL MOUNTED EQUIPMENT/INSTRUMENTS

- 3.5.1 The Charger shall have the following components mounted on the front panel. Each component shall be labelled for identification :
- 1) A two position ON/OFF AC main switch for charger input with pilot lamp (Green).

2) A four position DC output selector switch for the following settings :

- Off
 - Float
 - Boost
 - Automatic (Float/Boost)
- 3) An AC Voltmeter for input AC supply.
- 4) An AC Ammeter.
- 5) A DC ammeter with + or - full scale accuracy ranging from 0-150% of maximum output rated current.
- 6) A DC Voltmeter for output voltage.
- 7) Controls for the following functions (to be located on the control switch)
- Float voltage adjust
 - Boost voltage adjust
 - Current limit adjust
 - Over voltage trip adjust
 - Low voltage alarm adjust
- 8) Charger output MCBS - 6.
- 9) Status indications.
- 10) Alarm indications.
- 11) A lamp test push-button to test all lamps.

3.6 CONSTRUCTION

3.6.1 The Battery Charger shall be designed as a free standing equipment. All components shall be integrally designed 5to complete control and monitoring as required.

3.6.2 The Charger enclosure shall be of IP 21 construction and designed for indoor free standing installation. The cabinet enclosure may be constructed of welded steel material. Material sheet thickness shall be 2.5 mm minimum.

The Panel shall be made completely vermin proof.

3.6.3 Access to the equipment shall be from the front. The door shall have a handle with provision for locking. Entries of cables shall be through suitable cable glands.

3.6.4 Besides AC terminals the Chargers shall have two DC positive terminals (i.e. one for battery and the other for DC load) and one negative terminals on the other side. The positive terminals shall be marked "+B" and "+L" for battery and load respectively and coloured red. The negative terminal shall be marked "-" and coloured black. AC terminals shall be marked "AC" with proper phase marking where three (3) phase is used. AC/DC terminals shall be mounted on separate terminal blocks. All the markings shall be permanent.

3.6.5 The Charger shall be adequately ventilated for self cooling by natural air convection.

3.6.6 Provision shall be made for earthing of the panel and a bolted connector shall be provided to accommodate 75 sq.mm earthing conductor. All bolted parts shall use suitable washers to ensure electrical continuity of the structure.

3.6.7 An approved schematic diagram of the Charger identifying various components and referring to the appropriate drawings and erection instruction in English shall be affixed to the inside of the cubicle access door. The diagram shall be marked on durable non-fading material suitable for the specified climatic conditions.

3.6.8 Appropriate identification in the form of a name plate(s) shall be provided on each Charger component as far as possible. These name plates shall be the visible, engraved type, of appropriate size and attached to the panel by stainless steel screws or rivets.

3.7 WIRING

3.7.1 All wiring used within the Charger shall be installed and tested at the factory unless otherwise specified.

3.7.2 All control wiring shall be PVC insulated multistrand copper and in no case shall be smaller than 1.5 mm². Electronic and low signal wiring shall be manufacturer's standard.

3.7.3 All terminal block, except electronic systems internal terminal blocks, shall be rated 600V minimum, and shall have non-captive pan head screw terminals. Blocks shall be clearly numbered and identified. All wire terminations shall be ring type, or pin type stack-on or equivalent.

3.7.4 Wiring shall be carried in troughs or in neatly formed packs which shall be tied or otherwise secured at frequent intervals to prevent undue stress on equipment or connections. Connections across portions which are movable shall be made with flexible wire formed to distribute the bending motion. No wires shall be jointed between terminal points.

3.7.5 The AC and DC circuit terminals shall be fitted with non-flammable, transparent plastic covers to prevent accidental short circuit/contact with live parts or earthing of the battery.

3.7.6 All printed circuit boards shall be coated with a solderable polyurethane varnish.

3.7.7 All wiring shall be identified by a non-flammable permanent marking at each termination. Markers shall be of material that will not deform or deteriorate, and shall withstand the specified ambient temperatures.

3.8 PAINTING

The Charger cabinet painting shall be in accordance with MEW Standard OES-11.

3.9 NAME PLATE(S)

3.9.1 The Charger shall bear a name plate fixed on the front side of the panel. The plate shall be marked in English and Arabic with the following minimum information :

- 01) The words "BATTERY CHARGER"
- 02) Model Number and Type
- 03) Manufacturer's Name and Trade Mark
- 04) Year of Manufacture
- 05) Manufacturer's Serial Number
- 06) Rated AC Input Voltage
- 07) Rated AC Input Current
- 08) Frequency
- 09) Number of Phases
- 10) Rated DC Output Voltage

- 11) Rated DC Full Load Output Current
- 12) Range of Adjustments for :
 - Float Voltage
 - Boost Voltage
 - Current Limited

3.9.2 The name plate material shall be stainless steel or other non-corrodible material, but shall not include plastic aluminum, and shall fastened to the equipment by stainless steel screws or rivets. The markings shall be imprinted or etched in black, and shall be non-fading.

3.9.3 The rating plates for the sub-assemblies e.g. thyristor stack, converter transformer etc., shall bear the following minimum indications :

- a) Identification Reference/Manufacturer's Type Designation
- b) Serial Number
- c) Number of Input Phases
- d) Rated Input Voltage and Frequency
- e) Rated Input Current
- f) Rated Output Voltage
- g) Rated Output Current

3.10 INSPECTION AND TESTING

Tests

All Standard tests shall be carried out on complete Charger(s) in accordance with IEC or BSS Standards as applicable.

Certified test reports of type tests performed on identical chargers acceptable to MEW may be submitted for review and acceptance in lieu of the required design (type) tests above.

All circuits connected to the AC, DC power control input and output terminals shall be capable of withstanding a test voltage of 2000 volts RMS, 50 Hz, to ground for one (1) minute.

3.11 DATA REQUIREMENTS

General

The English shall be used at all times with respect to documents, drawings and labels procured or prepared by the Vendor pertaining to the work.

Documentation

The following minimum information shall be provided along with offer :

- 1) Overall dimensional drawing showing front, back, side and plan views with door closed and open.
- 2) Details of thyristor stack and associated control units including the information regarding forward and reverse characteristics.

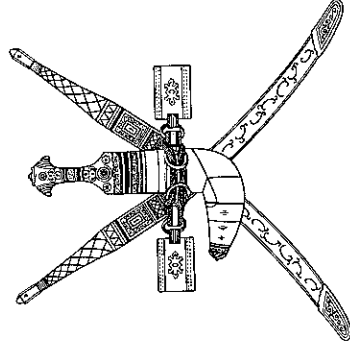
- 3) Details of relays, fuses and circuit breakers etc.
- 4) Method/Details of surge protection, riple control, voltage regulation, current limitation, automatic equalize system etc.
- 5) Charger sizing calculations.
- 6) Circuit diagram for the complete Charger.
- 7) List of recommended spare parts and special tools (if any) along with prices.
- 8) Dimensional drawing of the Charger unit showing the equipment mounted on front and inside.
- 9) The vendor, upon shipment of the equipment, shall supply four (4) copies of the following approved drawings and other documentation for record purposes :
 - a) One (1) reproducible of each approved drawing.
 - b) Instrumentation manuals covering installation, maintenance and operation of the Charger including trouble shooting. A functionally laid out and directional point-to-point testing sequence shall be described in the instructional manual.
 - c) Certified Test Reports, Certificates, Data and Curves etc.
 - d) A complete list of the component parts along with manufacturer's catalogue parts numbers.

110V BATTERY SWITCH TRIPPING UNIT
TECHNICAL GUARANTEED PARTICULARS

S. No.	Description	Particulars
A) BATTERIES		
01	Manufacturer	
02	Type	
03	Electrolyte	
04	Voltage	V
05	Capacity at 5 hours rate	A.H.
06	Number of cells	
07	Voltage per cell	V
08	Normal charging rate	A
09	Ampere hour efficiency at 5 hour rate	%
10	Dimensions of cells	mm
11	Dimensions of battery	mm
12	Weight of cell complete with electrolyte	Kg
13	Total weight of battery complete	Kg
14	Internal resistance per cell when fully charged	Ohms
15	Battery voltage at end of the duty cycle specified	V
B) CHARGES		
01	Manufacturer	
02	Type	
03	A.C. input to charger	KVA
04	D.C. output to charger	KW
05	Type of D.C. voltage control	V
06	Range of D.C. voltage control	%
07	Regulation	mm
08	Overall dimension	Kg
09	Total weight	
10	Boost charge contactors:	
	a) Manufacturer	A
	b) Maximum current rating	W
	c) Coil rating	
	d) Method of interlocking	
	Alarm relays :	
	a) Manufacturer	
	b) Type of reference	
	c) Power consumption:	
	1) Quiescent	W
	2) Operated	W
11	Number and rating of distribution circuits	
12	Overall dimensions	mm
13	Total weight	Kgs

SULTANATE OF OMAN

MINISTRY OF ELECTRICITY & WATER



**11.5KV 5MVAR CAPACITOR BANKS
STANDARD – OES 13**

BRIEF SPECIFICATIONS

Second Edition : January 1995

SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD : OES - 13
11.5KV SMVAR CAPACITOR BANKS

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SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD OES - 13
11.5KV 5MVAR CAPACITOR BANKS

01 GENERAL

The capacitor bank shall comprise five units of one MVAR rating 3 phase 11.5KV and shall be housed in metal clad outdoor cubicles, and a separate cubicle to accommodate the incoming 3 core 11KV cable, three phase 11KV off-load isolator and 11KV voltage transformer. The cubicles arranged in line to form a complete self standing board.

02 CAPACITORS

The 11.5KV capacitors shall comply with IEC 70/BS 1650 and shall be suitable in all respects for installation outdoor housed in metal clad cubicles, and for operation in the specified site conditions on the MEW 11KV system (clause 0.01 OES-11).

The capacitor shall be capable of the following permissible over loads as a minimum :

Current	: i.3 times rated current continuously
Voltage	: 1.1 times rated voltage of 11KV continuously
Output	: i.3 times rated output continuously

The capacitor container shall be of stainless steel welded construction. Alternative price shall be quoted with mild steel container which shall be protected with the following treatment :

- short blast
- zinc spray
- primary coat
- undercoat
- finishing coat

Bushings shall be of porcelain to withstand an impulse voltage of 75KV and shall have a minimum creepage of 275mm.

The capacitor shall include in-built discharge resistors inside the container permanently connected across the terminals to discharge the capacitor to 50 Volts in less than 5 minutes.

Lifting - fixing brackets shall be provided on tow sides of the capacitor container.

03 OUTDOOR CUBICLES

Each 1 MVAR capacitor unit with its associated control and protection gear shall be housed in metal-clad outdoor cubicle of mild steel construction with minimum plate thickness of 3mm.

The cubicle shall include hinged front door with lockable chromium finish handle, bottom plate and removable rear and side cover plates secured in position from inside the cubicle. The entire cubicle shall be protected against corrosion in accordance with clause 04 of OES-11 as a minimum.

The cubicle as a whole shall be manufactured to degree of protection IP55.

In addition to the cubicles for housing the capacitor units, a separate cubicle shall be provided for accommodating the incoming 11KV cable, control cables, 11KV isolator and 11KV voltage transformer.

All six cubicles shall be arranged in line to form a complete free standing board with base frame and fixing bolts, for installation outdoor on concrete foundation. The board shall include a ridged canopy for protection from rain. Ventillation louvre shall be provided in the cubicle with the gauze for vermin proof.

The board shall be provided with tinned copper earth bar 40 x 4mm running the entire length of the board with two earth terminals for connecting to the station earthing system.

04 INCOMING SUPPLY CUBICLE

04.1 The cubicle shall include the following :

- Cable entry and termination for 3 core 240 sq.mm copper XLPE/PVC/PVC/SWA cable, with all necessary dry type termination material including compression type brass gland with PVC shroud and earth tag, and crumpling type lugs.
- Control cable entries and terminations, terminal blocks.
- 3 phase 11KV off-load isolator 400 amps rating.
- Three 11KV lightning arrestors.
- 11KV voltage transformer dry type resin encapsulated connected across two phases ratio 11KV/110V, 500VA, min.
- Unbalance protection relays for each capacitor bank to trip the contactor of each bank in the event of unbalance.
- Two 11KV HRC fuses for protection of 11KV VT and one secondary HRC fuse link/MCB.
- 3 phase busbars covered with extruded insulation which shall be suitable for the site conditions.
- Over voltage relay to protect capacitor bank against over voltage, tripping all contactors.

04.2 CAPACITOR CUBICLE

The cubicle shall include the following :

- 11.5KV 3 phase 1 MVAR capacitor unit comprising two 500KVA Star connected capacitor banks in parallel and star point of each interconnected.
- Three 11KV single phase reactors for protection against switching inrush currents.
- 11KV 3 phase contactor 400 amp suitable for continuous operation at maximum voltage of 12.5KV.
- Three 11KV HRC fuses 125 amps
- 11KV busbars 400 amps covered with extruded insulation which shall be suitable for the site conditions.
- One current transformer of suitable ratio and burden on the interconnected star connection to energise sensitive unbalance relay for protection against unbalance current in the bank.

For automatic regulation of the station power factor by switching step by step the five capacitor units, a control console with necessary step by step control relay and associated ancillary equipment shall be supplied.

The console shall be wall mounting of moulded steel construction with minimum plate thickness of 2mm for indoor installation inside the substation building. The console shall include a hinged front door with locable chromium finish brass handle.

The regulating and control relay shall operate from the 11KV/110V voltage transformer provided in the incoming cubicle of the capacitor board (4.1 above) and 1 amp secondary current transformer on the 11KV incoming supply to the substation.

The 11KV contactors provided in the capacitor cubicles (4.2 above) controlling individual capacitor units shall close or trip in sequence, step by step, initiated by the regulating and control relay.

The regulating and control relay shall have the following features as a minimum :

No.of steps : 6 (with one spare)

Measuring principle : Power factor measured of phase shift between power supply voltage and CT current.

Target power factor : Range : 0.8 capacitive ...1.00 ...0.8 inductive.

Display modes : digital

- power factor (COS phi)
- capacitor steps
- inductive setting value
- target power factor
- operation time delay

No volt release : all steps to be released and output contacts disabled within 10 milli sec. After voltage is restored normal operation to resume in sequence step by step.

Operation time delay : the time delay range between steps to be 0 to 5 minutes.

Accuracy requirement : Power factor shall be maintained with + or - 2.5% of the target value.

Manual over-ride : Manual selector switch with three positions; off/manual/auto.

Alarm : The regulator alarm contact to close with a blink in the display if either the compensating power is insufficient or there is no voltage at the regulator input.

The entire equipment provided in the control console shall be suitable for operation continuously in an ambient of 50°C.

The console shall be manufactured to degree of protection IP40.

The corrosion protection treatment of the console shall be in accordance with OES-11.

The console shall include all necessary secondary wiring, terminal blocks, compressor type brass glands for control cables to capacitor cubicles (4:0 above) and 11KV switchboard at the station for CT secondary circuit.

All small wiring inside the capacitor cubicle and the console shall be carried out in accordance with Clause 0.20 OES-11.

11.5KV 5MVAR CAPACITOR BANKS
TECHNICAL GUARANTEED PARTICULARS

A CAPACITOR BANKS

- 1 Make
- 2 Model No.
- 3 Rated Voltage
- 4 Site MVAR rating at rated voltage KV MVAR
- 5 Permissible over-load capacity
 - a : as percentage of rated voltage
 - b : as percentage of rated current
 - c : as percentage of rated MVAR
- 6 Loss of MVAR capacitor unit walls
- 7 Type of di-electric material
- 8 Insulation level
- 9 No. of insulation layers
- 10 Thickness of each layer
- 11 Loss angle value at
 - a : 500C
 - b : 800C

B VOLTAGE TRANSFORMERS

- 1 Make
- 2 Type
- 3 Class
- 4 Ratio
- 5 Burden

C CURRENT TRANSFORMERS

- 1 Make
- 2 Type
- 3 Ratio
- 4 Class
- 5 Burden

D CONTACTORS

- 1 Make
- 2 Type
- 3 Rating
- 4 Current
- 5 Rated voltage : KV
- 6 Closing coil voltage : V
- 7 Coil current : Amp

Sl. No.	Description	Page No.
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E 11KV ISOLATIONS

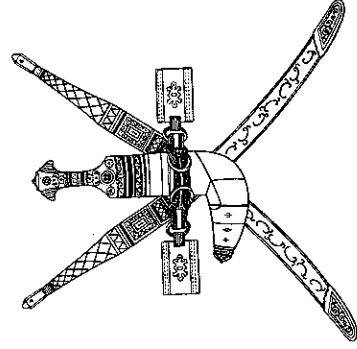
- 1 Make
- 2 Type
- 3 Rating

F REGULATING AND CONTROL RELAY

- 1 Make
- 2 Type/Model
- 3 No. of steps
- 4 Measuring principle
- 5 Frequency
- 6 Power supply
- 7 Power factor range
- 8 Display modes
- 9 Operation sequence
- 10 Operation delay range
- 11 Accuracy
- 12 Construction
- 13 Degree of protection
- 14 Dimensions

SULTANATE OF OMAN

MINISTRY OF ELECTRICITY & WATER



11KV INDOOR SWITCHGEAR

STANDARD – OES 14

BRIEF SPECIFICATIONS

Second Edition : January 1995

SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD : OES - 14
11KV INDOOR SWITCHGEAR

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SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD OES - 14
11KV INDOOR SWITCHGEAR

01 TYPE

Switchgear shall be of the indoor single busbar, totally enclosed metal-clad type withdrawable circuit breakers for installation in brick built substations.

02 GENERAL REQUIREMENTS

The switchgear shall comply with the Ministry's general specifications OES 11 for electrical materials and equipment.

Switchgear shall be robust construction and shall be unaffected in part or whole by the forces imposed by short-circuit or other currents, operation, vibration or temperature changes. The switchgear shall comply with BSS 5227/IEC 298 unless otherwise specified herein, and shall be extensible at both ends. All components and all materials used in switchgear shall conform to appropriate IEC/BSS. The switchgear shall be designed to facilitate inspection, cleaning, maintenance and repairs. The switchgear shall be of the compartmental design divided into separate compartments for the circuit breaker, the busbars, cable circuit and the low voltage control, protection and metering equipment.

The system voltage, rated symmetrical circuit and impulse level shall be as follows :

Normal system voltage	11KV
Highest system voltage	12.5KV
Symmetrical short circuit at rated voltage for 3 sec.	18.4KA
Impulse level	75KV

03 CURRENT RATING

The normal continuous rating of the circuit breakers in the climatic conditions obtaining at sites (Clause 0.01 of OES-11), shall be as follows :

All circuit breakers shall be rated for 400 amps, except for the 33/11KV transformer control circuit breaker and bus section circuit breaker which shall be rated for 1200 Amps.

All current carrying parts of the switchgear, namely the circuit breakers, bus bars, current transformers, isolating contacts, connections, joints etc., shall be capable of carrying the specified rated current continuously. The temperature rise in any part shall comply with BSS 159 taking into account the site ambient temperature. BSS rating alongside the site rating in each case shall be stated.

04 BUS BARS

The busbars shall be hard drawn high conductivity copper bars silicon rubber insulated. Other covering material of permanent fixage and suitable for climatic and system conditions in Oman are acceptable. Subject to prior approval, the bus bar shall be site treated for 2000A.

The busbars on the switchgear shall be arranged to permit future extensions at each end.

05 CIRCUIT BREAKERS

The circuit breakers shall be of the vacuum type. The circuit breakers shall have a guaranteed rupturing capacity of not less than 350KVA at 11000 volts and must conform to BSS 5311/IEC 56. Type test certificate for the circuit breakers from an internationally recognized testing authority acceptable to MEW shall be produced.

The circuit breaker shall be provided with AC 240V motor charged spring closing mechanism, 30V DC spring release coil, 30V DC closing coil and 30 V DC Shunt trip coil and shall include the following :

- Facility for manual charging of spring
- Spring charged/uncharged indicator
- Local barrel type control switch
- Mechanical ON/OFF indicator
- Red and green ON/OFF indicator lamps (5 watt 30V DC)

06 CIRCUITS

Each circuit breaker shall control either a feeder circuit or transformer circuit (500KVA or 200MVA) or for bus section 1200 amps or capacitor bank (5MVAR) as per details of equipment. The switchgear shall comprise 16 panels. The standard arrangement of switchgear circuits for a typical 33/11KV substation, when viewing the switchboard from the front and reading from left to right, shall be as follows :

- Panel Nos. 1 and 16 : for capacitor control
- Panel No. 2 : for station transformer control
- Panel Nos. 3, 4, 5, 6, 7, 11, 12, 13, 14 and 15 : for feeder control
- Panel Nos. 8 and 10 : for 20MVA 33/11KV transformer control
- Panel No. 9 : bus-section panel

07 CURRENT TRANSFORMERS

Current transformers shall conform to BS 3938/IEC 185 and shall be air or resin insulated with single or multi core. Current transformers shall be so rated and designed that they shall not sustain any damage due to through fault currents expected on a system fault level of 350MVA.

a) **Each feeder control panel and capacitor control panel :**

- One three phase set 400/5 amps 15VA (minimum) class 5P10 accuracy one set for metering and over-current and earth fault protection.

b) 500KVA 11KV/433V transformer control panel :

- One 3 phase set of 100/50/5A VA (minimum) class formers 15VA (minimum) class 5P10 accuracy for metering and overcurrent protection.

d) Each 33/11.5KV transformer control panel :

- i) One three phase set of current transformers class 'X' for biased differential protection having 1200/0.577 amp secondaries to match the characteristics of the current transformers on 33KV side which have a ratio of 400/1 amp.
- ii) One three phase set of current transformers for the restricted earth fault protection ratio 1200/1 amp 15VA (minimum) class 'X' to match current transformer on the neutral of the 20MVA transformer.
- iii) One three phase set of current transformers ratio 1200/amp 15VA (minimum) class 5P10 accuracy for metering, reverse power protection and standby E/F relay.
- iv) The current transformers offered for differential protection shall operate satisfactorily with the current transformers on the 33KV side. Characteristics curves of the current transformers shall be submitted with each tender and shall be subject to the approval of MEW. Test Certificates shall be provided for each current transformer supplied.
- v) The tenderer shall state that current transformers offered will operate satisfactorily with their associated protection devices. Confirmation of the suitability of the current transformers shall be obtained from the manufacturer of the protective systems and submitted for approval of MEW.
- vi) The capacity of each transformer shall be determined by the manufacturer of the switchgear and shall be adequate for the full burden of the connected apparatus plus as overload of 50 percent indefinitely in the worst temperature conditions at site. No current transformer shall, however, have a capacity less than 15VA.

08 11KV VOLTAGE TRANSFORMERS

Each 20MVA transformer control panel shall be provided on the incoming side with preferably a withdrawable type voltage transformer. The voltage transformer shall be 3 phase core type fully insulated star/star ratio $11000/\sqrt{3} / 110/\sqrt{3}$ 200 VA per phase class 1 accuracy to BS 3941/IEC 186.

Cartridge type secondary fuses or MCB's shall be provided.

09 PROTECTION

09.1 FEEDER CIRCUIT AND CAPACITOR CIRCUIT

Each feeder circuit and each capacitor control circuit on the switchboard shall be provided with protection comprising two overcurrent and one earth fault relay of the inverse definite minimum time. The IDMT overcurrent relays to have a current range from 50 to 200% in steps of 25% and time setting adjustable from zero to 3 seconds at ten times current setting and shall have characteristics to BSS 142. The earth fault relay to have current range 10% to 40% in steps of 10% and time setting zero to 3 seconds at ten times current settings and shall have characteristics to BSS 142.

09.2 11KV/433V TRANSFORMER CIRCUIT

The 11KV/433V transformer circuit shall be protected with a triple pole relay comprising two overcurrent and one earth fault unit.

The overcurrent unit shall comprise an inverse time overcurrent relay with definite minimum time (IDMT) and a high set instantaneous overcurrent unit combined and mounted on the same frame.

The IDMT unit to have a current range from 50 to 200% in steps of 25% and time setting adjustable from zero to 3 seconds at ten times current setting and shall have characteristics to BSS 142. The instantaneous element shall have current range from 200 to 800% and an operating time of 0.02 second. The earth fault relay shall have a current range from 10% to 40% and operating time to 0.02 second at two times setting.

09.3 Bus Section

The bus section panel on the switchboard shall be provide with three overcurrent relays of the inverse definite minimum time, with a current range from 50 to 200% in steps of 25% and time setting adjustable from zero to 3 seconds at ten times current setting.

09.4 20MVA 33/11KV Transformer

The transformer is 33/11KV Delta/Star group Dyn11 connected with onload tap changer, tap range being -15% to +5%.

Protection shall comprise :

- i) Overall biased differential protection to cover 33 and 11KV windings. The current transformers offered for the 11KV side shall operate satisfactorily with the current transformer on the 33KV side. The protection shall incorporate harmonic restraint and shall remain stable during magnetizing inrush surges without any intentional time delay.
The protection shall also incorporate percentage bias to cater for out-of-balance current due to tap changing.
- ii) The 11KV winding of the transformer shall also be protected by means of restricted earth fault protection. The current transformers for this service shall match the current transformer on the neutral of the transformer or.
The relay for this service shall be of the high impedance type with necessary protection sensitivity against over voltages. The relay shall have maximum and minimum operating time consistent with stability for faults outside the protected zone and magnetizing inrush surges.
- iii) The 11KV side of the transformer shall be further protected with three element reverse power relay (i.e. directional relay with 90⁰ - 45⁰ connection and 45⁰ MTA - setting 5 to 15%).

09.5 GENERAL

All relays shall be flush mounting pattern self resetting, draw out type with hand reset flag indicators or light emitting diodes and shall be accommodated on the switchgear panel in the front. The relays shall be of the electromagnetic or electronic type preferably of following make : GEC, Reyrolle and ABB.

10 11KV CABLE TERMINAL BOXES

10.1 11KV Feeder, 11KV/433V Transformer Panel and Capacitor Control Panel

The cable box shall be suitable for 11KV 3 core cross linked polyethylene single wire armoured and PVC served cable, cable size range 50 to 240 sq.mm. Dry type termination without the need for compound filling shall be provided. Cable box shall be complete with compression type brass gland, wire armour clamp, connecting copper bonding straps, cable lugs. The design shall provide sufficient space for core crossing without damage to core insulation.

All necessary termination materials and sundries for a complete termination shall be supplied. Cable boxes shall be separated from all other compartments such as C.T. chambers, busbar compartments etc.

10.2 20MVA 33/11.5KV Transformer Panel

The cable termination box shall be suitable to receive 6 single core 500 sq.mm 11KV XLPE insulated aluminium armoured cables (two cores for each phase). Fully detailed drawings shall be submitted for approval of MEW.

The box shall be complete with flexible copper connection, cable lugs, brass glands, earth bonding clamps and connections to earth bar.

10.3 The cable boxes shall be so positioned that the cable glands are clearly and sufficiently off-set from the switchboard to facilitate easy entry of the 11KV cable directly from the substation trench, obviating the need for a special slot for cable either in the floor or switchboard base plate. A channel iron bracket with cleat shall be provided for cable support.

11 BUS WIRES

The following bus wires of appropriate copper section, in no case less than 2.5 sq.mm PVC insulated in appropriate colour code shall be provided on the switchboard.

- DC trip circuit
- DC closing spring release coil circuit
- Remote group alarm circuit
- Circuit breaker close and open red and green lamp indication circuit (30V DC)
- Circuit breaker panel heater circuit (240V AC)
- DC auto trip amber lamp indication circuit

The bus wire shall be neatly cleated and terminated on both sides of each individual panel on terminal blocks with adequately rated terminal studs complete with all necessary provisions for interpanel connection. For connection off power and control cables to the bus wire, necessary cable glands and terminal blocks shall be provided in the switchgear panel for 500KVA 11KV/433V station transformer.

12 LABELS AND SECONDARY FUSES

Each panel of the switchboard shall have a blank circuit label approximately 30 cm x 8 cm mounted on the front of the panel in a prominent position. These labels shall be made of suitable engraving material approximately 2mm

thick, white surface with black engraving. Small blank labels of similar material shall be mounted on the rear of the panels. The circuit names shall be engraved at site later. All other labels shall be of similar material and engraved in English. All necessary fuses and links shall be supplied and they shall be fitted with clearly legible label indicating the circuit and shall be grouped according to their functions to facilitate identification. Fuse label shall indicate the current rating of the fuses and code symbols shall correspond with the diagrams. All secondary fuses shall be of the cartridge type to BSS 88.

MCB's in lieu of fuses are acceptable.

13 ISOLATION AND INTERLOCKS

Switchboard shall be provided with approved means of isolation of circuit breakers and circuit and be complete with automatic shutters to screen off all live parts. The switchgear shall be fully interlocked to prevent mal-operation. To obviate unauthorised operation, locks each with tow keys of approved make shall be included for :

- a) Locking out each circuit breaker in the isolated or off position.
- b) Locking movable shutters screening live parts (lock to be coloured red)
- c) Locking circuit breakers control switch
- d) Locking voltage transformer in the rack in position
- e) Locking voltage transformer spout shutters

All locks to differ and have individual keys.

To facilitate phasing out of any incoming circuits against the busbars, arrangements shall be provided to enable manual opening or closing any of the related shutters independently with the circuit breaker withdrawn and for locking any of these shutters independently in the open or closed position.

14 CIRCUIT BREAKER ISOLATING EQUIPMENT

The circuit breaker isolating equipment shall be an integral part of the circuit breaker.

15 INTEGRAL EARTHING

Integral earthing shall be provided in the switchboard for circuit preferably through circuit breaker. The earthing shall be complete with all necessary mechanical interlocks to prevent mal-operation.

The earthing of the busbar shall be arranged such that earth cannot be applied till all circuit breakers of that bus including bus section are tripped and brought to test position.

16 EARTHING

The switchboard shall be provided with a copper earth bar of sectional area not less than 50 mm x 4 mm. All metal instrument and relay cases on the panels, shall be connected to the earth by copper conductors not less than 2.5 sq.mm cross section.

17 HEATERS

In view of the high humidity prevailing at the sites, each panel shall be provided with suitably rated heater for operation from 240V AC supply and arranged for switching on when the breaker is off or isolated. This is to prevent condensation on breaker bushings, spout insulators etc.

18 INSTRUMENTS

Dial type, full deflection 270° 96 x 96mm switchboard pattern, flush mounting moving iron volt meters and ammeters shall be provided.

19 AUXILIARY SWITCHES

Auxiliary switches shall be provided to interrupt DC supply to trip and closing coils immediately after their operation has been completed.

All necessary auxiliary switches for control, protection and indication for supervisory control which may be adopted at a future date, shall be provided on each circuit breaker panel plus two spare ways normally close and two spare ways normally open. The auxiliary switches shall be wired to a suitable terminal block on the panel.

20 HEALTHY TRIP INDICATION

15 Watt 30V DC lamp with series limiting resistance operated through a spring loaded push button test switch shall be provided on each circuit breaker panel. Alternative continuously monitoring scheme with low consumption (less than 5mA) may be provided for consideration.

21 LOCAL/REMOTE/SUPERVISORY SELECTOR SWITCH

A local/remote/supervisory selector switch shall be provided on each circuit breaker panel to facilitate control of the breaker from a remote location. In supervisory position the control will get transferred to future SCADA.

22 TEST TERMINAL BLOCKS

Current transformer secondary wiring shall be connected through terminal blocks with change-over links to permit easy testing.

The terminal block shall be mounted in front of the panel and suitably insulated and provided with a detachable dust proof cover.

23 REMOTE ALARM

It is proposed to install at a later date SCADA for remote alarm and indication. Circuit breaker automatic tripping shall alone a two wire circuit to operate on alarm way. For this purpose each circuit breaker shall have necessary auxiliary contacts to enable resulting of the remote alarm being affected by the control switch.

24 SMALL WIRING

All wiring shall be 2.5 sq.mm stranded copper conductor, 600 V tropical grade PVC insulated. All small wiring shall be suitably terminated and fitted with captive identification with circuit number. Trip circuit shall have an additional ferrule coloured red and marked "Trip".

Each circuit identification number shall be suffixed with the panel identification letter. All terminal blocks shall be provided with detachable covers. The trip circuit cables shall be coloured black. The current transformer secondary wires shall preferably be coloured with their respective phase colours.

25 TESTS

25.1 TYPE TEST

Type test certificate from an internationally recognized authority shall be produced as evidence that the circuit breaker has been successfully tested to BSS 5311/IEC 56 on its own structure, complete with isolating features, with vent outlets forming part of the unit and with the main connections an busbars. The certificate shall include the test results and details of the circuit breaker performance during the tests.

25.2 TEMPERATURE RISE TEST

Temperature rise test shall be carried out in accordance with BSS on the following panels :

- a) One complete feeder panel of the switchboard.
- b) One complete 20MVA transformer panel of the switchboard.
- c) One complete bus section panel of the switchboard. Certificate of temperature rise test carried out previously on identical panels may be acceptable.

25.3 ROUTINE TESTS

Routine tests shall be carried out on all items of equipment in accordance with the relevant BSS/IEC.

26 DETAILS OF EQUIPMENT

26.1 FEEDER CONTROL PANEL

Each feeder panel shall include :

- a) One circuit breaker 350 MVA, 3 phase, 11KV 400 amps.
- b) Three current transformers, 400/5A, 15VA minimum capacity, accuracy class 5P10 for over current and earth fault protection and metering.
- c) One cable box for 11KV, 3 core cross-linked polyethylene steel wire armoured PVC served cable size 120 sq.mm to 240 sq.mm.
- d) One circuit breaker control switch located on front of the panel.
- e) Circuit breaker "closed" and "open" red and green indication lamps. (5W 30V DC).
- f) One local/remote selector switch on front of panel.
- g) One healthy trip indication lamp 15 Watts, 30V DC with resistance and push button.

- h) Auto-trip amber indication lamp (30V DC).
- i) Two overcurrent and one earth fault IDMT relay.
- j) One ammeter scaled 0-400 amps - with hand reset maximum demand indicator.
- k) Single shot auto reclose relay 30V DC with time delay of 0 to 5 minutes with counter.
- l) Integral earthing.
- m) One blank circuit label 30cm x 8 cm mounted on front of panel and a small blank circuit label on rear of panel.

26.2 11KV/433V TRANSFORMER CONTROL PANEL

The 11KV/433V transformer control panel shall include :

- a) One circuit breaker 350MVA 3 phase 11KV 400 amps..
- b) Three current transformers 100/50/5A 15VA minimum capacity.
- c) One cable box for 11KVA 3 core cross-linked polyethylene steel wire armoured PVC served cable size 50 sq.mm.
- d) One circuit breaker control switch located on front of the panel.
- e) One local/remote selector switch mounted on front of the panel.
- f) One healthy trip indication lamp, 15 watts, 30 volts DC with resistance and push button.
- g) Circuit breaker “closed” and “open” red and green indication lamps) (5W 30V DC).
- h) Auto trip amber indication lamp (30V DC).
- i) One overcurrent and earth fault relay :
 - i) Overcurrent IDMT 50 to 200%
 - ii) overcurrent instantaneous - 200 to 800%
 - iii) Earth fault instantaneous - 100 to 40%
- j) One ammeter scaled 0-100 amps connected on Y phase.
- k) Integral earthing.
- l) One blank circuit label 30 cm x 8 cm mounted on front of panel and one small blank circuit label on rear of panel.

26.3 BUS SECTION PANEL

The bus section panel shall include :

- a) One circuit breaker 350MVA 1200 Amps 3 Phase 11KV.
- b) Three current transformers 1200/5 VA minimum capacity.
- c) One circuit breaker control switch located on front of the panel.
- d) One local/remote selector switch mounted on front of the panel.
- e) Circuit breaker “closed” and “open” red and green indication lamps (5W 30V DC).
- f) One healthy trip indication lamp 15V 30V DC resistance and push button.
- g) Auto-trip amber indication lamp (30V DC).
- h) One three pole over current relay IDMT 50 to 200%.
- i) One blank circuit label 30cm x 8cm mounted on front of panel and one small blank circuit label on rear of the panel.

26.4

20MVA 33/11.5KV INCOMER TRANSFORMER CONTROL PANEL

Each 20MVA 33/11.5KV transformer panel shall include :

- a) One circuit breaker 350MVA 3 phase 11KV 1200 amps.
- b) Three current transformers class "X" for overall biased differential transformer protection with 1200/0.577 amp secondary ratio and characteristics to suit the characteristic of the current transformers on the 33KV side which shall have a ratio 400/1 amp.
- c) i) Three current transformers for restricted earth fault protection ratio 1200/1 amp class "X". The transformers to match the current transformer on the neutral connection of the 20MVA transformer.
ii) One neutral current transformer 1200/1 amp.
- d) Three current transformers ratio 1200/1 amp 15VA class 5P10 accuracy for metering, reverse power protection and standby earth fault protection.
- e) One cable box pointing vertically downwards suitable to receive six single core 500 sqmm cross linked polyethylene aluminium strip armoured cables complete with cable lugs, gland, all necessary termination materials and sundries for a complete termination.
- f) One circuit breaker control switch located front of the panel.
- g) One local/remote selector switch on front of the panel.
- h) Circuit breaker "closed" and "open" red and green indication lamps (5W 30V DC).
- i) One healthy trip indication lamp 15 W 30 V DC with resistance and push button.
- j) Auto-trip amber indication lamp (30V DC).
- k) One pilot wire protection relay with 15KV isolating transformer with inter trip and pilot supervision equipment to match pilot wire protection at sending end substation. The protection to operate from 400/1 CT's class "X" provided on the 20MVA 33/11.5KV transformer (in the case of 33KV cable feeders only).
- l) One duo-bias differential relay with harmonic restraint.
- m) One high impedance restricted earth fault relay.
- n) One three element reverse power (i.e. directional relay with 90^0 - 45^0 connection and 45⁰ MTA - 5 to 15% settings) with time delay.
- o) One standby earth fault relay IDMT 10 to 40%.
- p) One ammeter scaled 0-1200 amps suitable for connection to 1200/1 amps CT's with selector switch.
- q) One three phase voltage transformer star/star 11000/ $\sqrt{3}$ 110 / $\sqrt{3}$ volts 200 VA per phase class "T" accuracy connected on 11KV incoming supply from 20MVA transformer.
- r) One voltmeter scaled 0-15KV to operate from voltage transformer.
- s) One voltmeter selector switch to read voltages between phases and neutral.
- t) One blank circuit label 30 cm x 8 cm mounted on front of panel and a small blank circuit label on rear of panel.

26.5 CAPACITOR CONTROL PANEL

- a) One circuit breaker 350MVA 3 phase 11KV 400 amp.
- b) Three current transformers 400/5A 15VA minimum capacity. Accuracy class 5P10 for over-current and earth fault protection and metering.
- c) One cable box for 11KV 3 core 240 sq.mm XLPE PVC/SWA/PVC
- d) One circuit breaker control switch located on front of the panel.
- e) Circuit breaker "close" and "open" read and green indication lamps(5W 30V DC).
- f) One local/remote selector switch on front of panel.
- g) One healthy trip indication lamp 15W 30V DC with resistance and push button.

- h) Auto-trip amber indication lamp (30V DC).
- i) Two over-current and one earth fault IDMT relays.
- j) One ammeter scaled 0-400 amps.

27. ADDITIONAL EQUIPMENT

27.1 TESTING PLUGS

The switchboard shall be provide with one set of 3 phase test plugs fully insulated for test voltage usually applied to switchgear cables. Terminals of the test plugs shall be arranged to receive flexible conductors upto 120 sq.mm single core normally used for current injection tests.

27.2 TOOL CABINET

The switchboard shall be provided with a complete set of tools housed in a floor/wall mounting, sheet metal tool cabinet with double leaf doors fitted with handle, locking bar and lock with two keys.

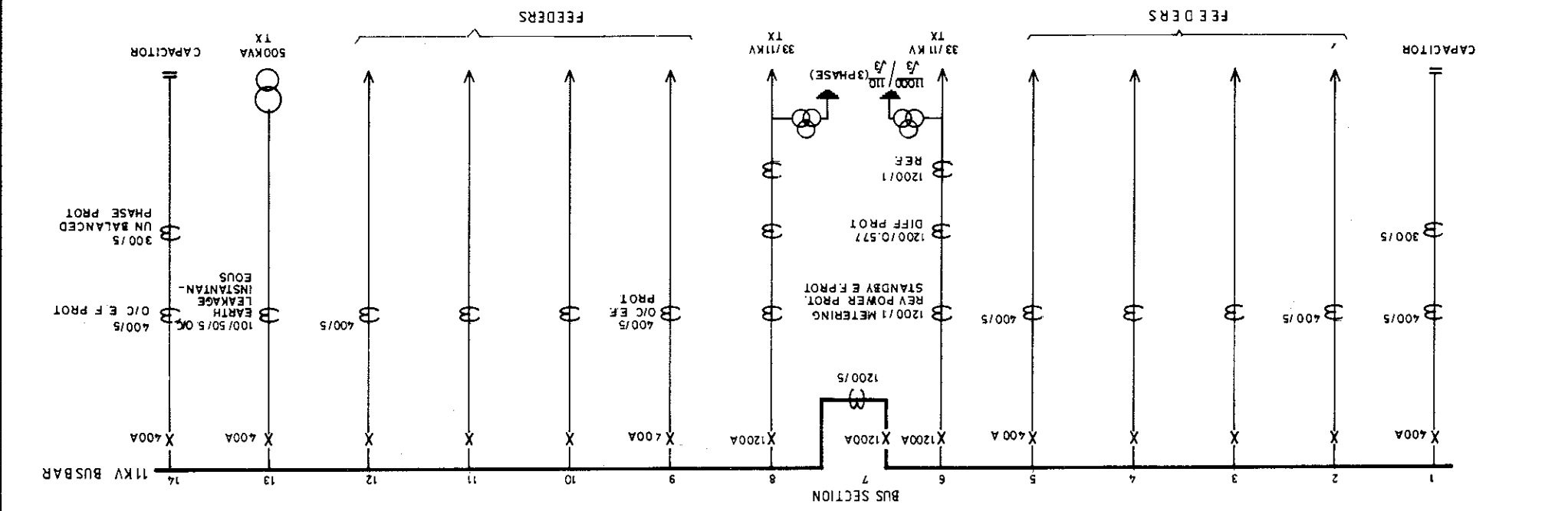
27.3 KEY CUPBOARD

The switchboard shall be provided with a sheet metal wall mounting key cupboard with a single leaf door fitted with locking bar and lock with two keys. The interior of the cupboard shall be arranged to store substation keys on brass hooks and shall be clearly labelled. The key cupboard shall include a log book for record of key issues.

27.4 PERMIT TO WORK LOCKING OFF BOXES

The switchboard shall be provided with two sheet metal, wall mounting boxes, with single leaf doors. The purpose of these boxes is for the storage of switchgear keys together with a copy of the "Permit to work" form issued for purposes of working on equipment and cables. The box shall be approximately 50cm long horizontally x 30cm wide x 15 cm deep and shall be fitted with three horizontal shelves or trays. The door shall be fitted with cylinder type lock with two individual keys. The box shall include six locking off padlocks suitable for bus bars and voltage transformer spout shutters. These shall not be master keyed but will have two individual keys. The locks shall be coloured "Red" and clearly numbered.

SULTANATE OF OMAN		MINISTRY OF ELECTRICITY AND WATER	
SINGLE LINE DIAGRAM 11 KV SWITCH GEAR (TYPICAL)			
DRAWN	CHECKED	FRANCIS	
APPROVED			
DRAWING NO: PL / SLD - E / 61			
SCALE N T S		DATE 10-10-1989	



SCHEDULE
TECHNICAL PARTICULARS & GUARANTEES
11KV 350MVA PANEL SWITCHBOARD

The following technical particulars and construction details of the switchgear shall be filled in. All ratings shall be the minimum rating under site service conditions.

NO.	DESCRIPTION	PARTICULARS			
		Feeder Panel	33/11KV Panel	Bus Section	11KV/433 Volts
1	2	3	4	5	6
A. 11KV Circuit Breaker					
01	Type				
02	Highest system voltage				
03	Service voltage				
04	Normal continuous Rating at normal voltage and frequency under Oman climatic conditions				
05	BSS normal continuous rating at normal voltage & frequency. Amps				
06	Maximum temperature rise of contacts at normal rating and frequency. 0C				
07	Method of closing				
08	Normal voltage of closing coil DC. Volts				
09	Normal current of closing coil. Amps				
10	Minimum voltage of closing coil DC. Volt				
11	Minimum voltage of trip coil DC voltage				
12	Normal current of trip coil DC. Amps				
13	Minimum voltage of trip coil DC. Volts				
14	Breaking capacity				
	Symmetrical current. KA				
	Asymmetrical current. KA				
15	Making current. KA				

SCHEDULE
TECHNICAL PARTICULARS & GUARANTEES
11KV 350MVA PANEL SWITCHBOARD

The following technical particulars and construction details of the switchgear shall be filled in. All ratings shall be the minimum rating under site service conditions.

NO.	DESCRIPTION	PARTICULARS			
		Feeder Panel	33/11KV Panel	Bus Section	11KV/433 Volts
1	2	3	4	5	6
16	Short Currents a) 1 second KA b) 3 seconds KA				
17	Voltage drop across the main contacts at normal full load current - milli volts				
18	Number of series breaks per phase				
19	Type of main contacts				
20	Type of arcing contacts				
21	Type and details of arc control device				
22	Opening time ms				
23	Arc - Duration ms				
24	Breaking capacity 1) 10% syn, breaking capacity 2) 30% - do - 3) 60% - do - 4) 100% - do -				
25	Make - Time ms				
26	Distance between circuit breaker compartment partition shutters and Busbar/Cable circuits contact live parts cm				
27	Material used for circuit breaker bushing insulators				

SCHEDULE
TECHNICAL PARTICULARS & GUARANTEES
11KV 350MVA PANEL SWITCHBOARD

The following technical particulars and construction details of the switchgear shall be filled in. All ratings shall be the minimum rating under site service conditions.

NO.	DESCRIPTION	PARTICULARS			
		Feeder Panel	33/11KV Panel	Bus Section	11KV/433 Volts
1	2	3	4	5	6
28	Material used for spout insulators and minimum clearance to earth in air mm				
29	Type of plug in contacts				
30	Weight of circuit breaker complete Kg				
	B) Bus Bars				
01	Continuous Current carrying capacity under site service conditions Amps				
02	BSS continuous current carrying capacity Amps				
03	Material of Busbars				
04	Cross sectional area of busbar and dimensions of section Sqmm				
05	Details of busbar insulation				
06	Minimum distance between phase busbars and earth mm				
07	Minimum distance between phase bus bars mm				
08	Maximum temperature rise at normal rating and frequency °C				

SCHEDULE
TECHNICAL PARTICULARS & GUARANTEES
11KV 350MVA PANEL SWITCHBOARD

The following technical particulars and construction details of the switchgear shall be filled in. All ratings shall be the minimum rating under site service conditions.

NO.	DESCRIPTION	PARTICULARS			
		Feeder Panel	33/11KV Panel	Bus Section	11KV/433 Volts
1	2	3	4	5	6
C. Weights					
01	Overall dimensions of one complete panel with breaker in position (length x depth x height) x cm				
	a) Feeder Panel cm				
	b) Transformer Panel cm				
02	Space required for complete withdrawal of circuit breaker cm				
03	Minimum space required between the wall and rear of switchgear cm				
Current Transformer					
	a) Type (Wound/Ring)				
	b) Ring				
	i) Main Protection				
	ii) Back-up Protection				
Relays					
01	Type over current/earth fault				
02	Available current IDMTL Overcurrent INST Earth Fault				

SCHEDULE
TECHNICAL PARTICULARS & GUARANTEES
11KV 350MVA PANEL SWITCHBOARD

The following technical particulars and construction details of the switchgear shall be filled in. All ratings shall be the minimum rating under site service conditions.

NO.	DESCRIPTION	PARTICULARS			
		Feeder Panel	33/11KV Panel	Bus Section	11KV/433 Volts
1	Available time setting Relay time of operation of instantaneous earth fault relay time of operation of overcurrent relays at 10 times plug setting Transformer biased differential protection Type and description of system Range of operating coil setting % of CT rating Recommended operating coil setting Sensitivity for earth faults at recommended settings : a) Least sensitivities phase and of CT rating b) Most sensitive phase % of CT rating	3	4	5	6

SCHEDULE
TECHNICAL PARTICULARS & GUARANTEES
11KV 350MVA PANEL SWITCHBOARD

The following technical particulars and construction details of the switchgear shall be filled in. All ratings shall be the minimum rating under site service conditions.

NO.	DESCRIPTION	PARTICULARS			
		Feeder Panel	33/11KV Panel	Bus Section	11KV/433 Volts
1	<p>Sensitivity for phase faults at recommended settings :</p> <p>a) Least sensitive phase % of CT rating</p> <p>b) Phase faults % of CT rating</p> <p>Maximum through fault at which the protection equipment is stable with recommended settings :</p> <p>a) Earth faults %</p> <p>b) Phase faults %</p> <p>Maximum time delay between initiation of fault and energizing of breaker trip current ms</p> <p>Details of magnetizing current bias unit for stability of protection</p> <p>Under switch surges</p> <p>Transformer restricted earth fault protection</p>				
		3	4	5	6

SCHEDULE
TECHNICAL PARTICULARS & GUARANTEES
11KV 350MVA PANEL SWITCHBOARD

The following technical particulars and construction details of the switchgear shall be filled in. All ratings shall be the minimum rating under site service conditions.

NO.	DESCRIPTION	PARTICULARS			
		Feeder Panel	33/11KV Panel	Bus Section	11KV/433 Volts
1		3	4	5	6
	Type of relay :				
	Sensitivity - % of CT rating				
	Magnitude of external phase or earth fault upto which the protection is stable % of CT rating				
	Burden of current Transformer				VA
	Time delay between initiation of fault and energizing of breaker trip coil at twice maximum setting				ms
	Time delay between initiation of fault and energizing of breaker trip coil at 10 times CT rating				ms

TECHNICAL PARTICULARS & GUARANTEES
33KV 1500MVA SWITCHBOARD

S. No.	Description	Feeder	Transformer	Bus Section
B	Type (Wound/Ring) i) Main protection ii) Back-up protection			
C	Ratio i) Main protection ii) Back-up protection			
D	Over current factor			
E	Short time rating			
	F. VOLTAGE TRANSFORMERS			
A	Type			
B	Ratio (limb voltage) i) Star/Star ii) Star/Open Delta			
	G. RELAYS			
A	Overcurrent and earth fault relays i) Type : Over-current Earth fault ii) Available plug setting : Over-current Earth fault iii) Available time setting : Over-current Earth fault iv) Time of operation at 10 Times plug setting : Over-current Earth fault v) Over-current relay connection (angle between voltage and current at unity power factor) vi) Maximum torque angle : Over-current Earth fault			

TECHNICAL PARTICULARS & GUARANTEES
33KV 1500MVA SWITCHBOARD

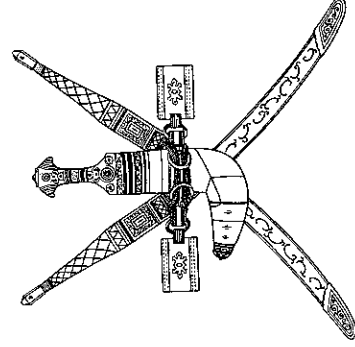
S. No.	Description	Feeder	Transformer	Bus Section
B	Directional relays i) Make ii) Type Over-current iii) Available current setting : Over-current Earth fault iv) Available time setting over-current relay v) Time of operation of instantaneous earth fault relay vi) Time of operation of over-current relays at 10 times plug setting			
C	Distance protection relays i) Type of relay and measuring system ii) Min. setting for near end fault : Single phase to earth Phase to phase Three phase Min. setting for faults at remote end : Single phase to earth Two phase to earth Three phase iii) Min. length of transmission line which can be protected KM iv) Max. length of transmission line which can be protected KM			

TECHNICAL PARTICULARS & GUARANTEES
33KV 1500MVA SWITCHBOARD

S. No.	Description	Feeder	Transformer	Bus Section
v)	<p>Max. time delay between initiation of fault in first zone and energizing of trip circuits</p> <p>a) At a current equal to CT rating</p> <p>b) At a current equal to five times CT rating</p> <p>c) At a current equal to 20 times CT rating</p> <p>Range of adjustment for time delay relays</p> <p>a) Second zone</p> <p>b) Third zone</p>			
vi)	<p>Burden imposed by protective equipment :</p> <p>a) Current circuits at 20 times CT rating VA</p> <p>b) Voltage circuits at normal rated voltage VA</p> <p>Reactive</p> <p>a) Current circuits at 20 times CT rating VA</p> <p>b) Voltage circuits at normal rated V VA</p>			

SULTANATE OF OMAN

MINISTRY OF ELECTRICITY & WATER



33KV INDOOR SWITCHGEAR

STANDARD – OES 15

BRIEF SPECIFICATIONS

Second Edition : January 1995

SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD : OES - 15
33KV INDOOR SWITCHGEAR

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SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD OES - 15
33KV INDOOR SWITCHGEAR

1.0 TYPE

Switchgear shall be of the indoor single busbar, totally enclosed metal-clad type with withdrawable circuit breakers or metal-clad SF6 insulated with vacuum or SF6 circuit breakers for installation in brick built sub-station.

2.0 GENERAL REQUIREMENTS

The switchgear shall comply with the Ministry's General Specifications Standard OES 11.

Switchgear shall be of robust construction and shall be unaffected in part of whole by the forces imposed by short circuit or other current, operation, vibration or temperature changes. The switchgear shall comply with BSS 5227 unless otherwise specified herein, and shall be extensible at both ends. All materials and components used in switchgear shall conform to appropriate IEC 298/BSS 5227. The switchgear shall be designed to facilitate inspection, cleaning, maintenance and repairs. The switchgear shall be of the compartmental design divided into separate compartments for the circuit breaker, the busbars, cable circuit and the low voltage control, protection and metering equipment.

The system voltage, rated symmetrical short circuit and impulse level shall be as follows :

Normal system voltage	33KV
Highest system voltage	36KV
Symmetrical short circuit at rated	26KV
Voltage for sec.	
Impulse level	170KV

3.0 CURRENT RATING

The normal continuous rating of the switchgear and busbars in the climatic conditions obtaining at sites (Clause 0.01 of OES 11), shall be as follows :

All circuit breakers shall be rated for 600 Amps, except for the bus section circuit breaker which shall be rated for 1200 Amps.

All current carrying parts of the switchgear, namely the circuit breaker, bus bars, current transformers, isolating contacts, connections, joints etc., shall be capable of carrying the specified rated current continuously. The temperature rise in any part shall comply with BSS 159 taking into account the site ambient temperatures. Tenderers shall state the BSS rating along side the site rating in each case.

4.0

BUS BARS

The bus bars shall be had drawn high conductivity copper bars silicon rubber insulated. Other covering material of permanent fixage are suitable for climatic and system conditions in Oman are acceptable subject to prior approval. The bus bars shall be site rated for 1200A.

The busbars on the switchgear shall be arranged to permit future extensions at each end.

5.0

CIRCUIT BREAKERS

The circuit breakers shall be of the vacuum type of sulphur hexafluoride SF6. The circuit breakers shall have a guaranteed rupturing capacity of not less than 25KA at 33000 volts and must conform to BSS. Type test certificate for the circuit breakers from an internationally recognised testing authority acceptable to MEW shall be produced.

The circuit breakers shall be provided with AC 240V motor charged spring closing mechanism, 110V DC spring release coil 110V closing coil and 110V DC shunt trip coil and shall include the following :

- Facility for manual charging of spring
- Spring charged/uncharged indicator
- Local barrel type control switch
- Mechanical ON/OFF indicator
- Red and green ON/OFF indicator lamps (5 watt 110V DC)

6.0

CIRCUITS

Each circuit breakers shall control either a feeder circuit or transformer circuit (20MVA) or for bus section 1200 Amps arrangement of switchgear circuits for a typical 33/11KV substation comprising 9 panels, when viewing the switchboard from the front and reading from left to right, shall be as follows :

- | | | |
|--------------|------------------|---------------------------------------|
| - Panel Nos. | 1, 2, 3, 7, 8, 9 | For Feeder Control |
| - Panel Nos. | 4 and 6 | For 20MVA 33/11KV transformer control |
| - Panel No. | 5 | Bus-section panel |

7.0

CURRENT TRANSFORMERS

Current transformers shall be air or resin insulated and conform to BS 3938/IEC 185. Current transformers shall be so rated and designed that they shall not sustain any damage due to through fault currents expected on a system fault level of 25KA. All secondaries shall be one ampere.

a) Each Feeder Panel

- One 3 phase set 400/1 Amp 15VA (minimum) Class 5P10 accuracy for metering and over-current and earth fault protection.
- One 3 phase set 400/1 Amp class 'X' for distance protection.

b) Bus Section Panel - 1200/1 Amp

One 3 phase set of 1200/1 Amps current transformers 15VA (minimum) class 5P10 accuracy for metering and over-current protection.

c) Each 33/11.5KV Transformer Panel

- i) One 3 phase set of current transformer 400/1 Amp class 'X' for biased differential protection of the transformer.
- ii) One 3 phase set of current transformers ratio 400/1 Amp 15VA (minimum) class 5P10 accuracy for metering, over-current and earth fault protection.

The current transformers offered for differential protection shall operate satisfactorily with the current transformers on the 11KV side. Characteristic curves of the current transformers shall be submitted with each tender and shall be subject to the approval of MEW. Test Certificates shall be provided for each current transformer supplied.

The tenderer shall state the current transformers offered will operate satisfactorily with their associated protection devices. Confirmation of the suitability of the current transformers shall be obtained from the manufacturer of the protective system and submitted for approval of MEW.

The capacity of each current transformer shall be determined by the manufacturer of the switchgear and shall be adequate for the full burden of the connected apparatus plus an overload of 50 percent indefinitely in the worst temperature conditions at site. No current transformer shall however, have a capacity less than 15VA.

8.0 33KV VOLTAGE TRANSFORMERS

Voltage transformers at feeder circuits shall be 3 phase fully insulated star/star/broken delta ratio

$$\frac{33000}{\sqrt{3}} / \frac{110}{\sqrt{3}} / \frac{110}{3}$$

200VA per phase class 1 accuracy. The voltage transformer shall be preferably of the draw out type fitted with worm gear/rollers and draw out handle to facilitate withdrawal and conform to BS 3941/186 IEC. Cartridge type secondary fuses or mcb's shall be provided.

9.0 METAL-CLAD SF6 INSULATED SWITCHGEAR (GIS)

The gas insulated switchgear shall in general comply with the requirements in Clauses 2 to 8 where applicable. In addition the specific requirements for this type of switchgear shall be as follows :

Switchgear shall be metal-clad and shall include bus bar circuit isolating switches, circuit earthing switches as well as the current and voltage transformers as required in the details of equipment.

All high voltage parts inside the switchgear shall be insulated from the earthed outer enclosure by SF6 gas. SF6 gas pressure shall be stated.

Bus bars and connections shall be of copper and of sufficient sections to withstand the mechanical and thermal stresses due to short circuits. The busbars shall be mounted on insulators. The individual phase bus bar shall be contained in separate, continuous bus bar chamber, each phase chamber having its own gas monitoring.

Each individual phase circuit breaker housed in a separate housing with its own monitoring. Each gas filled chamber shall have its individual SF 6 pressure monitoring so that any leakage may be quickly localised.

The gas tight bushings between gas filled chambers should furthermore confine any internal faults to the respective section of switchgear. Each gas compartment shall be capable of withstanding a fault arc of less than 1.0 Sec. duration. Facilities shall be provided in each compartment of the switchgear to allow for a pressure relief and a high degree of protection under fault condition. It shall be ensured that no body standing in front of the switch gear is exposed to any danger. Particular attention shall be paid to the sealing of all gas filled chamber joints so that the SF6 gas leakage is extremely low. All seals and gaskets shall be designed for a leakage not exceeding 1% per annum referred to each compartment.

The switch board shall be equipped with a gas supervising unit on each switchgear panel for monitoring and checking SF6 from a common service connection.

Individual phase circuit breakers shall be operated by 240 volt AC motorised operating mechanism, with a common shaft for simultaneous three phase operation, arranged for operation from the front of the panel, with mechanically linked indicator on the panel.

Fully interlocked three phase isolators with motorised operating mechanism, shall be provided for bus bar isolation and for circuit earthing through circuit breaker. Interlocks shall ensure that the isolators cannot be operated unless the circuit breaker is open. Facilities should be provided for integral earthing of either bus bar section through the bus section circuit breaker.

33KV cable termination shall be of the plug-in sealing end type suitable for copper conductor XLPE insulated PVC sheathed and armoured cables. The termination shall permit easy removal of the cable from the switchgear for isolation and testing.

10.0 CONTROL AND RELAY BOARD

Control and relay equipment shall be mounted on a separate control and relay board.

The combined control and relay board shall incorporate the protective gear, and all necessary control and indication facilities.

Each cubicle of the board shall form a complete enclosure accommodating the associated equipment.

The cubicles shall be self supporting floor standing complete with foundation bolts, and shall provide for bottom entry of power and control cables, through bottom plate and compression type brass glands for single wire armoured power and multicore control cables.

Cubicles shall include the cable glands. The cubicles shall be provided with rear access door. The inside shall be finished with a matt white surface and shall include a lamp controlled by a door operated switch. The outside shall be finished semi matt to colour Eau de Nil BS 381 No. 216.

11.0 PROTECTION

11. FEEDER CIRCUIT

- i) a) Distance Protection for overhead line feeders
- b) Pilot Wire Protection for underground cable feeders
- ii) Directional IDMT overcurrent and earth fault relays of the inverse current definite minimum time type. The IDMT over-current relays to have current range 50% to 200% in steps of 255 and time setting adjustable from zero to 3 seconds at ten times current setting and shall have characteristics to BSS 142. The voltage coil of relay shall be rated for 110V AC. The relay connection shall be 90 degrees leads.

The earth fault relays to have a current range from 20% to 80% in steps of 20% and time setting adjustable from zero to 3 seconds at ten times current setting and shall have characteristics to BSS 142. The voltage coil of the relay shall be rated for 110V AC. The relay shall be adequately compensated for power factor under feeder earth.

i) a) Distance Protection

Distance Protection for 33KV overhead line feeder circuits shall be of high speed type with 1 Amp rating.

The ensure necessary safety of the protection system, the following criteria shall be strictly observed.

- Relay shall be switched type covering phase and earth fault with a single common measuring element.
- The protection shall detect phase and earth faults.
- A switch on fault facility shall provide an instantaneous trip if the line is energised onto a three phase with line VT's.
- Transient over-each shall be reduced to less than 5%, thus allowing increased zone 1 setting, without mal-operation on external faults.
- Relay shall have quadrilateral characteristics for phase to earth faults and Mho characteristics for phase faults.
- Measuring elements of the polarized MHO type shall be provided.
- Undesired tripping on power swings shall be avoided.
- To detect faults with currents less than the rated current, the protection shall be equipped with impedance starters.
- The relay should have on line test facility
- P.T. fuse failure blocking and alarm should be provided.

b) **Pilot Wire Protection**

Pilot wire protection for underground cable feeders.

Pilots wire protection insulated to 15KV to match with Pilot Wire Protection provided at the other end of the feeder.

Pilot wire protection relay (15KV) shall be provided complete with :

- Surge proof inter-tripping relay (send)
- Surge proof inter-tripping relay (receive)
- Surge proof supervision equipment

11.2 20MVA 33/11KV TRANSFORMER PANEL

The transformers are 33/11KV Delta/Star group Dyn11 connected with on-load tap changer, tap range being -15% to +5%.

Protection shall comprise :

- i) Overall biased differential protection to cover 33 and 11KV windings. The current transformer offered for the 33KV side shall operate satisfactorily with the current transformers on the 11KV side.

The protection shall incorporate harmonic restraint and shall remain stable during magnetizing inrush surges without introducing an intentional time delay during fault operation.

The protection shall also incorporate percentage bias to cater for out-of-balance current due to tap changing.

- ii) Each transformer circuit shall be protected with over-current relay comprising three elements and one earth leakage instantaneous relay.

The over-current relay to have a current range from 50 to 200% in steps of 25% and time setting adjustable from zero to 3 seconds at ten times current settings and shall have characteristics to BSS 142.

The earth leakage unit shall be an instantaneous relay with current range from 10 to 40% and operating time of 0.01 seconds at three times setting.

11.3 BUS SECTION PANEL

The bus section panel on the switchboard shall be provided with three over-current relays of the inverse definite minimum time type with a current range from 50 to 200% in steps of 25% and time setting adjustable from zero to 3 seconds at ten times current rating.

11.4 GENERAL

All relays shall be flush mounting pattern self resetting, draw out type with hand re-set flag indicators or light emitting diodes and shall be accommodated on the control and relay board in the front. the relay shall be of the electro-magnetic or electronic type.

12.0 SYNCHRONISING

Manual synchronising facilities are required on 33KV feeder circuit breakers.

The system provided is to be to the approval of the Purchaser and is to be such that the synchronising of circuit must be established before the circuit breaker can be closed.

Synchronising check relays to prevent circuit breaker closing out of synchronism are to be included in each feeder circuit. Synchronising check relays shall check the phase and magnitude of the voltage difference at synchronising to prevent inadvertent manual closing outside acceptable limits. Means shall be provided at the synchronising panel to by-pass these relays when switching dead equipment or lines, together with warning lamp indication that the relays are out of circuit.

13.0 33KV CABLE TERMINAL BOXES

The cable and terminations shall be suitable for 33KV cables 3 core 300 sq.mm stranded copper XLPE/PVC/SWA/PVC. The cable terminations shall be complete with gland armour clamps, connecting copper bonding straps, cable lugs and all necessary making off material.

Cable terminations shall be separated from all other compartments such as CT chambers, busbar compartments etc.

The cable boxes shall be so positioned that the cable glands are clearly and sufficiently off-set from the switchboard to facilitate easy entry of the 33KV cable directly from the substation trench, obviating the need for a special slot for cable entry either in the floor or switchboard base plate. A channel iron bracket with cleat shall be provide for cable support.

14.0 BUS WIRES

The following bus wires of appropriate copper section, in no case less than 25 sq.mm PVC insulated in appropriate colour code shall be provided on the switchboard.

- DC trip circuit
- DC closing spring release coil circuit
- Remote group alarm circuit
- Circuit breaker close and open red and green lamp indication circuit (110V DC)
- Circuit breaker panel heater circuit (240V AC)
- DC auto trip amber lamp indication circuit

The bus wires shall be neatly cleated and terminated on both sides of each individual panel on terminal blocks with adequately rated terminal studs complete with all necessary provisions for inter panel connection.

15.0 LABELS AND SECONDARY FUSES

Each panel of the switchboard shall have a blank circuit approximately 30cm x 8cm mounted on the front of the panel in a prominent position. These label shall be made of suitable engraving material approximately 2mm thick, white surface with black engraving. Small blank labels of similar material shall be mounted on the rear of the panels. The circuit names shall be engraved at site later. All other labels shall be of similar material and engraved in English.

All necessary fuses and links shall be supplied and they shall be fitted with clearly legible label indicating the circuit and shall be grouped according to their functions to facilitate identification. Fuse label shall indicate the current rating of the fuses and code symbols shall correspond with the diagrams. All secondary fuses shall be of the cartridge type to BSS 88.

M.C.B.'s in lieu of fuse are acceptable.

16.0 ISOLATION AND INTERLOCKS

Switchboard shall be provided with approved means of isolation of circuit breakers and circuits and be complete with automatic shutters to screen off all live parts. The switchgear shall be fully interlocked to prevent mal-operation. To obviate unauthorised operations, locks each with two keys of approved make, shall be included for :

- a) Locking out each circuit breaker in the isolated or off position
- b) Locking movable shutter screening live parts (lock to be coloured red)
- c) Locking circuit breakers controls switch
- d) Locking voltage transformer in the rack in position
- e) Locking voltage transformer spout shutters

All locks to differ and have individual keys.

To facilitate phasing out of any incoming circuits against the bus bars, arrangements shall be provided to enable manual opening or closing any of the related shutters independently with the circuit breaker withdrawn and for locking any of these shutters independently in the open or closed position.

17.0 CIRCUIT BREAKER ISOLATING EQUIPMENT

The circuit breaker isolating equipment shall be integral part of the circuit breaker. Suitable external guide rails shall be supplied for fixing in the substation in front of the switchgear carriage while inserting or removing from the board.

18.0 INTEGRAL EARTHING

Integral means shall be provided in the switchboard for circuit and busbar earthing preferably through circuit breaker. The earthing shall be complete with all necessary mechanical inter-locks to prevent mal-operation.

Earthing of bus bar shall be arranged such that earth cannot be applied till all circuit breakers of that bus section including bus section bracket are tripped and brought to test position.

19.0 EARTHING

The switchboard shall be provided with a copper earth bar of sectional area not less than 50mm x 6mm. All metal instrument and relay cases on the panels, shall be connected to the earth bar by copper conductors not less than 2.5 sq.mm cross section.

20.0 HEATERS

In view of the high humidity prevailing at the sites, each panel shall be provided with suitably rated heater for operation from 240V AC supply and arranged for cutting in when the breaker is off or isolated. This is to prevent condensation on breaker bushings, spout insulators etc.

21.0 INSTRUMENTS

Dial type, full deflection 270° 96 x 96mm switchboard pattern, flush mounting type moving iron voltmeters and ammeters shall be provided.

22.0 AUXILIARY SWITCHES

Auxiliary switches shall be provided to interrupt DC supply to trip coil immediately after their operation has been completed.

All necessary auxiliary switches for control, protection and indication for supervisory control which may be adopted at a future date, shall be provided on each circuit breaker panel plus two spare ways normally close and two spare ways normally open. The auxiliary switches shall be wired to a suitable terminal blocks on the panel.

23.0 HEALTHY TRIP INDICATION

15 Watt 110V DC lamp with series limiting resistance operated through a spring loaded push button test switch shall be provided on each circuit breaker panel. Alternative continuously monitoring scheme with low consumption (less than 5 MA) may be provided for consideration.

24.0 SUPERVISORY LOCAL/REMOTE SELECTOR SWITCH

A local/remote selector switch shall be provided on each circuit breaker panel to facilitate control of the breaker from a remote location. In supervisory position the controls will get transferred to future scada.

25.0 TEST TERMINAL BLOCKS

Current transformer secondary wiring shall be connected through terminal blocks with change-over links to permit easy testing.

The terminal block shall be mounted in front of the panel and suitably insulated and provided with a detachable dust proof cover.

26.0 REMOTE ALARM

It is proposed to install SCADA at a later date remote alarm and indication of the automatic tripping of any circuit breaker in the substation. Circuit breaker automatic tripping shall close a two wire circuit to operate an alarm relay. For this purpose each circuit breaker control switch shall have necessary auxiliary contacts to enable resetting of the remote alarm being effected by the control switch.

27.0 SMALL WIRING

All wiring shall be 2.5 sq.mm stranded copper conductor, 600V tropical grade PVC insulated. All small wiring shall be suitably terminated and fitted with captive identification ferrules and marked with circuit number. Trip circuit shall have an additional ferrule coloured red and marked "Trip".

Each circuit identification number shall be suffixed with the panel identification letter. All terminal blocks shall be provided with detachable covers. The trip circuit cables shall be coloured black. The current transformer secondary wires shall preferably be coloured with their respective phase colours.

28.0 TESTS

28.1 Type Test

Type test certificate from an internationally recognized authority shall be produced as evidence that the circuit breaker has been successfully tested to BSS 5311/IEC 298 on its own structure, complete with isolating features, with vent outlets forming part of the unit and with the main connections and bus bars. The certificate shall include the test results and details of the circuit breaker performance during the tests.

28.2 Temperature Rise Test

Temperature rise test shall be carried out in accordance with BSS on the following panels :

- a) One complete feeder panel of the switchboard.
- b) One complete bus section panel of the switchboard.

Certificate of temperature rise test carried out previously on identical panels may be acceptable.

28.3 Routine Test

Routine tests shall be carried out on all items of equipment in accordance with the relevant BSS/IEC.

29.0 DETAILS OF EQUIPMENT

29.1 33KV Switchboard

29.1.1 Feeder Control Panel

Each feeder panel shall include :

- a) One circuit breaker 25KA, 3 phase, 33KV 600 Amps.
- b) Three current transformers 400/1A 15VA minimum capacity, accuracy class 5P10 for over-current and earth fault protection and metering.
- c) Three current transformers 400/1A class "X" for distance protection of overhead line feeders for pilot wire protection of underground cable feeders, characteristics matching the current transformers at the other end.
- d) One cable box for 33KV, 3 core cross-linked polyethylene steel wire armoured PVC served cable size 300 sq.mm.

- e) One circuit breaker control switch located on front of the panel.
- f) Circuit breaker “closed” and “open” red and green indication lamps (5W 110V DC).
- g) One local/remote selector switch on front of panel.
- h) One healthy trip indication lamp 15 watts, 110V DC with resistance and push button.
- i) Auto-trip amber indication lamp (5W 110V DC).
- j) Integral earthing.
- k) One blank circuit label 30cm x 8 cm mounted on front of panel and a small blank circuit label on rear of panel.
- l) 3 phase voltage transformer Star/Star/broken Delta
33000 / 110 / 110 V 200 V A/phase.

$$\frac{\sqrt{3}}{\sqrt{3}} \quad 3$$

29.1.2 Bus Section Panel

The bus section panel shall include :

- a) One circuit breaker 25KA 1200 Amps 3 phase 33KV.
- b) Three current transformers 1200/1A VA minimum capacity.
- c) One circuit breaker control switch located on front of the panel.
- d) One local/remote selector switch mounted on front of the panel.
- e) Circuit breaker “Closed” and “Open” red and green indication lamps (5W 110V DC).
- f) One healthy tip indication lamp 15W 110V DC resistance and push button.
- g) Auto-trip amber indication lamp (5W 110 DC).
- h) One blank circuit label 30cm x 8cm mounted on front of panel and one small blank circuit label on rear of panel.

29.1.3 20MVA 33/11.5KV Transformer panel shall include :

- a) One circuit breaker 25KA 3 phase 33VK 600 Amps.
- b) Three current transformers class “X” for overall biased differential transformer protection with 400/1Amp secondary ratio and characteristics to suit the characteristics of the current transformers on the 11KV side which shall have a ratio 1200/577 amp.
- c) Three current transformers ratio 400/1 Amp 15VA class 5P10 accuracy for metering, over-current and earth fault protection.
- d) One cable box pointing vertically downwards suitable to receive three core 300 sq.mm cross linked polyethylene PVC/steel wire armoured/PVC served cables complete with cable lugs, gland, all necessary termination materials and sundries for a complete termination.
- e) One circuit breaker control switch located on front of the panel.
- f) One local/remote selector switch on front of the panel.
- g) Circuit breaker “closed” and “open” red and green indication lamps (5W 110V DC).
- h) One healthy trip indication lamp (15W 110V DC) with resistance and push button.
- i) Auto-trip amber indication lamp (5W 110V DC).
- j) One blank circuit label 30cm x 8cm mounted on front of panel and a small blank circuit label on rear of panel.

29.2 Control and Relay Board

29.2.1 Equipment for 33KV Feeder Circuit

The control and relay equipment shall include :

- a) Section of mimic including bus and circuit isolation discrepancy type position indication.
 - b) Circuit breaker “closed” and “open” red and green indication lamps (5W 110V DC).
 - c) Fault trip Amber indication lamps (5W 110V DC).
 - d) Local/remote/supervisory selection switch.
 - e) Ammeter selector switch.
 - f) Ammeter scaled 0-400A.
 - g) Voltmeter scaled 0-40KV with fuses.
 - h) Voltmeter selector switch.
 - i) One healthy trip indication lamp (15 watts 110V DC) with resistance and push button.
 - j) One directional two pole over-current and one earth leakage relay for incoming feeder/plain over-current and earth leakage for outgoing feeder.
- | | | | |
|-----|-----------------------------|-----------|--------------|
| i) | Overcurrent IDMT 50 to 200% | - | two elements |
| ii) | Earth leakage | 20 to 80% | one element |
- k) Distance protection relay for overhead line feeder/pilot wire protection 15KV with pilot supervision for under ground.
 - l) One blank circuit label 20cm x 6 cm mounted on front panel and one small circuit label on rear of panel.
 - m) One single shot auto reclose relay 110V DC with time delay of 0 - 5 minutes along with counter.

29.2.2 Equipment for 33/11KV Transformer Control Circuit

The control and relay equipment for 33/11KV transformer control shall include :

- a) Section of mimic diagram including bus and circuit isolation discrepancy type position indication, circuit breaker control discrepancy type switch.
 - b) Circuit breaker “closed” and “open” and green indication lamps 5W 110V DC.
 - c) Fault trip amber indication lamp (5W 110V DC).
 - d) Local/remote supervisory selector switch.
 - e) Ammeter selector switch.
 - f) Ammeter scaled 0-400 Amps.
 - g) One healthy trip indication lamp (15W 110V DC) with resistance and push button.
 - h) One over-current and earth leakage relay.
- | | | |
|-----|--|------------|
| i) | Overcurrent IDMT 50 to 200% (three elements) | |
| ii) | Earth leakage instantaneous | 10 to 40 % |
- j) Master trip relay for tripping 33KV and 11KV circuit breakers controlling the transformer.
 - k) One blank circuit label 20cm x 6 cm mounted on front of panel and one small circuit label on rear of panel.

29.2.3 Equipment for 33KV Bus Section

The control and relay equipment for 33KV bus section shall include :

- a) Section of mimic diagram including bus and circuit isolation discrepancy type control switch.
- b) Circuit breaker “closed” and “open” red and green indication lamps (5W 110V DC).
- c) Fault trip amber indication lamp (5W 110V DC).
- d) Remote/supervisory selector switch.
- e) Ammeter selector switch.
- f) Ammeter scaled 0-1200 Amps.
- g) One healthy trip indication lamps (15W 110V DC) with resistance and push button.
- h) One three pole overcurrent relay IDMT 50 to 200%.
- i) One blank circuit label 20cm x 6cm mounted on front of panel and one small circuit label on rear of panel.
- j) One voltmeter scaled 0-40 KV for each busbar section.

30.0 SYNCHRONISING SWING PANEL

Hinged panel mounted in a suitable location on the control panel, complete with check synchronising relays, synchronising lamps, voltmeter, switches, wiring labels etc.

31.0 ADDITIONAL EQUIPMENT

31.1 Testing Plugs

The switchboard shall be provided with one set of 3 phase test plugs fully insulated for test voltage usually applied to switchgear cables. Terminals of the test plugs shall be arranged to receive flexible conductors upto 120 sq.mm single core normally used for current injection tests.

31.2 Tool Cabinet

The switchboard shall be provided with a complete set of tools housed in a floor/wall mounting, sheet metal tool cabinet with double leaf door fitted with handle, locking bar and with two keys.

31.3 Key Cupboard

The switchboard shall be provided with a sheet metal wall mounting key cupboard with a single leaf door fitted with locking bar and lock with two keys. The interior of the cupboard shall be arranged to store substation keys on brass hooks and shall be clearly labelled. The key cupboard shall include a log book for record of key issues.

31.4 Permit to Work Locking Off Boxes

The switchboard shall be provided with two sheet metal, wall mounting boxes, with single leaf doors. The purpose of these boxes is for the storage of switchgear keys together with a copy of the “Permit to Work” form issued for purposes of working on equipment and cables. The box shall be approximately 50cm long horizontally x 30 cm wide x 15 cm deep and shall be fitted with cylinder type lock with two individual keys. The box shall include six locking off pad locks suitable for busbars and voltage transformer spout shutters. These shall; not be master keyed but will have two individual keys. The locks shall be coloured “Red” and clearly numbered.

TECHNICAL PARTICULARS & GUARANTEES
33KV OUT DOOR BREAKERS

S. No.	Description	Feeder	Transformer	Bus Section
A) 33KV CIRCUIT BREAKER				
01	Type			
02	Service Voltage			33KV
03	Normal continuous rating at normal voltage and frequency under Oman climatic conditions			Amps
04	BSS normal continuous rating at voltage and frequency			Amps
05	Max. temperature rise of contacts at normal rating frequency			°C
06	Method of Closing			
07	Normal current of closing coil			Amps
08	Normal voltage of closing coil			DC V
09	Normal voltage of trip coil			DC V
10	Min. of voltage of trip coil			Volts
11	Normal current of trip coil			Amps
12	Breaking capacity			
	a) Symmetrical current			KA
	b) Asymmetrical current			KA
13	Making current			KA
14	Short time current			
	a) 1 second			KA
	b) 3 seconds			KA

TECHNICAL PARTICULARS & GUARANTEES
33KV OUT DOOR BREAKERS

S. No.	Description	Feeder	Transformer	Bus Section
15	Number of series breaks per phase			
16	Voltage drop across the main contacts at normal full load current			
17	Type of main contacts			
18	Type of arcing contacts			
19	Type and details of arc control device			
20	Material used for circuit breaker bushing insulators			
21	Material used for spout insulators and minimum clearance to earth in air			mm
22	Type of plug in contacts			
23	Weight of circuit breaker complete			Kgs
B. BUS BARS				
01	Continuous current carrying capacity under site service conditions			Amps
02	BSS continuous current carrying capacity			Amps
03	Material of busbars			
04	Cross sectional area of busbar and dimension of section			Sq.mm
05	Min. distance between phase busbars and earth			mm

TECHNICAL PARTICULARS & GUARANTEES
33KV 1500MVA SWITCHBOARD

S. No.	Description	Feeder	Transformer	Bus Section
06	Min. distance between phase busbars	mm		
07	Max. temperature rise at normal rating and frequency	0C		
C. WEIGHTS				
1	Approx. weight of heaviest part to be lifted during erection	Kgs		
2	Weight complete panel including the circuit breaker	Kgs		
D. DIMENSIONS				
1	Overall dimensions of one complete panel with breaker in position (length x depth x height)			
	a) Feeder panel		CM	
	b) Transformer panel		CM	
	c) Bus section		CM	
2	Space required for complete withdrawal of circuit breaker		CM	
3	Min. space required between the wall and rear or switch gear		CM	
E. CURRENT TRANSFORMERS				
A	Class			
	i) Main protection			
	ii) Back-up protection			

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SINGLE LINE DIAGRAM FOR
 33 KV SWITCHGEAR
 (TYPICAL)

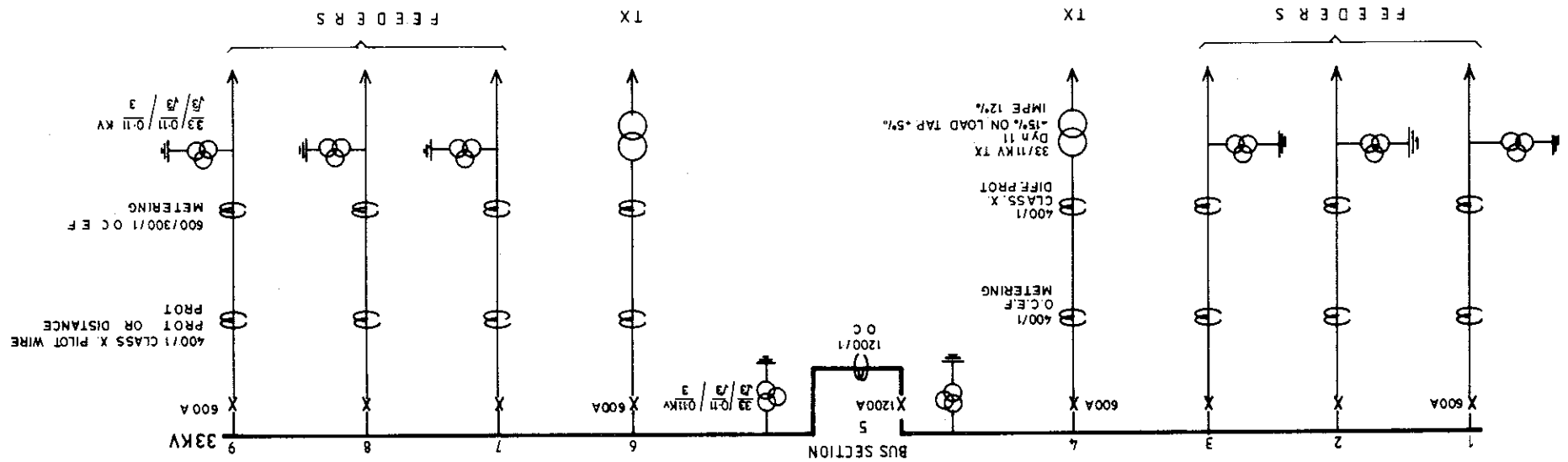
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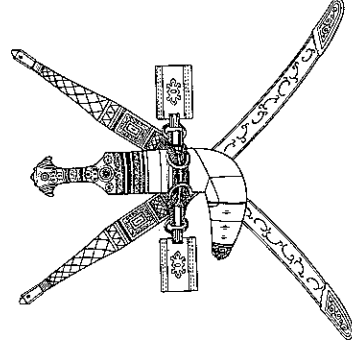
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SULTANATE OF OMAN

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**11KV OUTDOOR RING MAIN
SWITCHGEAR**

STANDARD – OES 19

BRIEF SPECIFICATIONS

Second Edition : January 1995

SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD : OES - 19
11KV OUTDOOR RING MAIN SWITCHGEAR

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SULTANATE OF OMAN
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STANDARD OES - 19
11KV OUTDOOR RING MAIN SWITCHGEAR

1 GENERAL

The equipment shall in general conform to MEW standard OES-11.

The switchgear shall comprise :

- Two three phase ring main switches 400 amps.
- One three phase tee-off switch 150 amps with HRC fuses.

All three switches and the fuse assembly shall be oil immersed.

Alternatively, switchgear shall have SF6 gas for insulation and current interruption, with either HRC fuses in air or SF6 circuit breaker for tee-off circuit.

The switchgear shall be metal-clad, weatherproof and shall comply with the recommendation of IEC 144 degree of protection IP54.

The switchgear shall be extensible on both sides.

2 11KV SWITCHES / CIRCUIT BREAKER

The 11KV switches/circuit breaker shall have the following definite positions.

- ON
- OFF / EARTH OFF
- EARTH

The operating shaft shall be capable of being padlocked only when it is in any one of the above definite positions.

The switches shall be spring assisted, the operation being initiated manually, but the speed of closing and opening being independent of the operator's speed of action, in switchgear where switch fuse is provided for the tee-off circuit, a tripping device shall be included to trip out the switch and open out all three phases, if fuse link on any one phase blows.

The ring main switches and tee-off switch/fuse/circuit breaker shall meet the following requirements as minimum :

- Rated voltage - 11KV
- Highest system voltage - 12.5KV
- Impulse withstand voltage - 75KV (1/50 wave)
- Power frequency test - 27KV

Rated normal current (site rating) :

Ring main switch - 400 amps

Tee-off switch/circuit breaker - 150 amps

Fuse rating on Tee-off switch fuse - 63 amps

Tee-off circuit transformer rating : 1000KVA

Rated breaking current of ring main switch - 400 amps

Fault rating (line and earth switches) - 350MVA at 11KV

Rated short time current for 3 secs.

– All switches including ring main earth switches - 18.4 KA

– Tee-off earth switch - 2 KA.

3 OPERATION AND INTERLOCKS

The complete 11KV switchgear unit shall be arranged for front operation and indication.

Fool proof, positive interlocks shall be provided to prevent the following :

- i) Direct operation of switching or tee-off switch fuse / circuit breaker from ON to EARTH ON OR from EARTH ON to ON
- ii) Switch access or test access cover being opened unless switch or switch fuse is in EARTH-ON position.
- iii) Operation of switch or tee-off switch fuse/circuit breaker at EARTH ON position to OFF/EARTH OFF.
- iv) Insertion or removal of test plugs unless the switch/circuit breaker is in EARTH position.
- v) Application of fuse earths while switch-fuse is in ON position.
- vi) Access for fuse replacement if switch-fuse is in ON position.
- vii) Operation of the switch-fuse to ON position with a blown fuse, a fuse link not properly inserted, fuse earths applied, or fuse cover not closed.

4 SF6 SWITCHGEAR

Each discrete SF6 gas chamber shall be fitted with a pressure gauge which shall be adequately protected from mechanical damage. Gas leak shall be less than 1% per annum.

5 CABLE BOXES

For the two ring main circuits and tee-off circuit of the switchgear, cable boxes shall be provided. The cable box terminations shall be dry type without the need for compound filling. Cable boxes shall be complete with all necessary fittings, compression type cable lugs and glands, terminal boots armour clamps, earth bonding copper strips, insulating tapes, sundries, for complete termination.

The cable box for the ring main circuit shall be suitable for 3 core XLPE PVC SWA PVC cable size range 185 to 300 sq.mm copper.

The cable box for the tee-off circuit shall be suitable for 3 core XLPE PVC SWA PVC cable 50 sq.mm copper.

6 TESTING FACILITIES

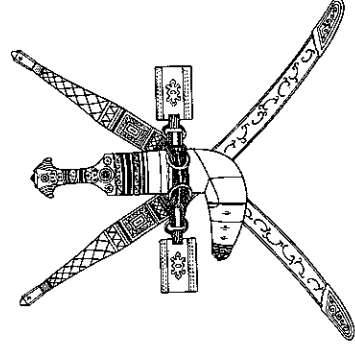
Set of three phase test plugs shall be provided for high voltage/insulation resistance/primary injection testing. Test plug current rating shall not be less than 200 amps.

7 EARTH FAULT INDICATOR

One ring main circuit of the 11KV switchgear shall be complete with an earth fault indicator together with the relative core balance current transformer (one set per switchgear unit).

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33KV OUTDOOR BREAKERS

STANDARD – OES 34

BRIEF SPECIFICATIONS

Second Edition : January 1995

SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD : OES - 34
33KV OUTDOOR BREAKERS

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SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD OES - 34
33KV OUTDOOR CIRCUIT BREAKERS

1.0 GENERAL

Circuit breakers shall be outdoor metal/porcelain clad vacuum type or SF6 type. The circuit breaker shall have a guaranteed rupturing capacity of 25KA at 33000 volts and must conform to BS-5311/IEC-56 and with degree of protection IP-55. Also should generally conform to OES-11 : General Specifications for Electrical materials and Equipment.

Each phase of three phase circuit breaker shall be self contained in an earthed metal/porcelain casing with common operating mechanism.

In the event of SF6 installation, gas pressure to be indicated and necessary safety devices to be provided against fall in pressure of SF6.

2.0 RATING

Circuit breaker shall be suitable for climatic conditions of Oman stipulated in OES-11, Clause 01 and shall comply with the following :

Normal system voltage	:	33KV
Highest system voltage	:	36KV
Symmetrical short	:	25KA for 3 seconds
Circuit current	:	
Normal current	:	600A/1200A depending upon duty (feeder or bus section)
Impulse level	:	170KV
Rated frequency	:	50Hz
Number of Phases	:	3

3.0 OPERATING MECHANISM

The circuit breakers shall be provided with 240V, 50/s. A.C., motor charged spring closing mechanism with 110/30V D.C. closing coil and shunt trip coils and shall include the following :

- Facility for manual charging of spring
- Spring 'charged', 'uncharged' indicators
- Local pistol grip type ON/OFF control switch
- Manual ON/OFF indicator lamps suitable for 240V 50 c/s A.C.
- Trip healthy indicating lamps of minimum watts or LED with series limiting resistance operated either through a spring loaded push button test switch or a continuous monitoring with minimum drain on DC system.

- Local/Remote switch for control of breaker from remote panel
- Mechanical counter for indicating number of opening operations.

Note

Auxiliary D.C. voltage shall be 110V or 30V D.C. depending on the availability.

4.0 OPERATING CUBICLE

The sheet metal operating cubicle shall be provided. The cubicle shall be weather proof, housing operating mechanism, drive linkages, control switches, auxiliary switches and ancillary equipment.

The main access door shall be provided with pad locking arrangement. An inspection window with vandal proof glass shall be provided to view mechanism indicators. The degree of protection of cubicle shall be IP-55.

The operating cubicle shall be supported on galvanised steel structure with minimum galvanising thickness of 127 microns and overall height of the complete circuit breaker and operating cubicle assembly shall be at least 3.0 metre from live part of bushing and fixing feet.

5.0 TERMINAL BUSHINGS

Outdoor bushings of circuit breaker shall be of porcelain with open profile aerofoil sheds and minimum creepage of 1320 mm. Each bushing shall be provided with adjustable arcing horn having two gaps in series and at 1800 opposite in case of metal class CBS. Phase to phase clearance shall be not less than 470 mm.

The terminal of bushing shall be suitable for connection to bimetallic lugs for ACSR conductor upto 200 sq.mm.

6.0 CURRENT AND VOLTAGE TRANSFORMERS

Provision shall be made for mounting outdoor current and voltage transformers on circuit breaker mounting structure.

7.0 LABELS AND SECONDARY FUSES

Circuit breaker shall have a blank circuit label approximately 30 cm x 8 cm mounted on the front of the panel in a prominent position. These labels shall be made of suitable material, white and black approximately of 2mm thick to provide white surface with black engravings. The circuit names shall be engraved at site later. All other labels shall be of similar material and should be engraved in English.

All necessary fuses and links shall be supplied and they shall be fitted with clearly legible labels indicating the circuit and shall be grouped according to their functions to facilitate identification. Fuse label shall indicate the current rating of the fuses and code symbols with the diagrams. All secondary fuses shall be of cartridge type BSS-88. MCB in lieu of fuse are acceptable.

8.0 HEATERS

In view of high humidity prevailing at sites breaker cubicle shall be provided with suitably rated heater for operation from 240V AC supply and should be normally remain energised. This is to prevent condensation on breaker bushings, spout-insulators.

9.0 AUXILIARY CONTACTS

Four normally open and four normally closed auxiliary contacts shall be provided. These shall be in addition to those required for operating mechanism control and indicator. All auxiliary contacts shall be positively operated by mechanical drive linkage to the breakers main contact. The auxiliary switches shall be wired to a suitable terminal block on the panel.

10.0 SMALL WIRING

All wiring shall be 2.5 sq.mm stranded copper conductor, 600V tropical grade PVC insulated. All small wiring shall be suitably terminated and fitted with captive identification ferrules and marked with circuit number. Trip circuit shall have an additional ferrule coloured red and marked "Trip".

11.0 EARTHING

Each circuit breaker shall be provide with two earthing terminal of brass or stainless tell, located diagonally opposite and at corners of the breaker support structure. The grounding pads shall be sized to accommodate XLPE insulated copper conductor 70 sq.mm.

12.0 PAINTING

The circuit breaker bushing and operating cubicle shall be painted as per OES-11 Clause 0.04(b).

13.0 NAME PLATE

Circuit breaker shall be provided with name plate of non corrosive and wether proof material and with following details engraved.

- a) Manufacturer's name and year of manufacture
- b) Serial number or type designation making it possible to get all relevant information
- c) Rated voltage
- d) Rated lightning impulse withstand voltage
- e) Rated frequency
- f) Number of Phases
- g) Rated normal current
- h) Rated short circuit breaking current
- i) Weight of breaker

In the case of SF6 breakers, the following additional information to be given :

- a) Rated normal pressure
- b) Minimum operating pressure for full breaking capacity
- c) Lockout pressure
- d) Leakage route

14.0 TESTS

14.1 Type Test

Type test certificate from an internationally recognised authority shall be produced as evidence that the circuit breaker has been successfully tested to BSS-5311/IEC-298 on its own structure, complete with isolating features, with vent outlets forming part of the unit and with the main connections and bus bars. The certificate shall include the test results and details of the circuit breaker performance during the tests.

14.2 Temperature Rise Test

Certificate of temperature rise test carried out previously on identical equipment may be acceptable.

14.3 Routine Tests

Routine tests shall be carried out on all items of equipment in accordance with the relevant BSS/IEC.

33KV OUTDOOR CIRCUIT BREAKER
SCHEDULE OF TECHNICAL GUARANTEED PARTICULARS

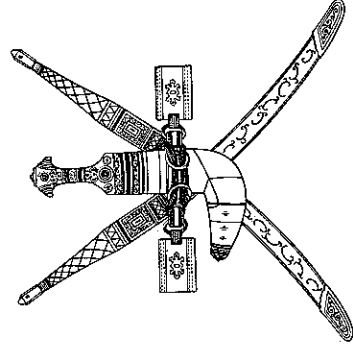
S. No.	Description	Particulars
A) CIRCUIT BREAKER		
01	Manufacturer	
02	Type (SF6, Vacuum or SOV)	
03	Standard	
04	Current rating at site	Amp
05	Rated breaking current	KA
06	Rated short time current and duration	KA
07	Rated peak withstand current	KA
08	Rated short circuit making current	KA
09	Critical current	KA
10	Insulation	
10.1	Creepage distance across interrupter	mm
10.2	Creepage distance to ground	mm
10.3	Impulse withstand across interrupter	KV
10.4	Impulse withstand line to ground	KV
10.5	50 Hz withstand line to ground :	
	a) Dry	KV
	b) Wet	KV
10.6	External insulation	
10.6.1	Interrupter units	
	- Material/Manufacturer	
10.6.2	Supporting structure	
	- Material/Manufacturer	

S. No.	Description	Particulars
10.6.3	Other insulating material	
11.0	Operating Mechanism	
11.1	Type of operating mechanism	
11.2	Operating supply	
11.3	Current required at rated voltage :	
	a) To operate closing coil	A
	b) To operate trip coil	A
11.4	Minimum supply voltage :	
	a) To operate closing coil	V
	b) To operate trip coil	V
11.5	Motor starting current	A
11.6	Motor running current	A
11.7	Time for motor to recharge spring	sec.
11.8	Number of stored operations	
11.9	Number and type of auxiliary switches	
12.0	General Details	
12.1	HV terminal pads – material used	
12.2	Weight of complete unit	Kg
12.3	Overall dimensions	mm
12.4	Maximum number of operations under full short circuit conditions before maintenance is essential	
	B) SF6 ONLY	
01	Rated normal pressure	bar g
02	Minimum operating pressure for full breaking capacity	bar g

S. No.	Description	Particulars
03	Lockout pressure	bar g
04	Low pressure alarm setting	bar g
05	Pressure relief device setting	bar g
06	Leakage rate of SF6 per annum	%
C) VACUUM ONLY		
01	Manufacture of vacuum bottles	
02	Type surge suppression fitted	
03	Method of monitoring state of vacuum	
04	Maximum chopping current	A
05	Maximum over voltages	KV
D) CURRENT TRANSFORMERS		
01	Manufacturer	
02	Standard	
03	Class	
04	V.A. burden	
E) RELAYS		
01	Overcurrent and earth fault relays	
	i) Type : Over - current	
	Earth fault	
	ii) Available time setting :	
	Over current	
	Earth fault	
	iii) Time of operation at 10 times	
	plugs setting :	
	Over current	
	Earth fault	

S. No.	Description	Particulars
iv)	Over current relay connection (angle between voltage and current at unit power factor)	
v)	Maximum torque angle : Over current Earth fault	

SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER



11KV OUTDOOR BREAKERS
FOR 3MVA/6MVA OUTDOOR SUBSTATION

STANDARD – OES 35

BRIEF SPECIFICATIONS

Second Edition : January 1995

SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD : OES - 35
11KV OUTDOOR BREAKER FOR 3MVA/6MVA OUTDOOR SUBSTATION

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SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER

STANDARD OES - 35
11KV-OUTDOOR BREAKER FOR 3MVA/6MVA OUTDOOR SUBSTATION

1.0 GENERAL

Circuit breakers shall be outdoor metal/porcelain clad vacuum type. The circuit breaker shall have a guaranteed rupturing capacity of 350MVA and conform to IEC-56/BS-5311. The degree of protection shall be IP-55. They also shall conform to OES-11 : General Specifications for Electrical Materials and Equipment.

Each phase of three phase circuit breaker shall be self contained in an earthed metal/porcelain casing with common operating mechanism.

2.0 RATING

The circuit breaker shall be suitable for climatic conditions stipulated in Clause 01 of OES-11. General Specifications for Electrical Materials and Equipment.

They shall comply with the following :

Normal system voltage	: 11KV
Highest system voltage	: 12.5KV
Symmetrical short circuit current	: 18.4KA for 3 sec.
Normal current	: 630A
Impulse level	: 75KV
Rated frequency	: 50 Hz
Number of Phases	: 3

The breaker shall be suitable for auto reclosing duty.

3.0 OPERATING MECHANISM

The circuit breakers shall be provided with 240V 50 c/s/ motor charged spring closing mechanism with 30V DC spring release closing and shunt trip coils and shall include the following :

- Facility for manual charging of spring
- Spring charged, uncharged indicator
- Local pistol grip type ON-OFF controls
- ON/OFF indicator lamps (5W 110/30V DC)
- Trip healthy DC indicating lamp of minimum watt capacity with series limiting resistance operated through a spring loaded push button test switch or continuous indication by use of LED.
- Local/Remote switch suitable for control of breaker from remote panel.
- Mechanical counter for indicating breaker operations
- Mechanical 'ON' - 'OF' indication

Note

Auxiliary DC voltage shall be 110 or 30V depending on the availability.

4.0 OPERATING CUBICLE

The sheet metal operating cubicle shall be provided. The cubicle shall be of weather proof, housing operating mechanism, drive linkage, control switches, auxiliary switches and ancillary equipment.

The main access door shall be provided with pad locking arrangement. An inspection window with vandal proof glass shall be provided to view mechanism indicators. The degree of protection shall be IP-55.

The operating cubicle shall be supported on galvanised steel structure with minimum galvanising thickness 127 microns and over all height of the complete circuit breaker and operating cubicle assembly shall be at least 3 metres from live part of bushing and fixing feet.

5.0 TERMINAL BUSHING

Outdoor bushings of circuit breaker shall be of porcelain with open profile aerofoil sheds and minimum creepage distance of 440mm. Wherever possible each bushing shall be provided with adjustable arcing horn having two gaps in series and at 180 degrees opposite in case of metal clad breakers. Phase to phase clearance minimum shall be 250 mm.

The terminal of bushing shall be suitable for connection to bimetallic lugs for ACSR conductor upto 150 sq.mm.

6.0 CURRENT AND VOLTAGE TRANSFORMERS

Provision shall be made for current and voltage transformers on circuit breaker.

7.0 PROTECTION RELAY

The following relays shall be provided in separate weather proof sheet metal enclosure with degree of protection IP-55 mounted on breaker structure.

- 1) IDMT 2 Overcurrent Relays - Range of 50 to 200% in steps of 25% and time setting adjustable from zero to 3 seconds at 10 times current setting.
- 2) 1 Earth Fault Relay - Current range of 10% - 40% in steps of 10% and time setting adjustable from zero to 3 seconds at 10 times current setting.
- 3) Single shot auto reclose relay 30V DC with time delay of 0 to 5 minutes.

All relays shall be flushing mounting type, self re-setting draw out type with hand reset flag indicators and suitable for outdoor installation and to withstand climatic conditions of Oman.

8.0 BATTERY AND CHARGER UNIT

110/30V DC Battery and Charger Unit of adequate capacity shall be provided in the relay cubicle; if required.

9.0 LABELS AND SECONDARY FUSES

Circuit breaker shall have a blank circuit label approximately 30cm x 8 cm mounted on the front of the panel in a prominent position. The label shall be made of suitable weather proof and non corrosive material approximately 2 mm thick, white surface with black engraving. The circuit names shall be engraved at site later.

All other labels shall be of similar material and should be engraved in English.

All necessary fuses and links shall be supplied and they shall be fitted with clearly legible labels indicating the circuit. Fuse label shall indicate the current rating of the fuse. All secondary fuses shall be of cartridge type.

10.0 HEATERS

In view of high humidity prevailing at sites breaker cubicle shall be provided with suitably rated heater for operation from 240V AC supply. This is to prevent condensation on breaker bushing, spout-insulators.

11.0 AUXILIARY CONTACTS

Four normally open and four normally closed auxiliary contacts shall be provided. These shall be in addition to those required for operating mechanism control and indicator. all auxiliary contacts shall be positively operated by mechanical drive linkage to the breakers main contact. The auxiliary switches shall be wired to a suitable terminal block on the panel.

12.0 SMALL WIRING

All wiring shall be 2.5 sq.mm stranded copper conductor, 600V tropical grade PVC insulated. All small wiring shall be suitably terminated and fitted with captive identification ferrules and marked with circuit number. Trip circuit shall have an additional ferrule coloured red and marked "Trip".

13.0 EARTHING

Each circuit breaker shall be provided with two earthing terminal of brass or stainless steel, located diagonally opposite and corners of the breaker support structure. The grounding pads shall be sized to accommodate XLPE insulated copper conductor 70 sq.mm.

14.0 PAINTING

The circuit breaker metal casings operating cubicle shall be painted as per OES-11 Clause 0.04(b).

15.0 NAME PLATE

Circuit breaker shall be provided with name plate of non corrosive and weather proof material and with following details engraved.

- a) Manufacturer's name and year of manufacture
- b) Serial number or type designation making it possible to get all relevant information
- c) Rated voltage

- d) Rated lightning impulse withstand voltage
- e) Rated frequency
- f) Number of phases
- g) Rated normal current
- h) Rated short circuit breaking current
- i) Weight of breaker

16.0 TESTS

16.1 Type Test

The test certificate fro an internationally recognised authority shall be produced as evidence that the circuit breaker has been successfully tested to BSS-531/IEC-298 on its own structure, complete with isolating feature, with vent outlets forming part of the unit and with the main connections and bus bars. The certificate shall include the test results and details of the circuit breaker performance during the tests.

16.2 Temperature Rise Test

Certificate of temperature rise test carried out previously on identical equipment may be acceptable.

16.3 Routine Tests

Routine tests shall be carried out on all items of equipment in accordance with the relevant BSS/IEC.

11KV OUTDOOR CIRCUIT BREAKERS
TECHNICAL GUARANTEED PARTICULARS

S. No.	Description	Particulars
A) CIRCUIT BREAKER		
01	Manufacturer	
02	Type (Vacuum)	
03	Standard	
04	Current rating at site	Amp
05	Rated breaking current	KA
06	Rated short time current and duration	KA
07	Rated peak withstand current	KA
08	Rated short circuit making current	KA
09	Critical current	KA
10	INSULATION	
10.1	Creepage distance across interrupter	mm
10.2	Creepage distance to ground	mm
10.3	Impulse withstand across interrupter	KV
10.4	Impulse withstand, line to ground	KV
10.5	50 Hz withstand line to ground :	
	a) Dry	KV
	b) Wet	KV
10.6	External insulation	
10.6.1	Interrupter units	
	- Material/Manufacturer	
10.6.2	Supporting structure	
	- Material/Manufacturer	

S. No.	Description	Particulars
10.6.3	Other insulating material	
11.0	Operating Mechanism	
11.1	Type of operating mechanism	
11.2	Operating supply	
11.3	Current required at rated voltage :	
	a) To operate closing coil	A
	b) To operate trip coil	A
11.4	Minimum supply voltage :	
	a) To operate closing coil	V
	b) To operate trip coil	V
11.5	Motor starting current	A
11.6	Motor running current	A
11.7	Time for motor to recharge spring	sec.
11.8	Number of stored operations	
11.9	Number and type of auxiliary switches	
12.0	GENERAL DETAILS	
12.1	HV terminal pads – material used	
12.2	Weight of complete unit	Kg
12.3	Overall dimensions	mm
12.4	Maximum number of operations under full short circuit conditions	
	before maintenance is essential	
	B) VACUUM	
01	Manufacturer of vacuum bottles	
02	Type of surge suppression fitted	

S. No.	Description	Particulars
03	Method of monitoring state of vacuum	
04	Maximum chopping current	A
05	Maximum over voltages	KW
	C) CURRENT TRANSFORMERS	
01	Manufacture	
02	Class	
03	V.A. burden	
	D) RELAYS	
01	Overcurrent and earth fault relays	
	i) Type :	
	- Overcurrent	
	- Earth fault	
	ii) Available time setting :	
	- Overcurrent	
	- Earth fault	
	iii) Time of operation at 10 times	
	- Overcurrent	
	- Earth fault	
	iv) Over current relay connection	
	(angle between voltage and	
	current at unity power factor)	
	v) Maximum torque angle :	
	- Overcurrent	
	- Earth fault	
02	Auto Reclose Relay	
	i) Type	
	ii) Make	
	iii) Time delay	
	iv) Auxiliary supply	