

***TECHNICAL SPECIFICATION FOR
LOW VOLTAGE SWITCHGEAR FOR TECH MOU***

BHEL DOCUMENT NO. : EPD-TS-CPBG-TECHMOU-01, REV-0



**BHARAT HEAVY ELECTRICALS LIMITED
ELECTROPORCELAINS DIVISION
BANGALORE – 560012**



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PRE-QUALIFICATION REQUIREMENT

ROUTE 1*

- I) Bidder/ Sub Vendor should have manufactured and supplied at least a total of four hundred & fifty (450) nos. draw out type Air Circuit Breaker Panels and / or draw out type Motor Control Centre Panels with fault rating of at least 45kA for 1 second and 105kA peak under a single order and these panels should have been in successful operation for a period of not less than two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
- II) Bidder/ Sub Vendor should have manufactured and supplied at least one hundred & fifty (150) nos. of Air Circuit Breakers having fault rating of at least 105kA MAKING and 45kA BREAKING, and their associated draw out type Air circuit breaker panels having fault rating of at least 45kA for 1 Second and 105kA peak, which should have been in successful operation for a period of not less than two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.

ROUTE 2*

- I) Bidder/Sub-vendor should have manufactured and supplied at least a total of two hundred & twenty five (225) nos. draw out type Air Circuit Breaker Panels and / or draw out type Motor Control Centre Panels with fault rating of at least 45kA for 1 second and 105kA peak under a single order and these panels should have been in successful operation for a period of not less than two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
- II) Bidder/Sub-vendor should have manufactured and supplied at least seventy five (75) nos. of draw out type Air Circuit Breaker panels having fault rating of at least 45Ka for 1 second and 105kA peak, which should have been in successful operation for a period of not less than two (2) years reckoned as on the date of consideration for approval but not later than six months after award date of contract to the Main bidder.
- III) Bidder/Sub-vendor shall Associate/Collaborate with a manufacturer who meets the requirements stipulated in Route 1. In such a case, Bidder/Sub-vendor should furnish a Deed of Joint Undertaking executed by Bidder/Sub-vendor and its Associate/Collaborator as per the format enclosed in the bidding document in which the Bidder/Sub-vendor and its Associate/Collaborator are jointly and severally liable to the Employer for successful performance of the LT



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Switchgears under this package. This Deed of Joint Undertaking should be submitted prior to the placement of order on approved Sub Vendor. In case of award, the Associate or Collaborator of the Bidder / Sub Vendor (as applicable) will be required to furnish an on-demand Bank Guarantee for INR 1 Million (Indian Rupees One Million only).

Note: Each Single Front Panel shall be counted as one (1) Panel, Double Front Panel as one (1) Panel and Air Circuit Breaker Panel as one (1) Panel.

*** BIDDER WHO DOES NOT FULLFILL THE ABOVE QR (ROUTE 1/ ROUTE 2) AT THE TIME OF TECHNICAL BID OPENING, HOWEVER INTEND TO DEVELOP THE CLOSED DOOR DESIGN AS MENTIONED IN THE SPECIFICATION AND EXPECTING TO QUALIFY THE QR BEFORE THE PRICE BID OPENING FOR PARTICULAR PROJECT, CAN ALSO PARTICIPATE FURNISHING THE DECLARATION FOR THE SAME.**



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1.00.00 CODES AND STANDARDS

All equipment shall, generally, comply with the updated issues of

(a.) Applicable Indian Standards

(b.) Indian Electricity Act.

(c.) Indian electricity rules

Equipment complying with any other authoritative / internationally recognized standards such as IEC, British, U.S.A., German, etc. will also be considered if it ensures performance equivalent or superior to Indian Standards. In such cases the contractor shall clearly indicate the standard adopted and furnish the copy of latest English version of the same along with the bid and bring out the salient features for comparison.

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as published one month prior to the date of opening of bids. In case of conflict between this specification and those (IS codes, Standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following codes and standards.

IS: 5	Colors for ready-mixed paints and enamels.
IS: 694	PVC insulated cables for working voltages up to and including 1100V.
IS: 722	A.C. Electricity Meters
IS: 1248	Electrical Indicating instruments
IS/IEC: 60947-1	Degree of protection provided by enclosures for low voltage Switchgear and Control gear
IS/IEC: 60947-2	A.C. circuit Breakers
IS: 2551	Danger Notice Plates
IS: 2629	Hot dip galvanising
IS: 2705	Current Transformers
IS/IEC: IEC-60947-4-1	Contactors and motors starter for voltages not exceeding 1000 V AC or 1200 V DC
IS: 3043	Code of practice for earthing.
IS: 3072	Code of practice for installation and maintenance of Switchgear
IS: 3156	Voltage Transformers
IS: 3202	Code of practice for climate proofing of electrical equipment.
IS: 3231	Electrical relays for power system protection.



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IS/IEC 60947	Air-Break Switches, air break disconnectors, air break disconnector and fuse combination units for voltages not exceeding 1000V AC or 1200 V DC.
IS/IEC 60947-1 /	General Requirements for Switchgear and Control gear for voltages not exceeding 1000 V.
IS: 5082	Wrought Aluminum and Aluminum alloys for electrical purposes.
IS: 6005	Code of practice of phosphating of iron and steel.
IS/IEC 60947-5-1 /	LV switchgear and Control gear Control current devices and switching element.
IS: 8623 / IEC:61439-1/2	Low Voltage Switchgear & Control gear assemblies
IS: 8686	Static Relays
IS: 13703 /	HRC Cartridge fuses
IS: 10118 (4 parts)	Code of practice for selection, installation and maintenance of switchgear and control gear.
IS: 11171	Specification for dry type transformers.
IEC: 60255	Electrical Relays
IEC: 61850	Communication networks and systems in substations
IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals
IS: 12021	Specification of control transformers for switchgear and Control gear for voltage not exceeding 1000V AC.
IEC: 60947-7-1	Terminal blocks for Copper conductors
IS :513 (2008)	Cold Rolled Low Carbon Steel Sheets and Strips

2.00.00 TECHNICAL PARAMETERS

POWER SUPPLY

AC SYSTEM

- 1) Voltage 415 V + 10%, 3 Phase, 4 wire, solidly earthed
- 2) Frequency 50 Hz +/- 5%
- 3) Combined variation (in volts & frequency) 10% absolute sum
- 4) Fault Level 50 kA (RMS)

DC SYSTEM

- 1) System Voltage 220 V DC 2-Wire, Unearthed



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2) Fault Level 20 KA

CONTROL SUPPLY VOLTAGE

1) Trip & closing coil of circuit breaker 220 V DC/110 V DC

2) Spring charging motor 220 V DC/110 V DC

3) MCC control supply 110 V AC Neutral solidly earthed

4) Space heater & lighting 240 V AC Neutral solidly earthed

CUBICLE DATA

Bus bar Rating

1) Continuous Current rating As per requirement

2) Short time rating where

a) CB is used as incomer

b) Fuse protection is used in Incomer

50 kA (RMS) for one sec
Prospective current of 50
kA (RMS) for the fuse
clearing time

3) Dynamic Rating where

a) CB is used as incomer

b) Fuse Protection is used in incomer

105 kA (PEAK)
Prospective current of
105 kA (PEAK) as limited by fuse

4) Bus bar insulation

a) For switchgear

b) For MCC

c) ACDB

d) DCDB

e) For fuse boards

PVC Sleeve insulated
PVC Sleeve insulated
PVC Sleeve insulated
PVC Sleeve insulated
PVC Sleeve insulated

CIRCUIT BREAKER

1) Type Air break spring charged stored
Energy type

2) Operating duty O-3 min-CO-3 min-CO

3) Symmetrical interrupting 50 kA (RMS)

4) Short circuit rating 105 kA (PEAK)

5) Short Circuit breaking current

a) AC Component

b) DC Component

50 kA (RMS)
As per IS/IEC 60947



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6) Short time withstand

50 kA (RMS) for 1 s

7) No of aux. contacts

4 NO + 4 NC for DDCMIS Interface

METERS

1) Accuracy class

2.0

2) One min. power frequency withstand test Voltage

2.0 kV (rms)

CURRENT TRANSFORMERS

1) Type

Cast Resin Bar Primary / Nylon Casing

2) Voltage class and frequency

650 V, 50 HZ

3) Class of insulation

E or better

4) Rated Secondary Current

1 A

5) Accuracy class & burden

a) For protection

5P20, 5VA
PS Class for REF

b) For metering

class 1.0, 5VA (min)
Class 0.2s, 5VA (min) for Feeders Indicated in SLD, if any

6) Instrument Security Factor (ISF) for metering CT

5

7) Short time withstand

a) For CT Associated with circuit breaker 50 kA (RMS) for 1 sec

b) For CT Associated with fuse protected feeders Prospective current of kA (RMS) for the Fuse clearing time

8) Dynamic withstand

a) For CTs Associated with circuit breaker

b) For CT Associated with fuse protected Feeder's

105 kA (PEAK)
Prospective current of 105 kA (PEAK) as Limited by fuse



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VOLTAGE TRANSFORMERS

- | | |
|---|---|
| 1) Type | Cast Resin |
| 2) Voltage Ratio | 415 / 110 V for line PT
415/ $\sqrt{3}$ / 110/ $\sqrt{3}$ V for Bus PT |
| 3) Method of Construction | V-V |
| 4) Accuracy Class | 0.5
0.2 for feeders indicated in SLD, if any |
| 5) Rated Voltage factor | 1.2continuous, 1.5 for 30 sec. |
| 6) Class of insulation | E or better |
| 7) One minute power frequency withstand voltage | 2.5 KV |

HRC FUSES

- | | |
|-----------------------|---|
| 1) Voltage Class | 650 Volts |
| 2) Rupturing capacity | 80 kA (rms) for AC ckt. 20 kA for DC ckt. |

CONTACTORS

- | | |
|-----------------------|---|
| 1) Type | Air break electro magnetic |
| 2) Utilizing Category | AC3 of IS/IEC 60947 for non-reversible AC4
of IS/IEC 60947 for reversible drives |

RELAYS

- | | |
|--------------------------------------|---------------------------------------|
| 1) Power frequency withstand voltage | 2.5 kV for 1 sec. or 2.0 kV for 1min. |
|--------------------------------------|---------------------------------------|

CONTROL TRANSFORMERS

- | | |
|---|--|
| 1) Type | Dry / Cast Resin |
| 2) Voltage Ratio | 415 / 110 with taps + 5% in steps
of 2.5% |
| 3) Class of insulation | Class-B or better |
| 4) One minute power frequency withstand voltage | 2.5 kV |
| 5) Rating | 1.5 X Adequate for application. |



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LIGHTING TRANSFORMER / WELDING TRANSFORMER

- | | |
|---|---|
| 1) Type & Rating | Dry type / 100 KVA (Welding TRF),
50KVA (Minimum) (Lighting TRF) |
| 2) Voltage Ratio | 415/415V, +/- 5% taps in steps of
2.5% |
| 3) Class of insulation | B or better |
| 4) One minute power frequency withstand voltage | 2.5 KV |
| 5) Enclosure protection | IP-42 |

TRANSDUCERS

- | | |
|------------------------|---|
| 1) Current transducers | |
| a) Input | 0-1 A (CT secondary) |
| b) Rated frequency | 50 Hz |
| c) Output | 4-20 mA (2 Nos. decoupled) |
| d) Over current | Transducer for motor current
ammeters shall be capable of
withstanding min. 6 times CT
sec.current of 1A for a min period
of 30 seconds |
| e) Accuracy | 1.0 |
| 2) Voltage Transducers | |
| a) Input | 110 V / 415 V / 240 V, 50 Hz (for
AC) / 220 V / 110 V DC (for DC) |
| b) Output | 4-20 mA (2 Nos. decoupled) |
| c) Accuracy | 1.0 |

MCCB

- | | |
|---|--------|
| 1) Rated voltage | 415V |
| 2) Rated insulation level | 690V |
| 3) Rated ultimate &Service S.C. breaking capacity | 50 kA |
| 4) Rated making capacity | 105 kA |
| 5) Utilization category | A |



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3.00.00 CONSTRUCTIONAL DETAILS OF SWITCHBOARDS

All Switchboards i.e., 415 V Switchgears, Motor Control Centre's (MCCs), AC Distribution Boards (ACDBs), 220 V DC Distribution Boards (DCDBs) and Solenoid Valve Distribution Boards, shall be of metal enclosed, indoor, floor-mounted, free-standing type.

All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material.

All panel edges and cover / door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members. The top covers of the panels should be designed such that they do not permanently bulge/ bend by the weight of maintenance personnel working on it.

The switchboards shall be of bolted design. The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cut-outs shall be true in shape and devoid of sharp edges.

All switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 5X as per IS/IEC 60947. However, the bus bar chambers having a degree of protection of IP: 42 are also acceptable where continuous bus bar rating is 1600A and above. Provision shall be made in all compartments for providing IP: 5X degree of protection, when circuit - breaker or module trolley has been removed. All cut-outs shall be provided with EPDM / Neoprene gaskets.

Provision of louvers on switchboards would not be preferred. However, louvers backed with metal screen are acceptable on the bus bar chambers where continuous bus bar rating is 1600 A and above.

The switchboards shall comply to the Internal arc fault containment tests of 50 kA for 0.3s.

The enclosure for outdoor panels shall be constructed of stainless steel sheets in order to have protection against corrosion. The Degree of protection for outdoor panels shall be IP:55. The panels shall be mounted on a pedestal at a height of 500mm from ground level.

All switchboards shall be of uniform height not exceeding 2450 mm. The height of the Operating handle, push buttons etc shall be restricted between 300mm and 2000mm.



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Switchboards shall be easily extendable on both sides by the addition of vertical sections after removing the end covers.

Switchboards shall be supplied with base frames made of structural steel sections, along with all necessary mounting hardware required for welding down the base frame to the foundation / steel insert plates. The base frame height shall be such that floor finishing (50mm thick) to be done by Contractor after erection of the switchboards does not obstruct the movement of doors, covers, withdraw able modules etc.

All switchboards shall be divided into distinct vertical sections (panels), each comprising of the following compartments:

(a.) BUSBAR COMPARTMENT

A completely enclosed bus bar compartment shall be provided for the horizontal and vertical bus bars. Bolted covers shall be provided for access to horizontal and vertical bus bars and all joints for repair and maintenance, which shall be feasible without disturbing any feeder compartment. Auxiliary and power bus bars shall be in separate compartments.

(b.) SWITCHGEAR / FEEDER COMPARTMENT

All equipment associated with an incomer or outgoing feeder shall be housed in a separate compartment of the vertical section. Two-tier breaker arrangement in a vertical section shall be offered for outgoing breaker feeders of rating up to 1600A. The design of the vertical section for such an arrangement shall ensure ease of termination of power cables of size & quantity appropriate to respective feeder rating. The compartment shall be sheet steel enclosed on all sides with the withdrawal units in position or removed. Insulating sheet at rear of the compartment is also acceptable. No live parts shall be accessible with equipment drawn out and degree of protection within the compartment shall be IP2X. The front of the compartment shall be provided with the hinged single leaf door with captive screws for positive closure.

(c.) CABLE COMPARTMENT OR CABLE ALLEY

A full-height vertical cable alley of adequate width shall be provided for power and control cables. Cable alley shall have no exposed live parts and shall have no communication with bus bar compartment. Cable terminations located in cable alley shall be designed to meet the Form 4b as per IEC 61439 for safety purpose. Necessary grommets shall be provided at the cable entry of individual modules. Wherever cable alleys are not provided for distribution boards, segregated cable boxes for individual feeders shall be provided at the rear for direct termination of cables. For circuit breaker external cable connections, a separately enclosed cable compartment shall also be acceptable. The contractor shall furnish suitable plugs to cover the cable openings in the partition between feeder compartment and cable alley. Cable alley door shall be hinged.



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(d.) CONTROL COMPARTMENT

A separate compartment shall be provided for relays and other control devices associated with a circuit breaker. Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal bus bar compartment. EPDM / Neoprene gasket shall be provided between the panel sections to avoid ingress of dust into panels.

After isolation of power and control circuit connections it shall be possible to safely carryout maintenance in a compartment with the bus bar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose. Wherever two breaker compartments are provided in the same vertical section insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on the other circuit.

All 415V switchgear (circuit-breaker) panels shall be of single-front type. MCCs and DBs shall be of single-front / double-front construction as per the requirements. All single-front switch boards shall be provided with single-leaf, hinged or bolted covers at the rear. The bolts shall be of captive type. The covers shall be provided with "DANGER" labels. All panel doors shall open by 90 deg or more. In case of double-front MCCs, if this cannot be achieved for panels adjacent to a breaker panel, suitable dummy panel shall be provided by the Contractor wherever necessary.

All ACDBs, DCDBs and Solenoid Valve DBs shall be of fixed module type. All 415V circuit breaker modules and contactor controlled motor modules shall be of fully draw-out type having distinct 'Service' and 'Test' positions. The equipment pertaining to a draw-out type incomer or feeder module shall be mounted on a fully withdrawable chassis which can be drawn out without having to unscrew any wire or cable connection. Suitable arrangement with cradle/ rollers, guides along with tool/lever operated racking in/out mechanism shall be provided for smooth and effortless movement of the chassis. For modules of size more than half the panel height, double guides shall be provided for smooth removal or insertion of module. All identical module chassis of same size shall be fully interchangeable without having to carry out any modifications. Suitable interlock shall be provided in DCDB for prevention of opening of Isolator (Incomer) when the bus coupler is open and vice-versa.

All draw-out modules shall be provided with “Closed door operation” feature wherein movement of the module from “Isolated” position to “Service” position & vice-versa and power ON / OFF operation of the module shall be possible only with the module door closed condition.

All disconnecting contacts for power and control circuits of draw-out modules shall be of robust and proven design, fully self-aligning and spring-loaded. Both fixed and moving shall be silver-plated and replaceable. The spring-loaded power and control draw out contacts shall be on withdrawable chassis and the same on fixed portion shall not be accepted.



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Individual opening in the vertical bus enclosure shall permit the entry of moving contacts from the draw-out modules into vertical droppers.

As indicated in schematic drawings of DDCMIS controlled modules, contractor shall supply & mount two (2) coupling relays in the corresponding modules.

All equipment and components shall be neatly arranged and shall be easily accessible for operation and maintenance. The internal layout of all modules shall be subject to Employer's approval. The Contractor shall submit dimensional drawings showing complete internal details of bus bars and module components, for each type and rating for approval of Employer.

Employer reserves the right to alter the cable entries, if required during detailed engineering, without any additional commercial implication.

Each switchboard shall be provided with undrilled, removable type gland plate, which shall cover the entire cable alley. Contractor shall ensure that sufficient cable glanding space is available for all the cables coming in a particular section through gland plate. For all single core cables, gland plate shall be of non-magnetic material. The gland plate shall preferably be provided in two distinct parts for the easy of terminating addition cables in future. The gland plate shall be provided with gasket to ensure enclosure protection. Recommended drilling chart of gland plates for all power and control cables in the vertical panels shall be indicated by the Contractor in the respective G.A. drawings of the boards.

The Contractor shall consider layout of panels in a switchboard consisting of various feeder modules in a straight line, unless specified otherwise. The actual composition and disposition of various modules in a switchboard shall be finalised during detailed engineering. The Contractor shall provide adopter panel / dummy panel required to meet various configuration / arrangement of bus bars adopted by the Contractor. The Switchboards fed from indoor transformer will be flange connected to the same and the same shall be located as close as desirable to the transformer. The details of transformer flanges for those transformers not being supplied under this package shall be given to the contractor for matching the connections. The switchboards fed from outdoor transformers of rating 1000kVA and above shall be connected through bus ducts. For transformers of 1000kVA rating, cable connection may also be acceptable in case of layout constraints. For lower rated transformers, the connection shall be through cables. Bus duct connections wherever applicable shall be preferably in a straight line alignment. Adopter panels and dummy panels shall be provided wherever required.

Adequate space in a separate compartment shall be identified for mounting of Ethernet Switch (19" rack mounting), in all switchgears having numerical relays. Further, mounting of Ethernet switch in the above compartment at site and provision of inter-panel wiring (Cat5e Ethernet / Fibre Optic) for connection of numerical relays to Ethernet switch shall be in the contractor's scope. Arrangement to provide required control supply (110 V / 220 V DC) to Ethernet switch shall be made in the switchgear.



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(e.) CLEARANCES

The minimum clearance in air between phases and between phases and earth for the entire run of horizontal and vertical bus bars and bus-link connections at circuit-breaker shall be 25 mm. For all other components, the clearance between "two live parts", "a live part and an earthed part", shall be at least ten (10) mm throughout. Wherever it is not possible to maintain these clearances, insulation shall be provided by sleeving or barriers. However, for horizontal and vertical bus bars the clearances specified above should be maintained even when the bus bars are sleeved or insulated. All connections from the bus bars up to switch / fuses shall be fully shrouded / insulated and securely bolted to minimize the risk of phase to phase and phase to earth short circuits.

4.00.00 PROTOTYPE PANELS

In order to establish the compliance with the requirements of this technical specification, prototype panels shall be made and offered for the Employer's inspection and approval before the start of manufacturing of panels for this project. The exact configuration of such prototype panels shall be finalized during detailed engineering.

5.00.00 CONSTRUCTIONAL DETAILS OF AC & DC FUSE BOARDS

All fuse boards shall be metal enclosed, fixed type, non-compartmentalized construction, suitable for indoor/ outdoor mounting on wall or steel structure.

The fuse board frame shall be fabricated using suitable mild steel structures or pressed and shaped cold rolled sheet steel of thickness not less than 2.0 mm. The frames shall be enclosed by cold rolled sheet steel of thickness not less than 1.6 mm.

The fuse boards shall be provided with doors on the front. The doors shall preferably be in two halves with hinges at the extreme ends and locking facility at the centre.

Suitable EPDM/Neoprene gaskets shall be provided to make fuse boards completely dust and vermin-proof with a degree of protection of IP-52 for indoor and IP-54 for outdoor application, as per IS/IEC 60947.

Each DC fuse board shall comprise of the following:

- (a.) 1 no. 63 A switch as incomer
- (b.) 100 A fully insulated (PVC sleeved or epoxy coated) bus bars.
- (c.) 8 nos. 16A outgoing Fuse feeders.
- (d.) 1 no. auxiliary contactor for supply monitoring.
- (e.) 1 no. indicating lamp with resistor and blue coloured lens.

Each AC fuse board shall comprise of the following:

- (a.) 1 no. 63A TPN switch as incomer.
- (b.) 100 A, 3-phase, 4-wire, fully insulated (PVC sleeved or epoxy coated) bus bars.



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(c.) 9 nos. 16 A single phase switch fuse units and 3 nos. 16 A TPN switch fuse units as outgoing feeders or alternatively 16 amps MCCB can be provided.

(d.) 3 nos. indicating lamps with resistors and coloured lenses (R, Y, B) for incoming supply monitoring.

The fuses shall be mounted in an insulating fuse carrier and it shall be possible to replace the outgoing feeder fuses without disturbing the other feeders. The handle of incoming switch shall be mounted on the door of the fuse board, with padlocking facility in both 'ON' and 'OFF' positions. The outgoing feeder switches shall preferably be of rotary type.

Cable entry facilities shall be provided at bottom with removable gland plates of suitable thickness. However, top cable entry may be allowed in case of layout constraints. All incoming and outgoing cables shall be terminated on suitable terminal blocks.

6.00.00 POWER BUSBARS AND INSULATORS

All 415 V Switchboards, MCCs and ACDBs shall be provided with three phase and neutral bus bars. Two separate sets of vertical bus bars shall be provided in each panel of double front MCCs / DBs. Interleaving arrangement for bus bars shall be adopted for switchboards with a rating of more than 1600A. DCDBs shall be provided with two (2) bus bars. Entire bus bar system shall be insulated with PVC sleeves. Bus bar sleeves shall be compliant to UL224 (Extruded insulating tubing), CE/UL certified, having fire retardant properties and working temperature of 105°C.

Vertical bus bars of non-breaker panels shall be completely phase segregated by suitable insulating supports / walls made of fire-retardant, non-hygroscopic, track-resistant material to minimise the occurrence of arc faults.

All bus bars and jumper connections shall be of high conductivity Aluminium alloy / Copper of adequate size.

The cross-section of the bus bars shall be uniform throughout the length of switchboard section and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents. Neutral bus bar short circuit strength shall be same as main bus bars.

All bus bars shall be adequately supported by non-hygroscopic, non-combustible, track resistant and high strength sheet moulded compound or equivalent type polyester fibre glass moulded insulator. Separate supports shall be provided for each phase and neutral bus bar. If a common support is provided, anti-tracking barriers shall be provided between the supports. Insulator and barriers of inflammable material such as Hylam shall not be accepted. The bus bar insulators shall be supported on the main structure.

All bus bar joints shall be provided with high tensile steel bolts, belleville / spring washers and nuts, so as to ensure good contacts at the joints. Non-silver plated bus bar joints shall be thoroughly cleaned at the jointed locations and suitable contact grease



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shall be applied just before making a joint. All bolts shall be tightened by torque spanner to the recommended value. The overlap of the busbars at each joint surface shall be such that the length of overlap shall be equal to or greater than the width of the bus bar. All Copper to Aluminium joints shall be provided with suitable bimetallic strips.

All bus bars shall be colour coded as per IS: 375.

The Contractor shall furnish calculations establishing the adequacy of bus bar sizes for specified current ratings.

7.00.00 AUXILIARY BUSBARS AND CONTROL TRANSFORMERS

AC CONTROL SUPPLY BUSBAR

Each bus-section of all Switchgears and MCCs shall be provided with two (2) nos. 415V / 110V control transformers. The 110V AC control supply from the control transformers shall be run through the MCC by means of two sets of control supply bus bars of electrolytic Copper. In case of one transformer failure, whole bus section can be fed through single transformer. The control supply to different modules shall be tapped individually from the control supply bus bars.

DC CONTROL SUPPLY BUSBARS

Electrically controlled circuit breaker boards shall be provided with DC control supply bus bars. The manually controlled breakers shall also be provided with such bus bars in case relays are provided. Each section of the switchboard shall be provided with a DC supply by the Contractor. The Contractor shall provide suitable terminals, switch-fuse etc. to receive the DC supply and distribute the same through above mentioned control bus bars to the required modules of the respective section. The DC control supply bus of one section shall be coupled to the control supply of other section through a switch located in the bus-coupler breaker panel. The DC supply to the bus-coupler breaker may be given from any of the control buses. For Emergency Switchgear, two DC supplies shall be provided along with suitable diodes for deriving the control supply through diode auctioneering. Power Supply to Numerical Relay and Ethernet switch shall be an independent circuit with switch and fuse tapped from the panel DC supply. Exact scheme for segregation of switchgear & numerical relay DC supplies shall be finalized during detailed engineering.

SPACE HEATER BUSBARS

Panel and motor space heaters shall be fed from separate AC auxiliary bus bars running throughout the switchboard. The supply for these bus bars shall be tapped from incomer, before the isolating switch/ circuit breaker. Incoming circuit to space-heater bus shall have an isolating switch, HRC fuse and neutral link of suitable rating. Suitable



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terminals shall also be provided to facilitate energisation of space-heater bus from outside during long shutdowns of unit / switch-board.

CONTROL TRANSFORMERS

The control transformers shall be 415 V / 110 V with neutral point-earthed, of insulation class 'B' or better. The sizing of Control transformers shall be carried out by Contractor considering the actual load of power contactors, auxiliary contactors, indicating lamps and other equipment in the module circuit. An additional load of 15 watts should also be considered for each module, for remote auxiliary relays and lamps to be connected in the control circuit of modules. Contractor shall also ensure that control transformers are adequately designed for meeting the momentary loading requirements & the voltage drop during this condition shall not be more than 5%.

8.00.00 EARTH BUS AND EARTHING

A galvanized steel / Copper / Aluminium earth bus shall be provided at the bottom of each panel and shall extend throughout the length of each switchboard. It shall be welded / bolted to the framework of each panel and breaker earthing contact bar. Vertical earth bus shall be provided in each vertical section which shall in turn be bolted / welded to main horizontal earth bus.

The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current to earth, as indicated in "Technical Parameters", without exceeding the allowable temperature rise.

Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting to Contractor's earthing conductors. The horizontal earth bus shall project out of the switchboard ends and shall have predrilled holes for this connection. All joint splices to earth bus shall be made through at least two bolts, and taps by proper lug and bolt connection.

All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosure framework and truck shall be maintained even after painting.

The carriage and breaker frame shall get earthed while being inserted in the panel and positive earthing of the breaker frame shall be maintained in all positions, i.e. SERVICE & ISOLATED, as well as throughout the intermediate travel.

Each module frame shall get engaged to the vertical earth bus before the disconnecting contacts on the module are engaged to the vertical bus bars.

All metallic cases of relays, instruments and other panel-mounted equipment shall be connected to earth by independent stranded Copper wires of size not less than 2.5 sq. mm. All the equipment mounted on the door shall be earthed through flexible wire/braids. Insulation colour code of earthing wires shall be green. Earthing wires shall



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be connected to terminals with suitable clamp connectors, soldering is not acceptable. Looping of earth connections, which would result in loss of earth connections to other devices, when a device is removed, is not acceptable. However, looping of earth connections between equipment to provide alternative paths to earth bus is acceptable.

VT and CT secondary neutral point earthing shall be at one place only, i.e. on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit shall be removed without disturbing the earthing of other circuit.

All hinged doors having potential carrying equipment mounted on it shall be earthed by flexible wire/ braid. For doors not having potential carrying equipment mounted on it, earth continuity through scraping hinges/ hinge pins of proven design may also be acceptable. The Contractor shall establish earth continuity at site also.

9.00.00 CIRCUIT BREAKERS

Circuit breakers shall be three pole, air break, horizontal draw out type, and shall have fault making and breaking capacities as specified in "Technical Parameters". The circuit breakers which meet specified parameters of continuous current rating and fault making / breaking capacity only after provision of cooling fans or special device shall not be acceptable.

Circuit breakers along with its operating mechanism shall be provided with suitable arrangement for easy withdrawal. Suitable guides shall be provided to minimize misalignment of the breaker.

There shall be "SERVICE", "TEST" and "FULLY WITHDRAWN" positions for the breakers. In "Test" position the circuit breaker shall be capable of being tested for operation without energizing the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the "SERVICE", "TEST" or "FULLLY WITHDRAWN" position. It shall be possible to close the door in "Test" position. The circuit breaker rack in and rack out from Service to Test, Test to Isolated position or vice-versa shall be possible only in the door closed position.

All circuit breakers shall be provided with "6NO" and "6NC" potential free auxiliary contacts. These contacts shall be in addition to those required, for internal mechanism of the breaker and should be directly operated from breaker operating mechanism. In case the manufacturer does not have a proven arrangement for providing the required number of circuit breaker auxiliary contacts on the fixed portion of the cubicle, necessary electrically reset latched relays shall be provided complete with all wiring in series with service position limit switch contacts, for multiplying the circuit breaker mounted auxiliary contacts and provide 4 NO and 4 NC contacts. Separate limit switches, each having required numbers of contacts shall be provided in both "SERVICE" and "TEST" position of the breaker. All contacts shall be rated for making, continuously carrying and breaking 10 Amp at 240 V AC and 1 Amp (Inductive) at 240 V DC respectively.



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Suitable mechanical indications shall be provided on all circuit breakers to show "OPEN", "CLOSE", "SERVICE", "TEST" AND "SPRING CHARGED" positions.

Main poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half a cycle of rated frequency.

All circuit breakers shall be provided with the following interlocks:

Movement of a circuit breaker between "SERVICE" and "TEST" position shall not be possible unless it is in open position. Attempted withdrawal of a closed circuit breaker shall preferably not trip the circuit breaker. In case the offered circuit breaker trips on attempted withdrawal as a standard interlock, it shall be ensured that sufficient contact exists between the fixed and draw out contact at the time of breaker trip so that no arcing takes place even with the breaker carrying its full rated current.

Closing of a circuit breaker shall not be possible unless it is in "SERVICE" position, "TEST" position or in "FULLY WITHDRAWN" position.

Circuit-breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the stationary isolated contacts when the breaker is withdrawn. It shall however be possible to open the shutters intentionally against pressure for testing purposes.

A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.

Circuit breakers shall be provided with coded key / electrical interlocking devices, as per requirements.

Circuit breaker shall be provided with anti-pumping relay and trip free feature, even if mechanical anti-pumping feature is provided.

Mechanical tripping shall be possible by means of front mounted Red "trip" push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.

Complete shrouding / segregation shall be provided between incoming and outgoing bus links of breakers. In case of bus coupler breaker panels the bus bar connection to and from the breaker terminals shall be segregated such that each connection can be approached and maintained independently with the other bus section live. Dummy panels if required to achieve the above feature shall be included in the Contractor's scope of supply.



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Circuit breaker shall be provided with Power operated mechanism as follows.

1	Power operated mechanism shall be provided with a universal motor suitable for operation on 220 V DC / 240 AC Control supply, with voltage variation from 198 V to DC to 242 V DC . Motor insulation shall be class "E" or better.
2	The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring at minimum available control voltage.
3	Once the closing springs are discharged, after one closing operation of circuit breaker, it shall automatically initiate recharging of the spring.
4	The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply at least one open-close-open operation shall be possible.
5	Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.
6	All circuit breakers shall be provided with closing and trip coils. The closing coil shall operate correctly at all values of voltage from 187-242 V DC/77 V-121 V DC. The trip coil shall operate satisfactorily at all values of voltage from 154-242V DC /77 V-121 V DC
7	Provision for mechanical closing of the breaker only in "Test" and "WITHDRAWN" positions shall be made. Alternately, the mechanical closing facility shall be normally made inaccessible; accessibility being rendered only after deliberate removal of shrouds
8	It shall not be possible to open the ACB panel door in breaker closed condition. Further, the racking mechanism shall be accessible only after opening the breaker panel door

Note: The circuit breakers for DC applications shall have manually operated mechanism of spring charged, stored energy type. The closing operation of the circuit breaker shall charge the tripping spring. Necessary interlocks shall be provided to inhibit closing of the circuit breaker unless the closing spring is fully charged.

10.00.00 TELESCOPIC TROLLEY

Telescopic trolley or suitable arrangement shall be provided for maintenance of circuit breaker module in a cubicle. The trolley shall be such that the top most breaker module can be withdrawn on the trolley and can be lowered for maintenance purpose. The telescopic trolley shall be such that all type, size and rating of breaker can be withdrawn /inserted of particular switchgear. The quantity of telescopic trolleys to be supplied shall be 2 Nos. per switchgear room.



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11.00.00 AIR BREAK SWITCHES

Air break switches shall be of heavy duty, single throw, group operated, load break, fault make type when associated with fuses. All switches for motor circuits shall be of utilization category AC-23A with 1NO +1NC auxiliary contact, which shall be wired to the control circuit as shown in the schematic drawings. All switches for other outgoing feeders shall be of utilization category AC-22A. All switches for DC circuits shall be suitable for 240 V DC and shall be of DC-22 utilization category.

Continuous current rating of the switches shall be selected from the 'Module Selection tables' for various feeders.

The combination of switch-fuse unit would be preferred. However, if separate switch and fuses are provided, switch shall be located before fuses.

The main switches shall be operable from outside the module door. The switch handle shall clearly indicate the position of switch. Switch operating handles shall be provided with padlocking facilities. However, incomer switches of switchboards shall be provided with padlocking facility in both 'ON' and 'OFF' positions.

Interlocks shall be provided such that the cubicle door will not open when the switch is in closed position and the switch will close only when the door is closed.

Switches and fuses for AC/DC control supply and heater supply wherever required, shall be mounted inside the cubicles. Toggle switch is not acceptable.

Even if a single phase feeder is required for certain applications, Contractor shall provide TPN switch, fuse-bases and cable/ link connections between switch/fuse and vertical bus bars for all the three phases, so that changing from single phase feeder to three phase feeder is possible without any modification other than inserting fuses at site.

12.00.00 MCCB

MCCB shall be fixed type / part of withdraw able feeder module as per specification, three pole, air break type having trip free mechanism with quick make and quick break type contacts. MCCB shall have current limiting feature. MCCB of identical ratings shall be physically and electrically interchangeable. MCCB shall be provided with 1 NO and 1NC auxiliary contacts.

MCCB shall be provided with Microprocessor based inbuilt front adjustable releases (Overload & Short-circuit) and shall have adjustable Earth Fault protection unit also. The protection settings shall have suitable range to achieve the required time & current settings. LED indications shall also be provided for faults, MCCB status (on/off etc.).



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MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit rating. Extended cable terminal arrangement for higher size cable may also be offered. ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB to prevent opening of the door unless the MCCB is in OFF position. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlocked. The MCCBs being offered shall have common / interchangeable accessories for all ratings like aux. switch, shunt trip, alarm switch etc. The MCCBs shall have the current discrimination up to full short circuit capacity and shall be selected as per manufacturer's discrimination table.

Auxiliary contacts of the MCCBs pertaining to critical feeders, to be decided during detailed engineering, shall be connected to the digital inputs available in the numerical relays of Incomer / Bus-coupler / Outgoing circuit breaker feeders, for integration into the numerical relay network.

13.00.00 CONTROL AND SELECTOR SWITCHES

Control and selector switches shall be of heavy duty, rotary type with escutcheon plates clearly marked to show the positions. The control & selector switches should be as per IS/IEC 60947 Part V section 1. The switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.

Ammeter and voltmeter selector switches shall have four stay put positions with adequate number of contacts for 3-phase 4-wire system. These shall have oval handles. Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondary.

Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service.

The contact ratings shall be at least the following:

1	Make and carry, continuously, 10 A at 240 V DC and 110 V AC
2	Breaking current at 240 V DC, 1 A (inductive)
3	Breaking current at 110 V AC and 0.3 lagging p.f., 5A

14.00.00 CONTACTORS

Motor starter contactors shall be of air break, electromagnetic type rated for uninterrupted duty as per IS/IEC 60947 Part-4 Section- 1.

Contactors shall be double-break, non-gravity type and their main contacts shall be silver faced.



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Direct-on-line contactors shall be of utilization category AC3. Reversing starters shall comprise of Forward and Reverse contactors mechanically and electrically interlocked with each other. These contactors shall be of utilization category AC4. DC contactors shall be of DC3 utilization category. For CHP conveyor motors, minimum rating of power contactors shall be 240% of full load current of the motors. For other CHP drives, minimum rating of power contactors shall be 160% of full load current of motor.

The number of normally open (NO) and normally closed (NC) auxiliary contacts of a contactor shall be as per requirement shown in the respective module drawings. It shall, however, be not less than 2NO+2NC.

Operating coil of contactors shall be of 110 V AC unless otherwise specified elsewhere. The contactor shall operate satisfactorily between 85% and 110% of the rated voltage. The contactor shall not drop out at 70% of the rated voltage but shall definitely drop out at 20% of the rated voltage.

Contactors for DC drives shall have a coil voltage of 240 V DC. DC operated contactor coil shall have an economy resistor and shall be suitable for satisfactory continuous operation at 187-242 V DC/ 93.5-121 V

15.00.00 FUSES

All fuses shall be of HRC cartridge fuse link type. Screw type fuses shall not be accepted. Fuses for AC circuits shall be rated for 80kA rms (prospective) breaking capacity at 415V AC and for DC circuits, 20kA rms breaking capacity at 240V DC.

Fuse shall have visible operation indicators. Insulating barriers shall be provided between individual power fuses.

Fuse shall be mounted on insulated fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of bases. In such cases one set of insulated fuse pulling handles shall be supplied with each switchboard.

Fuse ratings shall be selected by the Contractor from the 'Module Selection Tables' for various feeder ratings. However, the fuse ratings for motor feeders given in the 'Motor Module Selection Table' are indicative only, and the same shall be coordinated by the Contractor to achieve class-II protection coordination and also to match the motor characteristics. Switch rating shall in no case be less than the fuse rating.

The Neutral links shall be mounted on fuse carriers which shall be mounted on fuse bases.



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16.00.00 INSTRUMENT TRANSFORMERS

All current and voltage transformers shall be of cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated condition and the specified ambient temperature. The class of insulation shall be 'E' or better.

Alternatively, current transformers with unbreakable, flame retardant, self-extinguishing Nylon casing of UL94 grade are also acceptable.

All instrument transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum RMS short circuit breaking and peak making current ratings of the associated switchgear.

All instrument transformers shall have clear indelible polarity markings. All secondary terminals shall be wired to separate terminals on an accessible terminal block where star point formation and earthing shall be done.

Current transformers may be multi or single-core type. All voltage transformers shall be single phase type.

The bus VTs shall be housed in a separate compartment. All VTs shall have readily accessible HRC current limiting fuses on both primary and secondary sides.

All CTs shall be provided with supports independent of bus bar / bus bar supports.

The CTs shall be located in such a way that they can be easily approached for maintenance without necessitating shut down of adjacent feeders.

17.00.00 NUMERICAL RELAYS & NETWORKING

All circuit breaker feeders shall be provided with communicable numerical relays complying with IEC-61850, having protection, control, measurement and monitoring features. These relays shall be connected to the Switchgear SCADA System, through Ethernet switches. The relays shall be flush mounted on panel front with connections from the inside. These numerical relays shall be of types as proven for the application and shall be subject to Employer's approval. Numerical relays shall have appropriate setting ranges, accuracy, resetting ratio and other characteristics to provide required sensitivity. All equipment shall have necessary protections as detailed in the standard scheme drawings / module type descriptions.

Control of circuit breakers shall be carried out from DDCMIS through hardwired control commands in the form of 24V DC signal. Preferably, binary input of all relays shall be configurable to accept 24V DC signals directly from DDCMIS and no separate coupling relays shall be provided. The Local control console of the relay flush mounted on the switchgear would normally be used only for testing of circuit breaker in isolated position, and for tripping it in an emergency. Provision for closing & tripping of the circuit breaker



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locally from laptop through serial port shall be possible to facilitate commissioning activities. The basic control scheme of breaker feeders shall be developed using the programmable (soft) logics in the relay.

Each numerical relay shall be connected to the Ethernet switch (in Employers' scope) provided in the Switchgear through Cat5e Ethernet /FO cable. Ethernet Switches shall be connected through Fibre Optic cable to form a ring network.

The numerical relay shall be capable of measuring and storing values of a wide range of quantities, events, faults and disturbance recordings. The alarm / status of each of protection function and trip operation shall be communicated to Switchgear SCADA / DDCMIS. The numerical relays shall have built in feature / hardware interface to provide such inputs to Switchgear SCADA / DDCMIS for analog / digital values.

The required .ICD / .CID files of the Numerical relays under the scope of this package for the integration with the SCADA shall be provided by the Numerical relay vendor along with necessary engineering support.

All relays shall be rated for control supply voltage as mentioned elsewhere under parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Contacts for breaker close and trip commands shall be so rated as to be used directly used in the closing and tripping circuits of breaker without the need of any interposing / master trip relays. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and typically shall be more than 70% of the rated control supply voltage. One minute power frequency withstand test voltage for all numerical relays shall at least be 2kV (rms).

Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation.

Disturbance Record waveforms, event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data.

All IEDs shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts, the quantity of which shall be adequate to realize the associated interlocks / feedbacks. In case the offered IED does not have the required number of I/Os, the same can be achieved through external I/O device of same make complying with the requirement stated elsewhere in this specification.

All the numerical relays shall have communications on three ports, local front port for communication with laptop and dual ports on IEC 61850 to communicate with the Switchgear SCADA System.

All the numerical relays shall have adequate processor memory for implementing the programmable scheme logic required for the realization of the protection / control schemes, in addition to the built in protection algorithms.



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All Numerical relays shall have features for electrical measurements including voltage, current, power (active & reactive), frequency, power-factor and energy parameters.

Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping.

Master trip (86) and non-86 trips shall be software configurable to output contacts and no separate master trip relay shall be used.

All numerical relays shall have provision of both current (CT) and voltage (VT) inputs. Relays shall be suitable for both residually connected neutral CT input as well as CBCT input. Relays shall be suitable for CT secondary current of 1A. Motor relays shall have 4 CT inputs. Relays for Incomers, Bus-couplers & Ties shall have 4 CT inputs. All relays except incomers, ties and bus-couplers shall have 3Nos of VT inputs. Relays used in incomers, ties and bus couplers shall have provision of two sets of voltage inputs (3Nos for bus voltage & 1No. for line voltage) for the purpose of synchronization.

All CT terminals on the relays shall be of fixed type suitable for connection of ring-type lugs to avoid any hazard due to loose connection leading to CT open-circuit. In no circumstances Plug-in type connectors shall be used for CT / VT connections.

All numerical relay shall have key pad / keys to allow relay settings from relay front. All hand reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote.

Relays shall have self-diagnostic feature with self-check for power failure, programmable routines, memory and main CPU failures and a separate output contact for indication of any failure.

Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC / ANSI programmable characteristics.

Design of the relay must be immune to any kind of electromagnetic interference. Vendor shall submit all related type test reports for the offered model along with the offer.

All cards / hardware of numerical relays shall be suitable for operation in Harsh Environmental conditions with respect to high temperature, humidity & dust.

Relay shall be immune to capacitance effect due to long length of connected control cables. Any external hardware, if required for avoiding mal operation of the relay due to cable capacitance shall be included as a standard feature.

All I/Os shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.



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Numerical relays shall have two level password protections, one for read only and other for authorization for modifying the setting etc.

Numerical relays shall have feature for Time synchronization through the Switchgear SCADA System. The resolution of time synchronization shall be +/- 1.0 millisecond or better throughout the entire system.

Relays & Ethernet switches shall be suitable to accept both AC & DC supplies with range 110V or 220V with tolerance of 70 % to 120 % of rated voltage & shall be finalized during detailed engineering.

18.00.00 OTHER PROTECTIONS AND CONTROL FUNCTIONS IN THE RELAYS

Trip circuit supervision shall be provided for all feeders to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

Schematics requiring auxiliary relays / timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer function for protection function shall be as required. Timer functions shall be programmable for on/off delays.

Bus no volt condition shall be configured to an output contact of the relay of incomers for suitably interfacing with DDCMIS wherever required.

The numerical relay shall be able to provide supervisory functions such as trip circuit monitoring, circuit breaker state monitoring, VT and CT supervisions and recording facilities with post fault analysis.

The numerical processor shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided.

At least 200 time tagged events / records shall be stored with time stamping. Details of at least 5 previous faults including the type of protection operated, operating time, all currents & voltages and time of fault.

Diagnostics Automatic testing, power on diagnostics with continuous monitoring to ensure high degree of reliability shall be provided. The results of the self-reset functions shall be stored in battery back memory. Test features such as examination of input quantities, status of digital inputs and relay outputs shall be available on the user interface.

The alarm/status of each individual protection function and trip operation shall be communicated to Switchgear SCADA / DDCMIS.



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Sequence of events shall have 1ms resolution at device level.

Measurement accuracy shall be 1 % for RMS Current and voltage.

It shall be possible to carryout open / close operation of breakers from a laptop by interfacing from the relay front port during initial commissioning.

Required No. of extra binary inputs shall be provided in the numerical relay for digital inputs from critical outgoing MCCB feeders on that switchgear section.

Circuit-breaker status, protection status, etc. required for control logics shall be hardwired to DDCMIS. In addition, any other requirement of digital & analog signals for process controls shall be taken care of.

19.00.00 TRAINING

The contractor shall arrange for training on design, engineering, Commissioning and operation & maintenance of LV Switchgear, Numerical relays and Switchgear networking system for a duration of one (1) man-months.

The scope shall include training for a batch of engineers and a separate batch of Supervisors/Technicians at Project Site. One such Workshop shall be organized before the commissioning of First LV Switchboard and the second workshop shall be conducted before final system Commissioning. Owner shall provide the required Infrastructure such as Training Conference room, Projection systems etc

20.00.00 INDICATING INSTRUMENTS

All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96mm square size with 90 degree linear scale and shall have an accuracy class of 1.0 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment without removing or dismantling the instruments.

All instruments shall have white dials with black numerals & lettering. Black knife edge pointer shall be provided for meters.

Ammeters provided for motor feeders (for motors of rating $\geq 30\text{kW}$ & $< 100\text{kW}$) shall have a compressed scale at the upper current region to cover the starting current up to 6.0 times the CT primary current.

All motor feeders of rating $\geq 30\text{ kW}$ and $< 110\text{ kW}$ shall be provided with Multifunction Digital Energy Meter with communication facility to display the current, voltage, power factor, power energy related data locally as well as communicate these for remote



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metering/audit/analysis purposes. These meters shall the technical specification for Digital indicating energy meter shall be as follows:

- a) Input Voltage: 110VAC / 220VDC
- b) Input Current: 1A
- c) Size: 96X96 SQ.MM
- d) Power & Energy Accuracy: 1.0
- e) Mounting: Flush mounting
- f) Type: True RMS 3-PHASE V, I, kW, PF & kWh indication
- g) 4 Digit, seven segment LED display/LCD display, with floating decimal
- h) Communication: In built RS 485 bus port
- i) Operating Frequency: 45 HZ-65HZ
- j) Dielectric Test: 2KV RMS for 1 minute
- k) Over Current: 10 times for 3 sec.
- l) Aux supply: 90V-300V AC/DC
- m) Compliance: EMC/EMI
- n) Field programmable CT ratio
- o) Analog Current Output (4-20 mA)

21.00.00 PUSH BUTTONS

Push-buttons shall be of spring return, push-to-actuate type. Their contacts shall be rated to make, continuously carry and break 10 A at 110 V AC and 1 A (inductive) at 220 V DC.

All push buttons shall have two (2) normally open and two (2) normally closed contact, unless specified otherwise. The contact faces shall be of silver alloy.

All push-buttons shall be provided with integral escutcheon plates marked with its function.

The colour of the button shall as follows:

Green for motor START, breaker CLOSE, valve/ damper OPEN commands. Red for motor trip, breaker open, valve / damper close commands.

Black for all annunciation functions, overload reset and miscellaneous commands including reverse for clinker grinder etc.

All push buttons on panels shall be located in such a way that Red push button shall always be to the left of Green push button. In case of clinker grinder etc. the push buttons would be black - red-green from left to right.

All emergency push buttons shall have mushroom knobs.



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22.00.00 INDICATING LAMPS

Indicating lamps shall be of CLUSTER LED type. The lamps shall have escutcheon plates marked with its function, wherever necessary.

Lamps shall have translucent lamp-covers of the following colours, as warranted by the application:

Red for motor ON, valve / damper OPEN, breaker CLOSE.

Green for motor OFF, valve / damper CLOSE, breaker OPEN.

White for motor AUTO TRIP.

Blue for all healthy conditions (e.g. control supply, and also for SPRING CHARGED").

Amber for all Alarm Conditions (e.g. overload). Also for "SERVICE" and "TEST" position indications.

Bulbs and lamp covers shall be easily replaceable from the front of the cubicle. The method of mounting indicating lamp fittings on panels shall prevent their rotation under the action of lamp removal or replacements, reliance upon the tightness of ring nut for the purpose is not sufficient.

Indicating lamps should be located just above the associated push-button / control switches. Red lamps shall invariably be located to the right of green lamps. In case a white lamp is also provided, it shall be placed between the red and green lamps along the centre line of control switch / push button pair. Blue and Amber should normally be located above the Red and Green lamps.

When associated with push-buttons, red lamps shall be directly above the green push-button and green lamp shall be directly above the red push button.

All indicating lamps shall be suitable for continuous operation at 90% to 110% of their rated voltage.

23.00.00 SPACE HEATER

Space heaters shall be provided in the switchboards wherever the manufacturer considers them necessary and recommends their provision for preventing harmful moisture condensation. The space heaters shall be suitable for continuous operation on 240 V AC, 50 Hz, single phase supply, and shall be automatically controlled by thermostats. Necessary switches and fuses shall be provided.

The circuit for each panel and motor space heater should have an isolating switch, HRC fuse and isolating link. In addition, the space heater circuit of each panel shall also have a thermostat of suitable rating.



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24.00.00 INTERNAL WIRING

All switchboards shall be supplied completely wired internally up to the terminals, ready to receive external cables.

All inter-cubicle and inter-panel wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided by the Contractor.

All auxiliary wiring shall be carried out with 650V grade, single core stranded Copper conductor, colour coded, PVC insulated wires. Conductor size shall be 1.5 mm² (min.) for control circuit wiring and 2.5 mm² (min) for CT and space heater circuits.

Extra flexible wires shall be used for wiring to devices mounted on moving parts such as hinged doors. The wire bunches from the panel inside to the doors shall be properly sleeved or taped.

All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminal blocks.

All internal wiring terminations shall be made with solderless crimping type tinned Copper lugs which shall firmly grip the conductor or an equally secure method. Similar lugs shall also be provided at both ends of component to component wiring. Insulating sleeves shall be provided over the exposed parts of lugs to the extent possible. Screw less (spring loaded) / cage clamp type terminal shall also be provided with lugs.

Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification marking shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring.

Wiring for equipment, which are to be supplied by the Contractor and for which the Contractor has to provide mounting arrangement in his panels, shall also be provided by the Contractor, up to the terminal blocks.

All connections from vertical bus bars for individual modules above 100 A shall be by Copper / Aluminium links only. The cable connections for modules less than 100 A shall be selected in such a way that there will not be any melting / shorting in case of a short circuit inside the module and the cable shall have current rating to carry the let through energy of the corresponding fuses in case of a fault. The insulation of the cable and its cross section shall be decided considering the high ambient temperature within the module. For all modules where use of cable is envisaged by the Contractor specific approval from the Employer regarding cable details are to be taken. For power wiring colour coded wire insulation / tapes shall be provided.



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25.00.00 CONTROL TERMINAL BLOCKS

Terminal blocks shall be 650V grade, 10Amps rated, made up of unbreakable polyamide 6.6 grade. The terminals shall be either screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design.

Terminal blocks for CT and VT secondary leads shall be of stud type, made up of unbreakable polyamide 6.6 grade. They shall be provided with links to facilitate testing, isolation star / delta formation and earthing. Terminal blocks for CT secondary shall have the short circuiting facility. The terminals for remote ammeter connection etc. shall also be disconnecting type only. All metal parts shall be of non-ferrous material. Screws shall be captive.

In all circuit breaker panels MCC modules at least 10% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks.

All terminal blocks shall be suitable for terminating on each side two (2) nos. stranded Copper conductors of size up to 2.5 sq. mm each, or alternatively, the terminal blocks shall have the possibility of double shorting space to facilitate looping. However for DDCMIS terminals shall be suitable for 1.5 mm² cable.

All terminals shall be numbered for identification and grouped according to the function. Engraved white-in-black labels shall be provided on the terminal blocks.

Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Terminal blocks shall be arranged with at least 100mm clearance between two sets of terminal blocks. The minimum clearance between the first row of terminal blocks and the associated cable gland plate shall be 250 mm.

26.00.00 POWER CABLE TERMINATION

Cable termination compartment and arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded Aluminium conductor, PVC/ XLPE insulated, armoured / unarmoured and PVC sheathed cables. The size and type of cable for individual modules shall, preferably, be as indicated in the 'Module Selection Tables'. All necessary cable terminating accessories such as supporting clamps and brackets, hardware etc. for cables shall be provided by the contractor to suit the final cable sizes.



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All power cable terminals shall be of stud type and the power cable lugs shall be of tinned Copper solderless crimping ring type conforming to IS: 8309. All lugs shall be insulated/ sleeved.

27.00.00 NAME PLATES AND LABELS

All Switchgears, MCCs, Distribution Boards, Fuse boards, all feeders, local push-button stations and local motor starters shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear switchgear also.

All name plates shall be of non-rusting metal or 3-ply Lamicoid, with white engraved lettering on black background. Letter size shall be of at least 10mm height.

Suitable stencilled paint mark shall be provided inside the panel/module for identification of all equipment in addition to the plastic sticker labels, if provided. These labels shall be positioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring drawings.

Caution name plate "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end.

28.00.00 LIGHTING / WELDING TRANSFORMERS

Each AC Lighting Distribution Board (LDB) shall be fed from 415V / 415V, 50kVA (minimum) isolating transformer & Each Welding Distribution Board (LDB) shall be fed from 415V / 415V, 100kVA isolating transformer. The lighting / welding transformer may, preferably, be located inside the LDB / Welding DB panel itself. Otherwise, the same shall be located by the side of respective LDB / Welding DB. Lighting / Welding transformers shall be dry type, natural air cooled with class B insulation or better. Impedance of lighting / Welding transformer shall be so selected that the fault level of lighting /Welding system shall be reduced to 3 to 5 KA. Lighting / welding transformers shall be tested as per IS: 2026. Off circuit tap changer with $\pm 2.5\%$ and $\pm 5\%$ tapping shall be provided. In case the transformers are not mounted inside the LDB panels, the same shall be housed in a separate 2 mm thick CR sheet steel enclosure with IP-42 degree of protection as per IS/IEC 60947. However, the transformer terminal box shall have IP-52 degree of protection.

29.00.00 PAINTING

All sheet steel work shall be pre-treated, in tanks, in accordance with IS: 6005. Degreasing shall be done by alkaline cleaning. Rust and scales shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be



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"Class-C" as specified in IS: 6005. The phosphated surfaces shall be rinsed and passivated. After passivation, Electrostatic Powder Coating shall be used. Powder should meet requirements of IS 13871 (Powder costing specification). Finishing paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards, unless required otherwise by the Employer. The paint thickness shall not be less than 50 microns. Finished parts shall be suitably packed and wrapped with protective covering to protect the finished surfaces from scratches, grease, dirt and oil spots during testing, transportation, handling and erection.

30.00.00 GASKETS

The gaskets, wherever specified, shall be of good quality EPDM / Neoprene with good ageing, compression and oil resistance characteristics suitable for panel applications.

31.00.00 TEMPERATURE –RISE

The temperature rise of the horizontal and vertical bus bars and main bus links including all power draw-out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55⁰ C with silver plated joints and 40⁰C with all other types of joints over an outside ambient temperature of 50⁰C. The temperature rise of the accessible parts/external enclosures expected to be touched in normal operation shall not exceed 20⁰C. The temperature rise of manual operating means shall not exceed 10⁰C for metallic & 15⁰C for insulating material. Temperature rise for the bus bars shall be carried out at 90% of the rated current. The above temperature rise limits are applicable for bus ducts also without any current derating.

32.00.00 DERATING OF EQUIPMENTS

The Contractor shall ensure that the equipment offered will carry the required load current at site ambient conditions specified and perform the operating duties without exceeding the permissible temperature as per Indian Standards / Specification. Continuous current rating at 50⁰C ambient in no case shall be less than 90% of the normal rating specified. The Contractor shall indicate clearly the derating factors if any employed for each component and furnish the basis for arriving at these derating factors duly considering the specified current ratings and ambient temperature of 50⁰C.

33.00.00 PROTECTION CO-ORDINATION

It shall be the responsibility of the Contractor to fully coordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers / fuses / motor starters, to provide satisfactory discrimination. Further the various equipment supplied shall meet the requirements of Type 2 class of Co-ordination as per IS: 8544.



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34.00.00 TESTS AND TEST REPORTS

GENERAL

- (a.) All equipment to be supplied shall be of type tested design. The Contractor shall submit for Employer's approval the reports of all the type tests as listed in this specification and carried out not earlier than ten years prior to the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
- (b.) In case the Contractor is not able to submit report of the type test(s) conducted not earlier than ten years prior to the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost either at third party lab or in presence of client/Employer's representative and submit the reports for approval.
- (c.) All routine tests as per the specification and relevant standards shall be carried out.

The following type test certificates of LT Switchgear and MCC panels shall be submitted.

1	Circuit breaker of each rating
	a) Test sequence 1
	b) Combined test sequence (With Circuit breakers mounted inside the Switchgear panel)
2	Complete design verification of Switchgear/MCC Panels as per IEC 61439 Part-1, Annexure-D
3	Internal arc test for Personnel and Assembly Protection as per IEC/TR 61641
4	MCC modules of any three ratings, as selected by the Employer, for class – II protection Co-ordination.
5	Test for single phasing protection feature on 3 nos. bimetallic thermal overload relay selected by Employer. The relay shall be tested for compliance with manufacturers printed / declared characteristic curve.

For the following equipment the contractor shall submit the reports of all the type tests as per applicable standards and carried out not earlier than ten years prior to the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. In case the Contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost to the Employer either at third party



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lab or in presence of client/Employer's representative and submit the reports for approval.

- (a.) NUMERICAL RELAYS
- (b.) LOCAL PUSH BUTTON STATION
- (c.) LOCAL MOTOR STARTER
- (d.) MCCB

Type test reports for the following tests on the model of the Numerical relays, Ethernet switches shall be submitted for Employer's review.

S. No.	TEST ITEMS	Standard
	Dimensions of structure and visual inspection	IEC 60297-3-101
	Functional requirements:	Relevant IEC 60255-100 series
	Product safety requirements	IEC 60255-27
	EMC requirements:	IEC 60255-26
	Energizing quantities:	IEC 60255-11
	Contact performance	N/A
	Communication requirements	Relevant IEC protocol standards
	Climatic environmental requirements:	IEC 60068-2-14/1/2/78/30,
	Mechanical requirements: – Shock	IEC 60255-21-1/2/3
	Enclosure protection	IEC 60255-27

The type test reports once approved for any projects shall be treated as reference. For subsequent projects of NTPC, an endorsement sheet will be furnished by the manufacturer confirming similarity and "No design Change". Minor changes if any shall be highlighted on the endorsement sheet.

All routine tests as per the specification and relevant standard IS 8623 shall be carried out.



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35.00.00 MODULEWISE BILL OF MATERIAL

SL NO	MODULE TYPE	ITEM DESCRIPTION	QTY.
1	DAET (I/C)	PCC/PMCC INCOMER OF 1600A, 2500A, 3000A, 3200A, 4000A SHALL COMPRISE OF:	
		ACB TP, ELECTRICALLY OPERATED D/O TYPE, WITHOUT RELEASES, CONTROL SUPPLY VOLTAGE 220V DC, 4NO + 4NC AUXILIARY CONTACTS (FOR CUSTOMER USE), POSITION LIMIT SWITCH FOR TEST & SERVICE POSITION. SPRING CHARGE LIMIT SWITCH, OPERATION COUNTER, DOOR INTERLOCK WITH PAD LOCKING FACILITY	1
		CONTROL FUSE 6A	15
		CONTROL FUSE 16A	4
		FUSE BASE 32A	19
		INDICATING LAMP	5
		CURRENT TRANSFORMER (PROTECTION & METERING) 10VA,CL-5P20	3
		CURRENT TRANSFORMER (PROTECTION) with VDR 10VA,CL-PS	3
		POTENTIAL TRANSFORMER -CAST RESIN, OVER VOLTAGE FACTOR 1.2 CONT./1.5 FOR 30 SEC . 415/110,50 VA CL-0.5 INSL CL-E	1
		NEUTRAL LINK 32A	1
		CONTROL TERMINALS(FIXED)	As required
		CT SHORTING TERMINAL-STUD TYPE	As required
		POWER TERMINAL	As required
		DOUBLE POLE ON/OFF SWITCH-16 A,220 V DC	2
		2POLE 2POS1 SELECTOR SWITCH KEY LOCKABLE-10A, 220VDC	1
		NUMERICAL RELAY WITH COMMUNICATION FACILITY AS PER IEC-61850 SHALL HAVE METERING FACILITY AND FOLLOWING PROTECTION FUNCTIONS:50,50N,51,51N,51Ns,64,64R,25,27,95,CBM, PT FUSE FAILURE.	1
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
2	DAE (I/C)	MCC INCOMER OF 630A, 800A, 1000A, 1250A, 1600A,2500A SHALL COMPRISE OF:	



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SL NO	MODULE TYPE	ITEM DESCRIPTION	QTY.
		ACB TP, ELECTRICALLY OPERATED D/O TYPE, WITHOUT RELEASES, CONTROL SUPPLY VOLTAGE 220V DC, 4NO + 4NC AUXILIARY CONTACTS (FOR CUSTOMER USE), POSITION LIMIT SWITCH FOR TEST & SERVICE POSITION. SPRING CHARGE LIMIT SWITCH, OPERATION COUNTER, DOOR INTERLOCK WITH PAD LOCKING FACILITY	1
		CONTROL FUSE 6A	15
		CONTROL FUSE 16A	4
		FUSE BASE 32A	19
		INDICATING LAMP	5
		CURRENT TRANSFORMER (PROTECTION & METERING) 10VA,CL-5P20	3
		POTENTIAL TRANSFORMER -CAST RESIN, OVER VOLTAGE FACTOR 1.2 CONT./1.5 FOR 30 SEC . 415/110,50 VA CL-0.5 INSL CL-E	1
		NEUTRAL LINK 32A	1
		CONTROL TERMINALS(FIXED)	As required
		CT SHORTING TERMINAL-STUD TYPE	As required
		POWER TERMINAL	As required
		DOUBLE POLE ON/OFF SWITCH-16 A,220 V DC	2
		2POLE 2POS1 SELECTOR SWITCH KEY LOCKABLE-10A, 220VDC	1
		NUMERICAL RELAY WITH COMMUNICATION FACILITY AS PER IEC-61850 SHALL HAVE METERING FACILITY AND FOLLOWING PROTECTION FUNCTIONS:50,50N,51,51N,51Ns,64,25,27,95,CBM, PT FUSE FAILURE.	1
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
3	DAET/DAE (B/C)	PMCC/MCC BUSCOUPLER OF 630A, 800A, 1000A, 1250A, 1600A, 2500A, 3000A, 3200A,4000A SHALL COMPRISE OF:	
		ACB TP, ELECTRICALLY OPERATED D/O TYPE, WITHOUT RELEASES, CONTROL SUPPLY VOLTAGE 220V DC, 4NO + 4NC AUXILIARY CONTACTS (FOR CUSTOMER USE), POSITION LIMIT SWITCH FOR TEST & SERVICE POSITION. SPRING CHARGE LIMIT SWITCH, OPERATION COUNTER, DOOR INTERLOCK WITH PAD LOCKING FACILITY	1
		CONTROL FUSE 6A	9



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SL NO	MODULE TYPE	ITEM DESCRIPTION	QTY.
		CONTROL FUSE 16A	6
		FUSE BASE 32A	15
		AUXILIARY CONTACTOR 2NO+2NC 220VDC	3
		BREAKER CONTACT MULTIPLICATION RELAY (MECHANICALLY LATCH ELECTRICALLY RESET) TYPE VAJC 11 OR EQVT	1
		INDICATING LAMP	4
		CURRENT TRANSFORMER (PROTECTION) 10VA,CL-5P20	3
		NEUTRAL LINK 32A	1
		CONTROL TERMINALS(FIXED)	As required
		CT SHORTING TERMINAL-STUD TYPE	As required
		POWER TERMINAL	As required
		DOUBLE POLE ON/OFF SWITCH-16 A,220 V DC	5
		2POLE 2POS1 SELECTOR SWITCH KEY LOCKABLE-10A, 220VDC	1
		NUMERICAL RELAY WITH COMMUNICATION FACILITY AS PER IEC-61850 SHALL HAVE METERING FACILITY AND FOLLOWING PROTECTION FUNCTIONS:50,50N,51,51N,51Ns,64,25,27,95,CBM, PT FUSE FAILURE.	1
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
		DC SOURCE SLECTION SWITCH	2
4	DAEG(-I/C)	EMERGENCY MCC INCOMER OF 800A, 1000A, 1250A, 1600A, 2000A, 2500A,3200A,4000A SHALL COMPRISE OF:	
		ACB TP, ELECTRICALLY OPERATED D/O TYPE, WITHOUT RELEASES, CONTROL SUPPLY VOLTAGE 220V DC, 4NO + 4NC AUXILIARY CONTACTS (FOR CUSTOMER USE), POSITION LIMIT SWITCH FOR TEST & SERVICE POSITION. SPRING CHARGE LIMIT SWITCH, OPERATION COUNTER, DOOR INTERLOCK WITH PAD LOCKING FACILITY	1
		CONTROL FUSE 6A	15
		CONTROL FUSE 16A	4
		FUSE BASE 32A	19
		INDICATING LAMP	5
		CURRENT TRANSFORMER (PROTECTION & METERING) 10VA,CL-5P20	3



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SL NO	MODULE TYPE	ITEM DESCRIPTION	QTY.
		CURRENT TRANSFORMER (PROTECTION) with VDR 10VA,CL-PS	3
		POTENTIAL TRANSFORMER -CAST RESIN, OVER VOLTAGE FACTOR 1.2 CONT./1.5 FOR 30 SEC . 415/110,50 VA CL-0.5 INSL CL-E	1
		NEUTRAL LINK 32A	1
		CONTROL TERMINALS(FIXED)	As required
		CT SHORTING TERMINAL-STUD TYPE	As required
		POWER TERMINAL	As required
		DOUBLE POLE ON/OFF SWITCH-16 A,220 V DC	2
		2POLE 2POS1 SELECTOR SWITCH KEY LOCKABLE-10A, 220VDC	1
		NUMERICAL RELAY WITH COMMUNICATION FACILITY AS PER IEC-61850 SHALL HAVE METERING FACILITY AND FOLLOWING PROTECTION FUNCTIONS:50,50N,51,51N,51Ns,64,64R,25,27,95,CBM, PT FUSE FAILURE.DIFFERENTIAL PROTECTION (HIGH IMPEDANCE),REVERSE POWER PROTECTION,DG NEUTRAL DISPLACEMENT, DG MONITORING	1
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
5	DAE/DAE-TIE (O/G)	OUTGOING BREAKER FEEDER OF 630A, 800A, 1000A, 1250A, 1600A, 2500A SHALL COMPRISE OF:	
		ACB TP, ELECTRICALLY OPERATED D/O TYPE, WITHOUT RELEASES, CONTROL SUPPLY VOLTAGE 220V DC, 4NO + 4NC AUXILIARY CONTACTS (FOR CUSTOMER USE), POSITION LIMIT SWITCH FOR TEST & SERVICE POSITION. SPRING CHARGE LIMIT SWITCH, OPERATION COUNTER, DOOR INTERLOCK WITH PAD LOCKING FACILITY	1
		CONTROL FUSE 6A	8
		CONTROL FUSE 16A	2
		FUSE BASE 32A	10
		INDICATING LAMP	3
		CURRENT TRANSFORMER (PROTECTION & METERING) 10VA,CL-5P20	3
		NEUTRAL LINK 32A	1
		CONTROL TERMINALS(FIXED)	As required
		CT SHORTING TERMINAL-STUD TYPE	As required
		POWER TERMINAL	As required



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SL NO	MODULE TYPE	ITEM DESCRIPTION	QTY.
		DOUBLE POLE ON/OFF SWITCH-16 A,220 V DC	1
		2POLE 2POS1 SELECTOR SWITCH KEY LOCKABLE-10A, 220VDC	1
		NUMERICAL RELAY WITH COMMUNICATION FACILITY AS PER IEC-61850 SHALL HAVE METERING FACILITY AND FOLLOWING PROTECTION FUNCTIONS: 50, 50N, 51, 51N, 51Ns, 64, 27, 95, CBM, PT FUSE FAILURE.	1
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
6	DM /PM	BREAKER CONTROLLED MOTOR 110KW & ABOVE SHALL COMPRISE OF:	
		ACB TP, ELECTRICALLY OPERATED D/O TYPE, WITHOUT RELEASES, CONTROL SUPPLY VOLTAGE 220V DC, 4NO + 4NC AUXILIARY CONTACTS (FOR CUSTOMER USE), POSITION LIMIT SWITCH FOR TEST & SERVICE POSITION. SPRING CHARGE LIMIT SWITCH, OPERATION COUNTER, DOOR INTERLOCK WITH PAD LOCKING FACILITY	1
		CONTROL FUSE 6A	9
		CONTROL FUSE 16A	2
		FUSE BASE 32A	11
		Indicating Lamp	2
		CURRENT TRANSFORMER (METERING) 10VA, CL-1	1
		CURRENT TRANSFORMER (PROTECTION) 10VA,CL-5P20	3
		CURRENT TRANSDUCER (DC),4-20mA, DUAL O/P,AUX.-220V DC	1
		NEUTRAL LINK 32A	1
		CONTROL TERMINALS(FIXED)	As required
		CT SHORTING TERMINAL-STUD TYPE	As required
		POWER TERMINAL	As required
		SP ON/OFF ROTARY SWITCH FOR MOTOR SPACE HTR. OF BREAKER MOTOR FDR-12A, 240VAC	1
		DOUBLE POLE ON/OFF SWITCH-16 A,220 V DC	1
		2POLE 2POS1tion SELECTOR SWITCH KEY LOCKABLE-10A, 220VDC	1



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SL NO	MODULE TYPE	ITEM DESCRIPTION	QTY.
		NUMERICAL RELAY WITH COMMUNICATION FACILITY AS PER IEC-61850 SHALL HAVE METERING FACILITY AND FOLLOWING PROTECTION FUNCTIONS:50,50N,51,51N,64,27,95,CBM,BLOCKED ROTOR PROTECTION ,CURRENT UNBALANCE PROTECTION,NEGATIVE PHASE SEQUENCE, THERMAL OVERLOAD TRIP	1
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
7	G1	BUS PT MODULE FOR PCC / PMCC SHALL COMPRISE OF:	
		CONTROL FUSE-6A	7
		FUSE BASE-32A	7
		POTENTIAL TRANSFORMER -415/ROOT3 /110/ROOT3, 50 VA CL-0.5 INSL CL-E	3
		NEUTRAL LINK-32A	1
		CONTROL TERMINALS(FIXED)	As required
8	G2	BUS PT MODULE FOR DG PCC SHALL COMPRISE OF:	
		CONTROL FUSE-6A	7
		FUSE BASE-32A	7
		POTENTIAL TRANSFORMER -415/ROOT3 /110/ROOT3, 50 VA CL-0.5 INSL CL-E	3
		NEUTRAL LINK-32A	1
		CONTROL TERMINALS(FIXED)	As required
9	VM	BUS PT MODULE FOR MCC/ACDB SHALL COMPRISE OF:	
		CONTROL FUSE-6A	3
		FUSE BASE-32A	3
		AUX. CONTACTOR 2NO+2NC CV. 415 V AC	2
		VOLTMETER (AC),96 X 96 mm2, SCALE-90, CL-1.5,0-500V DIRECT	1
		VOLTAGE TRANSDUCER (AC),4-20 m A DUAL O/P AUX. 220 V DC,0-500/4-20mA, 415V DIRECT	1
		VOLTMETER SELECTOR SWITCH-12 A,415 V AC	1
10	CS	EACH CONTROL SUPPLY OUTGOING SHALL COMPRISE OF:	



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		CONTROL FUSE-6A	4
		CONTROL FUSE-25A	4
		FUSE BASE-32A	8
		AUX. CONTACTOR , 2NO+2NC,CV. 110 V AC	4
		NEUTRAL LINK-32A	6
		CONTROL TERMINALS(FIXED)	As required
		POWER TERMINALS	As required
		CONTROL TRANSFORMER,DRY TYPE, CAST RESIN,415/110V	2
		4POLE,2POSI, SELECTOR SWITCH FOR CONTROL TRF.-25A, 110V AC	2
11	DB	220V DC INCOMER FROM BATTERY SHALL COMPRISE OF:	
		DC AMMETER WITH SHUNT AND CENTER ZERO	1
		DC FUSE BOX WITH FUSE FAILURE MONITORING RELAY	1
12	DC	220V DC BUS COUPLER SHALL COMPRISE OF:	
		DOUBLE POLE 250V DC SWITCH/ISOLATOR/CIRCUIT BREAKER WITH 2NO+2NC AUXILIARY CONTACTS	1
13	CH	220V DC INCOMER OF DCDB FROM CHARGER SHALL COMPRISE OF:	
		DOUBLE POLE 250V DC SWITCH/ISOLATOR/CIRCUIT BREAKER WITH 2NO+2NC AUXILIARY CONTACTS	1
		INDICATING LAMP	2
		DC VOLTMETER	1
		DC AMMETER WITH SHUNT AND CENTER ZERO	1
		CURRENT TRANSDUCER	1
14	HD	220V DC ISOLATING SWITCH/CIRCUIT BREAK MODULE SHALL COMPRISE OF:	
		DOUBLE POLE 250V DC SWITCH/ISOLATOR/CIRCUIT BREAKER WITH 2NO+2NC AUXILIARY CONTACTS	1
15	S	220V DCDB BUS MODULE FOR METERING & PROTECTION SHALL COMPRISE OF:	
		UNDERVOLTAGE (INSTANNANEIOUS WITH SETTING OF 95% OF 220VDC. THE RESETING OF RELAY SHOULD NOT BE MORE THAN 1.05)	1



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		OVERVOLTAGE (INSTANEOUS WHICH SHALL OPERATE AT 110% OF 220V DC. THE RESETINGRATION SHOULD NOT BE LESS THAN .95)	1
		EARTHFAULT (CAEM21 OR EQV.)	1
		INDICATING LAMP	2
		CONTROL FUSE-6A	3
		FUSE BASE-32A	3
		NEUTRAL LINK	1
		DC VOLTAGE METER (0-300V)	1
		VOLTMETER SELECTOR SWITCH	1
		AUXILIARY CONTACTOR,2NO+2NC,CV 220AC	1
		PUSH BUTTON- SPRING RETURN WITH 1NO+1NC AUX, CONTACT	2
16	X	220V DC OUTGOING FEEDER SHALL COMPRISE OF:	
		DOUBLE POLE 220V DC FUSE SWITCH UNIT	1
		HRC FUSES	2
17	CC	ISOLATOR INCOMER WITH CONTACTOR UPTO 630A SHALL COMPRISE OF	
		3 POLE LOAD BREAK ISOLATING SWITCH	2
		Power Fuse	6
		Auxiliary Switch	1
		INDICATING LAMP	4
		CONTROL FUSE-6A	5
		FUSE BASE-32A	5
		SERVICE POSITION LIMIT SWITCH	2
		3 POLE POWER CONTACTOR WITH COIL SUITABLE FOR 415V AC WITH 2NO+2NC AUX	2
		AUXILIARY CONTACTOR 2NO+2NC ,CV 415V AC	2
		TERMINAL BLOCKS (FIXED)	30
18	EM3 (I/C)	INCOMER MCCB FOR MCC / ACDB FOR RATING from 100A UPTO 630A	
		CONTROL FUSE-6A	1
		FUSE BASE-32A	1
		MCCB TP MICROPROCESSOR BASED ADJ. O/L,S/C & E/F RELEASE	1
		AUX. SWITCH FOR MCCB-2C/O	2
		ALARM SWITCH FOR MCCB-1C/O	1



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		EXTENDED ROTORY HANDLE	1
		INDICATION LAMP	3
		NEUTRAL LINK 32A	1
		NEUTRAL LINK AS PER MCCB RATING	1
		CONTROL TERMINALS (DRAWOUT)	AS REQUIRED
19	EM3 (B/C)	BUSCOUPLER MCCB FOR MCC / ACDB FOR RATING UPTO 630A	
		MCCB TP MICROPROCESSOR BASED ADJ. O/L,S/C & E/F RELEASE	1
		AUX. SWITCH FOR MCCB-2C/O	2
		ALARM SWITCH FOR MCCB-1C/O	1
		EXTENDED ROTORY HANDLE	1
		AUXILARY CONTACTOR	2
		CONTROL FUSES-6A	2
		FUSE BASE-32A	2
		NEUTRAL LINK	3
		INDICATING LAMP	2
		CASTLE KEY (3 LOCK 2 KEY)	1
		CONTROL TERMINALS (DRAWOUT)	AS REQUIRED
20(A)	E/E3	TPN AC OUTGOING MCCB OPERATED FEEDER FOR RATING 100A AND ABOVE	
		MCCB TP MICROPROCESSOR BASED ADJ. O/L,S/C & E/F RELEASE	1
		AUX. SWITCH FOR MCCB-2C/O	2
		ALARM SWITCH FOR MCCB-1C/O	1
		EXTENDED ROTORY HANDLE	1
		CONTROL FUSES-6A	2
		FUSE BASE-32A	2
		NEUTRAL LINK	2
		INDICATING LAMP	3
		NETURAL LINK EQUIVALENT TO POWER FUSE RATING	1
		CONTROL TERMINALS (DRAWOUT)	AS REQUIRED
20(B)	E/E3	TPN AC OUTGOING SFU OPERATED FEEDER FOR RATING below 100A	
		3 POLES SWITCH FUSE UNIT	1
		POWER FUSE	3



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		NETURAL LINK EQUIVALENT TO POWER FUSE RATING	1
21(A)	E2	2 POLE AC OUTGOING MCCB OPERATED FEEDER FOR RATING 100A AND ABOVE	
		MCCB TP MICROPROCESSOR BASED ADJ. O/L,S/C & E/F RELEASE	1
		AUX. SWITCH FOR MCCB-2C/O	2
		ALARM SWITCH FOR MCCB-1C/O	1
		EXTENDED ROTORY HANDLE	1
		CONTROL FUSES-6A	2
		FUSE BASE-32A	2
		NEUTRAL LINK	2
		INDICATING LAMP	3
		NETURAL LINK EQUIVALENT TO POWER FUSE RATING	1
		CONTROL TERMINALS (DRAWOUT)	AS REQUIRED
21(B)	E2	2 POLE AC OUTGOING SFU OPERATED FEEDER FOR RATING below 100A	
		2 POLE SWITCH FUSE UNIT	1
		HRC FUSE (POWER)	2
		NETURAL LINK EQUIVALENT TO POWER FUSE RATING	1
22(A)	E1	SINGLE PHASE AC OUTGOING MCCB OPERATED FEEDER FOR RATING 100A AND ABOVE	
		MCCB TP MICROPROCESSOR BASED ADJ. O/L,S/C & E/F RELEASE	1
		AUX. SWITCH FOR MCCB-2C/O	2
		ALARM SWITCH FOR MCCB-1C/O	1
		EXTENDED ROTORY HANDLE	1
		CONTROL FUSES-6A	2
		FUSE BASE-32A	2
		NEUTRAL LINK	2
		INDICATING LAMP	3
		NETURAL LINK EQUIVALENT TO POWER FUSE RATING	1
		CONTROL TERMINALS (DRAWOUT)	AS REQUIRED
22(B)	E1	SINGLE PHASE AC OUTGOING SFU OPERATED FEEDER FOR RATING below 100A	
		3 POLESWITCH FUSE UNIT	1



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		HRC FUSE (POWER)	1
		NETURAL LINK EQUIVALENT TO POWER FUSE RATING	1
23	DK2/PK2/ AK2	UNIDIRECTIONAL MOTOR FEEDER BELOW 30KW (CONTROLLED FROM ATRS/DDCMIS/PLC SHALL COMPRISE OF:	
		3 POLE SWITCH FUSE UNIT	1
		AUX. CONTACT FOR SFU (1NO+1NC)	1
		HRC FUSE (POWER)	3
		CONTROL FUSE-6A	1
		FUSE BASE-32A	1
		POWER CONTACTOR(AC) WITH2NO+2NC AUX CONTACT COIL VOLTAGE 110V AC	1
		AUX. CONTACTOR,2NO+2NC, CV. 110 V AC	2
		ADD ON AUX. CONTACTOR BLOCK 2NO+2NC	1
		OVERLOAD RELAY,BUILT IN SINGLE PHASE PROTECTION FEATURE 1NO+1NC AUX. & INDEPENDENT MOUNTING TYPE	1
		RESET CORD ACTUATOR	1
		INDICATING LAMP	4
		NEUTRAL LINK-32A	1
		CONTROL TERMINALS (DRAWOUT)	30
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
24	DK21/PK21/ AK21	UNIDIRECTIONAL MOTOR FEEDER 30KW & ABOVE UPTO 110KW CONTROLLED FROM DDCMIS/PLC/ATRS SHALL COMPRISE OF:	
		3 POLE SWITCH FUSE UNIT	1
		AUX. CONTACT FOR SFU (1NO+1NC)	1
		HRC FUSE (POWER)	3
		CONTROL FUSE-6A	2
		FUSE BASE-32A	2
		POWER CONTACTOR(AC) WITH 2NO+2NC AUX CONTACT COIL VOLTAGE 110V AC	1
		AUX. CONTACTOR,2NO+2NC CV. 110 V AC	2
		ADD ON AUX. CONTACTOR BLOCK 2NO+2NC	1
		OVERLOAD RELAY,BUILT IN SPPR FEATURE 1NO+1NC AUX. & INDEPENDENT MOUNTING TYPE	1
		RESET CORD ACTUATOR	1



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		INDICATING LAMP	4
		CURRENT TRANSFORMER (METERING) 10VA, CL-1	3
		AMMETER CT SEC 1A (AC),96 X 96 mm2, SCALE-90, CL-1.5	1
		CURRENT TRANSDUCER (AC),4-20mA, DUAL O/P,AUX.-110V AC	1
		NEUTRAL LINK	1
		CONTROL TERMINALS (DRAWOUT)	50
		CT SHORTING TERMINAL-STUD TYPE	18
		SP ON/OFF SWITCH FOR MOTOR SPACE HTR. OF MOTOR FDR.,10A, 240VAC	1
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
		Digital Energy Meter /MFM with Analog output of Current (4-20 mA)	1
25	EA1	1-PHASE SFU+ CONTACTOR CONTROLLED FEEDER SHALL COMPRISE OF:	
		3 POLE SWITCH FUSE UNIT	1
		AUX. CONTACT FOR SFU (1NO+1NC)	1
		HRC FUSE (POWER)	2
		CONTROL FUSE-6A	1
		FUSE BASE-32A	1
		2P POWER CONTACTOR(AC) WITH 2NO+2NC AUX CONTACT COIL VOLTAGE 110V AC	1
		AUX. CONTACTOR,2NO+2NC, CV. 110 V AC	2
		ADD ON AUX. CONTACTOR BLOCK 2NO+2NC	1
		INDICATING LAMP	4
		NEUTRAL LINK-32A	1
		CONTROL TERMINALS (DRAWOUT)	30
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
26	EA3	3-PHASE SFU CONTACTOR CONTROLLED FEEDER SHALL COMPRISE OF:	
		3 POLE SWITCH FUSE UNIT	1
		AUX. CONTACT FOR SFU (1NO+1NC)	1
		HRC FUSE (POWER)	3
		CONTROL FUSE-6A	1
		FUSE BASE-32A	1



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		3P POWER CONTACTOR(AC) WITH 2NO+2NC AUX CONTACT COIL VOLTAGE 110V AC	1
		AUX. CONTACTOR,2NO+2NC, CV. 110 V AC	2
		ADD ON AUX. CONTACTOR BLOCK 2NO+2NC	1
		INDICATING LAMP	3
		NEUTRAL LINK-32A	1
		CONTROL TERMINALS (DRAWOUT)	As required
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
27	DK2E	UNIDIRECTIONAL MOTOR FEEDER (RE-ACCELERATION) BELOW 30KW CONTROLLED FROM DDCMIS/PLC/ ATRS SHALL COMPRISE OF:	
		3 POLE SWITCH FUSE UNIT	1
		AUX. CONTACT FOR SFU (1NO+1NC)	1
		HRC FUSE (POWER)	3
		3P POWER CONTACTOR(AC) WITH 2NO+2NC AUX CONTACT COIL VOLTAGE 110V AC	1
		OVERLOAD RELAY,BUILT IN SPPR FEATURE 1NO+1NC AUX. & INDEPENDENT MOUNTING TYPE	1
		RESET CORD ACTUATOR	1
		INDICATING LAMP	4
		CONTROL FUSE	4
		Contorl Fuse base	4
		NEUTRAL LINK	2
		CONTROL TERMINALS (DRAWOUT)	30
		AUX. CONTACTOR,2NO+2NC CV. 110 V AC	2
		ADD ON AUX. CONTACTOR BLOCK 2NO+2NC	1
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
		MOTOR RESTART TIMER	1
28	DK21E	UNIDIRECTIONAL MOTOR FEEDER (RE-ACCELERATION) 30KW & ABOVE UPTO 110KW CONTROLLED FROM ATRS/DDCMIS/PLC SHALL COMPRISE OF:	
		3 POLE SWITCH FUSE UNIT	1
		AUX. CONTACT FOR SFU (1NO+1NC)	1
		HRC FUSE (POWER)	3



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		3P POWER CONTACTOR(AC) WITH 2NO+2NC AUX CONTACT COIL VOLTAGE 110V AC	1
		OVERLOAD RELAY,BUILT IN SPPR FEATURE 1NO+1NC AUX. & INDEPENDENT MOUNTING TYPE	1
		RESET CORD ACTUATOR	1
		INDICATING LAMP	4
		CONTROL FUSE	8
		Contorl Fuse base	8
		NEUTRAL LINK	2
		AUX. CONTACTOR,2NO+2NC CV. 110 V AC	2
		ADD ON AUX. CONTACTOR BLOCK 2NO+2NC	1
		CONTROL TERMINALS (DRAWOUT)	50
		CT SHORTING TERMINAL-STUD TYPE	18
		SP ON/OFF SWITCH FOR MOTOR SPACE HTR. OF MOTOR FDR.,10A, 240VAC	1
		CURRENT TRANSFORMER (METERING) 10VA, CL-1	1
		AMMETER CT SEC 1A (AC),96 X 96 mm2, SCALE-90, CL-1.5	3
		CURRENT TRANSDUCER (AC),4-20mA, DUAL O/P,AUX.-110V AC	1
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
		Digital Energy Meter /MFM with Analog output of Current (4-20 mA)	1
		MOTOR RESTART TIMER	1
29	K2	UNIDIRECTIONAL MOTOR FEEDER BELOW 30KW CONTROLLED FROM LPBS SHALL COMPRISE OF:	
		3 POLE SWITCH FUSE UNIT	1
		AUX. CONTACT FOR SFU (1NO+1NC)	1
		HRC FUSE (POWER)	3
		CONTROL FUSE-6A	1
		FUSE BASE-32A	1
		POWER CONTACTOR(AC) WITH2NO+2NC AUX CONTACT COIL VOLTAGE 110V AC	1
		AUX. CONTACTOR,2NO+2NC, CV. 110 V AC	2
		ADD ON AUX. CONTACTOR BLOCK 2NO+2NC	1
		OVERLOAD RELAY,BUILT IN SINGLE PHASE PROTECTION FEATURE 1NO+1NC AUX. & INDEPENDENT MOUNTING TYPE	1



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SL NO	MODULE TYPE	ITEM DESCRIPTION	QTY.
		RESET CORD ACTUATOR	1
		INDICATING LAMP	4
		NEUTRAL LINK-32A	1
		CONTROL TERMINALS (DRAWOUT)	30
30	K21	UNIDIRECTIONAL MOTOR FEEDER 30KW & ABOVE UPTO 110KW CONTROLLED FROM LPBS SHALL COMPRISE OF:	
		3 POLE SWITCH FUSE UNIT	1
		AUX. CONTACT FOR SFU (1NO+1NC)	1
		HRC FUSE (POWER)	3
		CONTROL FUSE-6A	2
		FUSE BASE-32A	2
		POWER CONTACTOR(AC) WITH 2NO+2NC AUX CONTACT COIL VOLTAGE 110V AC	1
		AUX. CONTACTOR,2NO+2NC CV. 110 V AC	2
		ADD ON AUX. CONTACTOR BLOCK 2NO+2NC	1
		OVERLOAD RELAY,BUILT IN SPPR FEATURE 1NO+1NC AUX. & INDEPENDENT MOUNTING TYPE	1
		RESET CORD ACTUATOR	1
		INDICATING LAMP	4
		CURRENT TRANSFORMER (METERING) 10VA, CL-1	3
		AMMETER CT SEC 1A (AC),96 X 96 mm2, SCALE-90, CL-1.5	1
		CURRENT TRANSDUCER (AC),4-20mA, DUAL O/P,AUX.-110V AC	1
		NEUTRAL LINK	1
		CONTROL TERMINALS (DRAWOUT)	50
		CT SHORTING TERMINAL-STUD TYPE	18
		SP ON/OFF SWITCH FOR MOTOR SPACE HTR. OF MOTOR FDR.,10A, 240VAC	1
		Digital Energy Meter /MFM with Analog output of Current (4-20 mA)	1
31	DN1	BIDIRECTIONAL MOTOR FEEDER CONTROLLED FROM DDCMIS SHALL COMPRISE OF:	
		3 POLE SWITCH FUSE UNIT	1
		AUX. CONTACT FOR SFU (1NO+1NC)	1
		HRC FUSE (POWER)	3
		CONTROL FUSE-6A	1



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		FUSE BASE-32A	1
		POWER CONTACTOR(AC) WITH2NO+2NC AUX CONTACT COIL VOLTAGE 110V AC WITH MECHANICAL INTERLOCK	2
		AUX. CONTACTOR,2NO+2NC, CV. 110 V AC	2
		ADD ON AUX. CONTACTOR BLOCK 2NO+2NC	1
		OVERLOAD RELAY,BUILT IN SINGLE PHASE PROTECTION FEATURE 1NO+1NC AUX. & INDEPENDENT MOUNTING TYPE	1
		RESET CORD ACTUATOR	1
		INDICATING LAMP	5
		NEUTRAL LINK-32A	1
		CONTROL TERMINALS (DRAWOUT)	50
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
32	DK2*/PK2*/AK2*	UNIDIRECTIONAL ESSENTIAL MOTOR FEEDER BELOW 30KW (CONTROLLED FROM ATRS/DDCMIS/PLC SHALL COMPRISE OF:	
		3 POLE SWITCH FUSE UNIT	1
		AUX. CONTACT FOR SFU (1NO+1NC)	1
		HRC FUSE (POWER)	3
		CONTROL FUSE-6A	1
		FUSE BASE-32A	1
		POWER CONTACTOR(AC) WITH2NO+2NC AUX CONTACT COIL VOLTAGE 110V AC	1
		AUX. CONTACTOR,2NO+2NC, CV. 110 V AC	2
		ADD ON AUX. CONTACTOR BLOCK 2NO+2NC	1
		OVERLOAD RELAY,BUILT IN SINGLE PHASE PROTECTION FEATURE 1NO+1NC AUX. & INDEPENDENT MOUNTING TYPE	1
		RESET CORD ACTUATOR	1
		INDICATING LAMP	4
		NEUTRAL LINK-32A	1
		CONTROL TERMINALS (DRAWOUT)	30
		INTERPOSING RELAY WITH BUILT IN LED, TEST KNOB & FREEWHEELING DIODE	2
		CT SHORTING TERMINAL-STUD TYPE	4
		CURRENT TRANSFORMER (METERING) 10VA, CL-1	1
		CURRENT TRANSDUCER (AC),4-20mA, DUAL O/P,AUX.-110V AC	1



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33	WDB I/C	INCOMER MCCB/SFU TPN WITH LIGHTING TRANSFORMER	
		MCCB TPN O/L,S/C,THERMAL-MAGNETIC BASED, BC:-50 KA WITH SPREADER,EXTENDED ROTARY HANDLE	1
		TPN SWITCH FUSE UNIT	1
		HRC FUSE LINK - DIN TYPE	3
		LIGHTING TRANSFORMER, CLASS F, RESIN IMPEGRATED, 415/433V, AIR COOLED,DRY TYPE,OFF LOAD CIRCUIT +-5%, IN STEP S 2.5%	1
		CURRENT TRANSFORMER METERING, Accuracy Class 1,VA-10 , RING TYPE RESIN CAST 50 Hz	3
		ANALOG AMMETER RANGE,MI TYPE, FSD 90°,CTR- /1A, SIZE:96x96MM	1
		AMMETER SELECTOR SWITCH 3 POSITION WITH OFF	1
		ANALOG VOLTMETER AC,RANGE:- 0-500V,MI TYPE, FSD 90°,SIZE:96x96MM	1
		VOLT METER SELECTOR SWITCH 3 POSITION WITH OFF	1
		Indicating Lamp for R, Y, B indication with LED. Voltage: 415 V AC	3
		Fuse Link 6A WITH FUSE BASE	6

34	DCFB I/C	INCOMER SFU DP WITH METERS FOR 220V DC FUSE BOX	
		SWITCH FUSE UNIT DP WITH AUX SWITCH	1
		HRC FUSE LINK DIN TYPE	2
		ANALOG AMMETER ,MC TYPE, FSD 90°,SIZE:96x96MM,CL:1 WITH SHUNT 75mV	1
		ANALOG VOLTMETER DC,RANGE:- 0-300V,DC MC TYPE, FSD 90°,SIZE:96x96MM ,CL:1	1
		INDICATION LAMP WITH LED 220V DC,	2
		Fuse Link 6A WITH FUSE BASE	4

35	DCFB O/G	OUTGOING SFU DP FOR 220V DC FUSE BOARDS	
		SWITCH FUSE UNIT DP	1
		HRC FUSE LINK DIN TYPE	2

36	ACFB I/C	INCOMER SFU TP WITH METERS FOR 415V AC FUSE BOARDS	
		SWITCH FUSE UNIT TNP WITH AUX SWITCH	1



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LOW VOLTAGE SWITCHGEAR**

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TECHMOU, REV-0

Saturday, 02 March 2019

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SL NO	MODULE TYPE	ITEM DESCRIPTION	QTY.
		HRC FUSE LINK DIN TYPE	3
		ANALOG VOLTMETER AC,RANGE:- 0-500V,MI TYPE, FSD 90°,SIZE:96x96MM	1
		VOLT METER SELECTOR SWITCH 3 POSITION WITH OFF	1
		Indicating Lamp for R, Y,B indication with LED.	3
		Fuse Link 6A WITH FUSE BASE	6
37	ACFB O/G-SP	OUTGOING SFU SP FOR 415V AC FUSE BOARDS	
		SWITCH FUSE UNIT DP	1
		HRC FUSE LINK DIN TYPE	1
		NEUTRAL LINK	1
38	ACFB O/G-TP	OUTGOING SFU TP FOR 415V AC FUSE BOARDS	
		SWITCH FUSE UNIT TP	1
		HRC FUSE LINK DIN TYPE	3



**TECHNICAL SPECIFICATION FOR
LOW VOLTAGE SWITCHGEAR**

SPECIFICATION NO. EPD-TS-CPBG-
TECHMOU, REV-0

Saturday, 02 March 2019

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38.00.00 TENTATIVE LIST OF BOARDS & QUANTITY

SL.NO.	BOARD DESCRIPTION	QTY
1	415V LT SWITCHBOARD 4000A	10
2	415V LT SWITCHBOARD 3200A	20
3	415V LT SWITCHBOARD 1250A	5
4	415V LT SWITCHBOARD 1600A	5
5	415V LT SWITCHBOARD 800A	5
6	220V DCDB	5
7	AC FUSE DB'S	20
8	DC FUSE DB'S	6
9	WELDING DISTRIBUTION BOARD 100KVA	5
10	LIGHTING DISTRIBUTION BOARD 100KVA	5
11	WELDING DISTRIBUTION BOARD 50KVA	5
12	LIGHTING DISTRIBUTION BOARD 50KVA	5
13	DC LIGHTING BOARD	5

NOTE: - THE ABOVE INDICATED QTY AND RATING IS TENTATIVE CONSIDERING THE MULTIPLE PROJECT REQUIREMENT AND SHALL BE ORDERED AS PER PROJECT SPECIFIC REQUIREMENT. ACTUAL QUANTITY MAY VARY AND SHALL BE FURNISHED AT THE TIME OF OBTAINING PRICE BID FOR PARTICULAR PROJECT.

		MANUFACTURER'S NAME & ADDRESS:	MANUFACTURING QUALITY PLAN						PROJECT :								
			ITEM : PCC, MCC , ACDB AND DCDB (UP TO 4000 A)			QP NO. 1 REV. NC DATE : Page			Acceptance Norms		Format of Records		Agency 10		Remarks		
						Quantum of check, 6		Reference Document		8		9		D* M** C N		11	
Sl. No.		Component & Operations		Characteristics		Classification		Type of Check		M		C/N		7			
1		2		3		4		5		6		8		9		10	

Note: Prototype inspection to be offered for witness on each rating / type of panel by NTPC & BHEL before bulk manufacturing clearance by NTPC

- 1) Makes of bought out items as per Attached Make of Component
- 2) **Relay Fat procedure to be submitted as a separate document for review**
- 3) Documents identified in the QP for NTPC verification will be maintained. However, other documents i.e. all QC records & supplier's TCs mentioned in the QP will also be maintained by the Manufacturer, which NTPC may verify on surveillance basis at the time of final inspection.
- 4) Outsourcing / subcontracting of panel fabrication, assembly, painting, pretreatment, wiring, final assembly and testing activity in Switchgear manufacturing process shall be done; only with prior approval of NTPC

A	<u>Raw material</u>
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1.	Angles, channels & Sheet Steel for fabrication (CRCA / HR)	1) Dimensions	Major	Meas	1 sample of each type & size per lot	-	IS-513 (94), IS-1079 (94), IS 2062 (99)	As per NTPC spec.	QC record	P		
		2) Surface finish check for waviness / flatness.	Major	Visual	-do-	-	IS-513 (94), IS-1079 (94), IS 2062 (99)	As per Mnfr std./ Drg.	QC record	P		
		3) Tensile / Bending Test	Major	Mach Test	As per IS	-	IS-513 (94), IS-1079 (94), IS 2062 (99)	IS-513 (94), IS-1079 (94), IS 2062 (99)	Supplier TC	V		
2.	Bus bars – Aluminum & Copper	1) Dimensions	Major	Meas	1 sample of each type & size per lot	-	IS-5082 (98) (for Al) IS1897 (83) (for Cu), NTPC Approved Drgs. / data sheet	IS-5082 (98) (for Al) IS1897 (83) (for Cu), NTPC Approved Drgs. / data sheet	QC record	P		
		2) Surface finish	Major	Visual	-do-	-	IS-5082 (98) (for Al) IS1897 (83) (for Cu),	IS-5082 (98) (for Al) IS1897 (83) (for Cu),	QC record	P		
		3) Conductivity	Major	Elect.	As per IS	-	IS-5082 (98) (for Al) IS1897 (83) (for Cu),	IS-5082 (98) (for Al) IS1897 (83) (for Cu),	Supplier TC	V	V	V

B	Bought out items:
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1.	Air Circuit Breaker	1) Make, type & rating	Major	Visual	100%	-	IS-13947 Part 2/ NTPC approved drg. & data sheet	IS-13947 Part 2/ NTPC approved drg. & data sheet	QC Records	V	V	V
		2) All routine tests including calibration of releases	Critical	Tests	-do-	100%	IS-13947 Part 2/ NTPC approved drg. & data sheet	IS-13947 Part 2/ NTPC approved drg. & data sheet	Suppliers TC	V	V	V
2.	CT's	1 Overall dimensions & mounting arrangement	Major	Meas	10% of each type & rating per lot	-	Mnfr drg.	Mnfr drg.	QC Record	P	-	-

		GEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN DOCUMENTATION. ** M: MANUFACTURER/SUB-CONTRACTOR, C: CONTRACTOR /NOMINATED INSPECTION AGENCY, N: NTPC INDICATED "P" PERFORM "W" WITNESS AND "V" VERIFICATION ALL "W" INDICATED IN COLUMN "N" SHALL BE 'CHP' OF NTPC.	FOR NTPC USE	DOC. NO.		
MANUFACTURER/SUB / SUPPLIER						
SIGNATURE						
				REVIEWED BY	APPROVED BY	APPROVAL SEAL

MANUFACTURER'S NAME & ADDRESS:				MANUFACTURING QUALITY PLAN						PROJECT :			
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Sl. No.	Component & Operations	Characteristics	Classification	3	4	5	Type of Check	Quantum of check, 6	Reference Document	Acceptance Norms	Format of Records	Agency 10	Remarks
1	2												
			Major	2) Numerical relay fat tests .	Major	Elect		10% each type, Per lot	NTPC App. Fat procedure	NTPC App. Fat procedure	Test report		11
7	Timers	1) Make ,Type & rating	Major		Major	Visual		10% of each type, & rating per lot	NTPC App. Drag. & data sheet	NTPC App. Drag. & data sheet	QC Records	P	
		2)Contact configuration	Major		Major	Elect		10% of each type, & rating per lot	NTPC App. Drag. & data sheet	NTPC App. Drag. & data sheet	QC Records	P	
		3) Functional Check	Major		Major	Elec.		--do--	Mnfr Std	Mnfr Std	QC Records	P	
8	HRC Fuses	1) Make, type & rating	Major		Major	Visual		10% of each rating per lot	IS-13703 / (93) NTPC App. Drgs.	IS-13703 / (93) NTPC App. Drgs.	QC Records	P	
9	Indicating Instruments	1) Make, type & ratings	Major		Major	Visual		10% of each type & rating per lot	NTPC Appr .drag / data sheet	NTPC Appr .drag / data sheet	QC Records	P	
		3) Routine tests including calibration & accuracy test reports	Major		Major	elect		10% of each type & rating per lot	IS 1248 (93), NTPC Appr .drag / data sheet	IS 1248 (93), NTPC Appr .drag / data sheet	Supplier's test report	V	
10	KWH meters	1) Make, type & ratings	Major		Major	Visual		10% of each type & rating per lot	NTPC Appr .drag / data sheet	NTPC Appr .drag / data sheet	QC Records	P	
		3) Routine tests including calibration & accuracy test reports	Major		Major	elect		100%	IS 722 (86) & IS 13779 (99) & NTPC Appr .drag / data sheet	IS 722 (86) & IS 13779 (99) & NTPC Appr .drag / data sheet	Supplier's test report	V	
11	Transducers	1) Make, type & ratings	Major		Major	Visual		10% of each type & rating per lot	NTPC Appr .drag / data sheet	NTPC Appr .drag / data sheet	QC Records	P	
		3) Routine tests including calibration & accuracy test reports	Major		Major	elect		100%	IEC 60688 & NTPC Appr .drag / data sheet	IEC 60688 & NTPC Appr .drag / data sheet	Supplier's test report	V	
12	Push Button & Indicating Lamp	1) Make, Type, colour & rating	Major		Major	Visual		5 samples of each type & rating per lot	IS 13947 Part 5 sec1 (93) NTPC App. Drag. & data sheet	IS 13947 Part 5 sec1 (93) NTPC App. Drag. & data sheet	QC record	P	
13	Control & Selector Switches	1) Make ,Type & rating	Major		Major	Visual		5 samples of each type & rating per lot	IS 13947 Part 5 sec1 (93) NTPC App. Drag. & data sheet	IS 13947 Part 5 sec1 (93) NTPC App. Drag. & data sheet	QC record	P	
		2) Contact configuration check	Major		Major	Visual		--do--	--do--	--do--	QC record	P	

MANUFACTURER'S NAME & ADDRESS:			MANUFACTURING QUALITY PLAN										PROJECT : PACKAGE: CONTRACT NO. : MAIN SUPPLIER: M/S BHEL – EPD (BANGLORE)			
			ITEM : PCC, MCC , ACDB AND DCDB (UP TO 4000 A)		QP NO. : REV. NC DATE : Page											
Sl. No.	Component & Operations	Characteristics	Classification	4	5	Type of Check	Quantum of check, 6		Reference Document	Acceptance Norms	Format of Records	Agency 10		Remarks		
1	2	3					M	C/N	7	8	9	D*	M**	C	N	11
20	Synthetic rubber Gasket	1) Material Type	Major		Visual	1 sample of each type & size per lot	1 sample of each type & size per lot	1 sample per lot	NTPC spec & IS 11149	NTPC spec & IS 11149	QC Record		P	V	V	Type, Dimensions & profile of the gaskets should be same as type tested panel gaskets
		2) Dimensions, profile & Visual Inspection	Major		Meas	-do-	-do-	-do-	Mnfr Std	Mnfr Std	QC Record		P			
		3) Shore Hardness	Critical		Test	Test	Mnfr Std	Mnfr Std	-do-	-do-	Supplier's TC		V			
		4) Elongation at break & ageing	Major		Test	Test	-do-	-do-	-do-	-do-	Supplier's TC		V			
		5) Compression set	Critical		Test	Test	-do-	-do-	-do-	-do-	Supplier's TC		V			
		6) Ozone Resistance	Major		Test	Test	-do-	-do-	-do-	-do-	Supplier's TC		V			
21	PVC wires (ISI marked)	1) Verify size, colour and BIS marking	Major		Visual	1 sample of each type & rating per lot	1 sample of each type & rating per lot	-	IS-694	IS-694	QC Records		P	-	-	
22	Space Heater, Thermostat, pin socket, hooter	1) Dimension/ Mounting arrangement	Major		Measure ment	-do-	-do-	-	Mnfr std.	Mnfr std..	QC record		P	-	-	
		2) Functional test	Major		By Test	-do-	-do-	-	Mnfr std.	Mnfr std..	QC record		P	-	-	
23	ACB Handling trolley	Overall dimensions & functional Checks	Major		test	-do-	-do-	-	Mnfr std	Mnfr std	QC Record		P			
24	Bus bar fish plates	Dimensions	Major		Visual	5 sample of each type & rating per lot	5 sample of each type & rating per lot	-	Mnfr Std.	Mnfr Std.	QC Records		P	-	-	
25	Bus bar Joint shrouds	Dimensions	Major		Visual	- do -	- do -	-	Mnfr Std.	Mnfr Std.	QC Records		P	-	-	
26.	Spring loaded power & control contacts	Silver plating thickness, adhesion check	Major		Mach	-do-	-do-	-	-do-	-do-	QC Records		P	-	-	
27	Terminal Block	1) Make, type & rating	Major		Visual	-do-t	-do-t	-	NTPC Approved Drgs.	NTPC Approved Drgs.	QC Records		P	-	-	
28	Paint	1) Make, type & shelf life	Major		Visual	100 %	100 %	-	Mnfr Std	Mnfr Std.	QC Records		P	-	-	
C In – Process:																
1.	Fabrication	1) Cutting, punching, shearing & bending	Major		Meas	Mnfr Practice	Mnfr Practice	-	Mnfr std. / drag.	Mnfr std. / drag.	QC Records		P	-	-	
		2) panel front door cut-outs punching	Major		Meas	-do-	-do-	-	Mnfr std. /NTPC Approved GA Drgs.	Mnfr std. / NTPC Approved GA Drgs.	QC Records		P	-	-	

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SIGNATURE		MAIN SUPPLIER			REVIEWED BY	APPROVED BY	APPROVAL SEAL

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MANUFACTURER'S NAME & ADDRESS:			Characteristics		Classification	Type of Check	Quantum of check, 6		Reference Document	Acceptance Norms	Format of Records			Agency 10		Remarks	
							M	C/N			7	8	9	D*	M**		C
1	2	3	4	5	6	7			8	9						D*	
2.	Pretreatment & Painting (powder coating)	1)Chemical concentration checks of all tanks for pre treatment of sheet steel	Major	Chemical	-do-	Mnfr Practic e	Mnfr Std practice, NTPC spec. IS-6005	Mnfr Std practice, NTPC spec. IS-6005	QC Records	P	V	V		Process parameters records as per Mnfr. plant std. to be maintained for verification by NTPC on surveillance basis			
		2) Paint Shade	Major	Visual	1 sample per lot	1 sample per lot	NTPC spec., Approved Drgs.	NTPC spec., Approved Drgs., RAL std shade card	QC Records	P	-	-					
		3) Paint Thickness & Adhesion	Major	Measurement & test	Mnfr Practice	Mnfr Practic e	-do-	-do-	QC Records	P	-	-		Paint adhesion check by Cross hatch method using Packing tape at final inspection			
3.	Panel Assembly	1) Panel shell assembly, Top & back cover assembly, Panel door assembly, hinge fitting & door knob fitting etc.	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC Records	P	-	-					
		2) Form 4B , 7 Type design in cable alley	Major	Process	100%	Sample	Mnfr std.	Mnfr std.	QC Records	P	V	V					
		3) Size of bus bar & bus bar finish	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC Records	P	-	-					
		4) Colour coding of bus bar	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC Records	P	-	-					
		5) Insulator type & mounting	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC Records	P	-	-					
		6) Bus bar joints	Major	Process	100%	Sample	Mnfr std.	Mnfr std.	QC - Records	P	-	-					
		7) Bus bar support distance, tightness of bolts for Main , Control & Auxiliary bus bars and bus bar joints	Major	Process	100%		Mnfr std. NTPC Spec. / QP Manual/ NTPC Approved	Mnfr. std. NTPC Approved drg. / Type test report	QC Records	P	-	-		1) Busbar support insulator type & distance between two supports should be in line with the Type test report			
		8) Main , control & Auxiliary Bus bar Clearances	Major	Process	100%		Mnfr std.	Mnfr std.	QC Records	P	-	-					
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									REVIEWED BY			APPROVED BY			APPROVAL SEAL		

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Sl. No.		Component & Operations	Characteristics	Classification	Type of Check	Quantum of check, 6			Reference Document	Acceptance Norms	Format of Records				Agency			Remarks		
						4	3	2			5	M	C/N	7	8	9	D*		M**	C
1																				
			9)CT / PT mounting arrangement & tightness	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC Records		P	-	-						11
			10)CT secondary shorting	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
			11)Termination for power & control circuits	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
			12)Lug size & crimping quality	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
			13)Earthing bus bar size & continuity ; earthlings of panel & doors	Major	Process	100%	-	Mnfr std.	Mnfr std.	– Records		P	-	-						
			14)Breaker safety shutter operation	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
			15)Spring loaded power & control contacts alignment	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
4.	Module assembly		1) Component identification	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
			2) Component layout, mounting & dimensions	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
			3) Incoming & outgoing power & control contacts assembly & alignment	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
			4) Power circuit wire / strip termination & clearances	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
			5) Functional Checks	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
			6) Alignment of module with master gauge	Major	Process	100%	-	Mnfr std.	Mnfr std.	QC – Records		P	-	-						
5.	Control Wiring		1) Wire Size & lug size. Colour of wire	Minor	Visual	100%	-	Wiring diagram	Wiring diagram	QC – Records		P	-	-						
			2) Proper wire Clamping & Ferruling	Minor	Visual	100%	-	As per shop practice	As per shop practice	QC – Records		P	-	-						
			3) Continuity as per wiring drag.	Critical	Test	100%	-	NTPC Appr. Drag.	NTPC Appr. Drag.	QC – Records		P	-	-						
			4) Tightness of termination & crimping check	Major	Test	100%	-	Mnfr std	Mnfr std	QC – Records		P	-	-						
D	Final Inspection: Note: 1) Type test clearance from NTPC-Engg to be verified 2) Before start of inspection , manufacturer's internal inspection (QC) records of the offered panels/ equipments & main contractor's inspection report to be submitted																			

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MANUFACTURER/SUB / SUPPLIER	MAIN SUPPLIER					
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL

Sl. No.		Component & Operations	Characteristics	Classification	MANUFACTURING QUALITY PLAN		PROJECT :								
					Quantum of check, 6	Reference Document	Acceptance Norms	Format of Records				Agency			Remarks
								Type of Check	M	C/N	7	8	9	D*	
1	2	3	4	5	6	7	8	9	D*	M**	C	N	11		
		1. Overall visual check for aesthetics, verticality of panels and alignment between two transport sections	Major	Visual	100%	10%	As per approved GA Drgs	As per approved GA Drgs	QC Records	✓	P	W	W		
		2. Verification of- overall dimensions including sheet steel thickness	Major	Meas.	100%	1 sample /lot	As per approved GA Drgs	As per approved GA Drgs	QC Records	✓	P	W	W		
		3. Bus duct interface, phase sequence, flange dimensions & clearances	Major	Visual	100%	100%	NTPC appd Drag / NTPC spec	NTPC appd Drag / NTPC spec	QC Records	✓	P	W	W		
		4. Bus bar (Main, control & Aux.) – clearances, colour coding, phase sequence identification	Critical	Measurement & visual	100%	10%	NTPC Appr. Drgs / NTPC spec	NTPC Appr. Drgs / NTPC spec	QC Records	✓	P	W	W		
		5. Bus bar support arrangement centre – centre distance between supports	Major	Measurement	100%	Random sample's	NTPC accepted Type test reports	NTPC accepted Type test reports	QC Records	✓	P	W	W		
		6. Overlapping of bus bar joints	Major	Elect	100%	10%	NTPC appd Drg / NTPC spec	NTPCappd Drag / NTPC spec	QC Records	✓	P	W	W		
		7. Measurement of tightness of bus bar joints by torque wrench	Critical	Mach	100%	10%	M60.300.70KGFM,M8-1.25-2.5KGFM, M10-1.252.5KGFM, M10-2.5-4KGFM, M12-4.3-7.1KGFM, IS-13947-1993	M60.300.70KGFM, M8-1.252.5KGFM, M10-1.252.5KGFM, M10-2.54KGFM, M124.37.1KGFM,IS-139471993	QC Records	✓	P	W	W	CT's & PT's will not supported on the bus bars	
		8. CT /PT fixing & mounting arrangement	Major	Mech.	100%	10%	Mnfr std.	Mnfr std.	QC Records	✓	P	W	W		
		9. Check shrouding of accessible live parts , Cable supports and tool falling shroud in cable alley	Major	Visual	100%	10%	NTPC spec	NTPC spec	QC Records	✓	P	W	W		
		10. For modules more than 30KW, minimum 4 no of support guide arrangement required.	Major	Visual	100%	10% of each type/	NTPC approved GA / scheme drag	NTPC approved GA / scheme drag	QC Records	✓	P	W	W	Same to be witnessed at random during final inspection	

MANUFACTURER/SUB / SUPPLIER	SIGNATURE	GEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN DOCUMENTATION. ** M: MANUFACTURER/SUB-CONTRACTOR, C: CONTRACTOR /NOMINATED INSPECTION AGENCY, N: NTPC INDICATED "P" PERFORM "W" WITNESS AND "V" VERIFICATION ALL "W" INDICATED IN COLUMN "N" SHALL BE 'CHP" OF NTPC.		FOR NTPC USE		DOC. NO
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MANUFACTURER'S NAME & ADDRESS:		MANUFACTURING QUALITY PLAN					PROJECT :							
		ITEM: PCC, MCC , ACDB AND DCDB (UP TO 4000 A)					QP NO. _____ REV. NC DATE : _____ Page							
							PACKAGE: CONTRACT NO. : _____							
							MAIN SUPPLIER: M/S BHEL – EPD (BANGLORE)							
Sl. No.	Component & Operations	Characteristics	Classification	Type of Check	Quantum of check, 6		Reference Document	Acceptance Norms	Format of Records		Agency 10		Remarks	
1	2	3	4	5	M	C/N	7	8	9	D*	M**	C	N	11
		11. Mounting arrangement of components shall be verified such that there would be no hindrance for accessibility	Major	Visual	100%	10% of each type/	NTPC approved GA / scheme drag	NTPC approved GA / scheme drag	QC Records	✓	P	W	W	
		12. Check control wiring / terminal arrangement & ferruling	Major	Visual	100%	10%	As per NTPC approved drag.	As per NTPC approved drag.	QC Records	✓	P	W	W	
		13. Safety Shutters operation check & padlocking arrangement	Critical	Mech.	100%	10%	NTPC spec	NTPC spec	QC Records	✓	P	W	W	
		14. Check door interlock & defeat interlock	Major	Mech.	100%	10%	NTPC spec	NTPC spec	QC Records	✓	P	W	W	
		15. Mach operation test for ACB as per IS	Critical	Elect	100%	100%	IS 13947	IS 13947	QC Records	✓	P	W	W	
		16. Breaker operation at service , test & isolate position	Critical	Elect	100%	100%	NTPC spec	NTPC spec	QC Records	✓	P	W	W	10% random sample by NTPC
		17. Power & control draw out contacts alignment check	Major	Elect	100%	10% of each type	NTPC spec	NTPC spec	QC Records	✓	P	W	W	10% random sample by NTPC
		18. Check for Breaker antidumping & trip free feature	Major	Elect	100%	*100%	NTPC spec	NTPC spec	QC Records	✓	P	W	W	
		19. Interlocks & operation check:- elect. / Machopen, close under test & service.	Critical	Elect	100%	10% of each type	Approved drgs & NTPC Spec.	Approved drgs & NTPC Spec.	QC Records	✓	P	W	W	10% random sample by NTPC
		20. FRP sheets material used as barriers shall be Flame retardant material	Major	Flame Test	Sampling as per Mfr. Std.	Sampling as per Mfr. Std. g as per Mfr. Std.	As per IS 6746 , table -4 grade –I	As per IS 6746 , table -4 grade –I	Suppliers TC	✓	P	W	W	
		21. Bus bar Sleeves material shall be as per NTPC Spec. and marking UL on sleeve. Material Certification for the sleeve material complying to UL 224	Major	Measurement	5 sample of each type per lot	5 sample of each type per lot	Mnfr. Std. / Mnfr. drg.	Mnfr. Std. / Mnfr. drg.	Suppliers TC		P	W	W	Marking of UL on sleeve and relevant UL certification for the sleeve material complying to UL 224 shall be verified by NTPC at time of final inspection
		22 Interchangeability check for draw out modules	Major	Mech	100%	10%	NTPC spec	NTPC spec	QC Records	✓	P	W	W	
		GEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN DOCUMENTATION. ** M: MANUFACTURER/SUB-CONTRACTOR, C: CONTRACTOR / NOMINATED INSPECTION AGENCY, N: NTPC INDICATED "P" PERFORM "W" WITNESS AND "V" VERIFICATION ALL "W" INDICATED IN COLUMN "N" SHALL BE 'CHP' OF NTPC.					FOR NTPC USE		DOC. NO					
MANUFACTURER/SUB / SUPPLIER		SIGNATURE					MAIN SUPPLIER		REVIEWED BY		APPROVED BY		APPROVAL SEAL	

MANUFACTURER'S NAME & ADDRESS:			MANUFACTURING QUALITY PLAN					PROJECT :						
			ITEM : PCC, MCC , ACDB AND DCDB (UP TO 4000 A)		QP NO. / REV. NC			PACKAGE:						
			DATE : Page					CONTRACT NO. :						
									MAIN SUPPLIER: M/S BHEL – EPD (BANGLORE)					
Sl. No.	Component & Operations	Characteristics	Classification	Type of Check	Quantum of check, 6		Reference Document	Acceptance Norms	Format of Records	Agency 10			Remarks	
1	2	3	4	5	M	C/N	7	8	9	D*	M**	C	N	11
		23. Earth bus dimensions , earthing of draw out modules, door etc.	Major	Elec	100%	10% of each type f	NTPC spec	NTPC spec	QC Records	✓	P	W	W	Paint Thickness to be checked as per NTPC spec./ app. drag/ Mnfr std.
		24. Check Paint shade, thickness, Adhesion & finish	Major	Visual/ Test	100% for shade & finish; 2 – 3 samples / lot	2 - 3 samples / board	As per NTPC approved drg. For shade	As per NTPC approved drg. For shade	QC Records	✓	P	W	W	std. Paint adhesion check by cross hatch method using packing tape
		25. Degree of protection check, check fixing of gaskets	Major	Visual	2-5 samples at casketed joints per board	2 - 5 samples / board	NTPC approved drags / NTPC spec	No insertion possible from openings & casketed joints	QC Records	✓	P	W	W	Paper insertion method for IP 5X compartment & 1 mm wire insertion method for IP 4X compartment.
		26. IR Test before & after the HV Test	Major	Elect.	100%	100%	IS-8623	IS-8623	QC Records	✓	P	W	W	
		27. HV test on Power & control ckt.	Critical	Elect.	100%	100%	IS-8623	IS-8623	QC Records	✓	P	W	W	
		28. Fitting of sheet steel covers at one ends of transport units	Major	Visual	100%	100%	NTPC spec	NTPC spec	QC Records	✓	P	V	V	1) Generally, verification of compliance report of Manufacturer
6	Packing & transportation	Panels cleared by dispatch to be packed suitably & transported to site after proper packing & crating	Major	Visual	100%	-	Mnfr std	Mnfr std	QC Records		P			Panels cleared by NTPC for dispatch to be packed suitably & transported to site after proper packing and crating

Make of Components – Annexure-I

Sr. No.	Item	Make
1.	Air Circuit Breaker	C&S ELECTRIC-NOIDA/L&T -MUMBAI/GE-BANGALORE/SIEMENS-GERMANY/SCHNEIDER-FRANCE/ABB-BANGALORE
2	Switch/Switch Fuse Unit	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.
3.	HRC Fuse Link & fuse base	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.
4.	Contactors & Over Load Relays	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.
5.	Current Transformer	AE – MUMBAI / KAPPA – BANGALORE / PRAGATI – THANE / PRAYOG – PUNE / INDCOIL - MUMBAI / PRECISE - MUMBAI / SOUTHERN ELECTRIC – CHENNAI, NEWTEK Electrical – Aurangabad

	GEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN DOCUMENTATION. ** M: MANUFACTURER/SUB-CONTRACTOR, C: CONTRACTOR / NOMINATED INSPECTION AGENCY, N: NTPC INDICATED "P" PERFORM "W" WITNESS AND "V" VERIFICATION ALL "W" INDICATED IN COLUMN "N" SHALL BE 'CHP' OF NTPC.		FOR NTPC USE	DOC. NO.	
MANUFACTURER/SUB / SUPPLIER					
SIGNATURE			REVIEWED BY	APPROVED BY	APPROVAL SEAL

Sl. No.		Component & Operations	Characteristics	Classification	3				MANUFACTURING QUALITY PLAN				PROJECT :			
					Quantum of check, 6	Type of Check	C/N	7	Acceptance Norms	Format of Records	Agency 10	Remarks				
1		2	3	4	5	M		8	9	D*	M**	C	N	11		
6.		Potential Transformer	AE – MUMBAI / KAPPA – BANGALORE / PRAGATI – THANE / PRAYOG – PUNE / INDCOIL – MUMBAI / PRECISE – MUMBAI / SOUTHERN ELECTRIC – CHENNAI													
7.		Control Transformer	AE – MUMBAI, KAPPA – BANGALORE, SOUTHERN ELECTRIC – CHENNAI, PRAGATI – THANE, PRAYOG – PUNE, INDCOIL – MUMBAI, PRECISE – MUMBAI, G&M – BARODA, LOGICSTATE – DELHI, NEWTEK Electrical – Aurangabad													
8.		Lighting Transformer	AE – MUMBAI, PAGATI – THANE, INDCOIL – MUMBAI, PRECISE – MUMBAI, LOGICSTATE – DELHI													
9.		Protection relays (Numerical)	ABB – BARODA / ALSTOM T&D – CHENNAI / GE – CANADA / SIEMENS – GOA SEL – US A, SCHNIEDER – FINLAND (EUROPE)													
10.		Protection relays (Electromechanical)	ABB / AREVA (ALSTOM) / SIEMENS / SCHNIEDER													
11.		Indicating lamp	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.													
12.		Push Button	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.													
13.		Indicating/Measuring Instrument	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.													
14.		Plug in Terminal & Terminals Block	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.													
15.		Space Heater	MANUFACTURER ACCEPTANCE SOURCE													
16.		Thermostat	ANCO/ MANUFACTURER ACCEPTANCE SOURCE													
17.		BKR control switch	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.													
18.		Selector Switch	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.													
19.		Coupling relay	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.													
20.		Transducer	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.													
21.		TIMER	L&T/SIEMENS/C&S ELECTRIC													
22.		Neutral link	MANUFACTURER ACCEPTANCE SOURCE													
23.		Cable Lugs	DOWELLS/3D/CHETNA													
24.		Cable Gland	MANUFACTURER APPROVED SOURCE													
25.		3 PIN POWER SOCKET	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.													
26.		MCB	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.													
27.		WIRE	BIS APPROVED													
28.		KWH METER	Any make's Model with VDE, CE, UL, CSA OR BIS Approved with CML No.)													
29.		AL BUSBAR (RAW MATERIAL)	HINDALCO / BALCO / INDALCO													
30.		SHEET STEEL	TATA/SAIL/BHUSHANSTEEL/JINDAL/ESSAR/TISCO/IISCO													
31..		Copper Bubar (RAW MATERIAL)	HINDUSTAN COPPER LTD/ STERLITE													
32.		Paint.	MANUFACTURER ACCEPTANCE SOURCE / AKZONOBEL/IOTUN/ SHARP COATING / ASIAN PAINT / NAROLAC													

		GEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN DOCUMENTATION. ** M: MANUFACTURER/SUB-CONTRACTOR, C: CONTRACTOR / NOMINATED INSPECTION AGENCY, N: NTPC INDICATED "P" PERFORM "W" WITNESS AND "V" VERIFICATION ALL "W" INDICATED IN COLUMN "N" SHALL BE 'CHP' OF NTPC.	FOR NTPC USE	DOC. NO
MANUFACTURER/SUB / SUPPLIER	MAIN SUPPLIER			
SIGNATURE		REVIEWED BY	APPROVED BY	APPROVAL SEAL

DRIVE CONTROL PHILOSOPHY

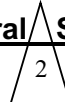
REV 01	DATE 26.11.14	RK --sd--	MK --sd--	BS --sd--	PROJECT							
			CONTRACTOR		DEPT CODE I		NAME	SIGN	DATE			
						DSGN	RK	--sd--	14.07.14			
						CHD	MK	--sd--	14.07.14			
						APPD	BS	--sd--	14.07.14			
				TITLE	DRIVE CONTROL PHILOSOPHY (STATION C&I)							
DRG. NO.												
	JOB NO.: 405				SHEET 01 OF 13			REV 05				

	DOCUMENT TITLE	DOCUMENT			
	DRIVE CONTROL PHILOSOPHY(STATION C&I)	NUMBER			
	PROJECT:	REVISION NUMBER	05	DATE	03.09.15
		SHEET	2	OF	13

A. DRIVE CONTROL PHILOSOPHY

The control philosophy for different type of Drives is detailed below:

1 Bi-directional drives with Integral Starter(Open/Close duty and inching/regulating duty) (BID)



- a) All bi-directional drives shall have integral starter. These drives shall be operable from Remote i.e. from Central Control Room (CCR).
- b) Remote manual operation of all drives shall be done from Operator Works Station (OWS).
- c) Remote control commands i.e. open/close generated from DCS shall be issued to Integral Starter through interposing relays, mounted in Integral Starter. For open/close duty bi-directional drives, DCS output command shall be latched in DCS, except for inching duty bi-directional drives where latching is not required.
- d) Necessary electrical protections shall be realized at Integral Starter, whereas process interlocks and protection shall be realized in DCS.
- e) Following signal exchange shall take place between Integral Starter & DCS.
 - open & close command
 - Integral Starter Disturbed (Loss of power supply/Loss of control supply/ Motor thermostat trip/ Thermal O/L /Local/off/Remote S/S in Local or Off mode/Stop PB optd).
 - Valve status feedback by means of limit switches (open/close).
 - Valve position feedback (4-20mA) for inching duty drives.

The above signal exchanges are diagrammatically represented in sheet no. 7.

2 Unidirectional LT Drives (Contactor Operated) (LTUD)



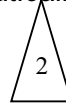
- a. Unidirectional LT drives shall be operable from Remote i.e. from Central Control Room (CCR). Drives shall be provided with Local Emergency Stop Push Button (**EPB**).
- b. Remote manual operation of all drives shall be done from OWS.
- c. Remote control commands i.e. start/stop, shall be generated from DCS and shall be issued to MCC through interposing relays located in respective MCC.DCS output command shall be latched in MCC. EPB (stay put type), in MCC supplier's scope, shall be wired directly to MCC. The EPB shall be provided with press to lock and turn to release type, keyless mechanism.
- d. Necessary electrical protections for the drives shall be realised at MCC, whereas process interlocks and protections shall be realized in DCS.

	DOCUMENT TITLE	DOCUMENT NUMBER	
	DRIVE CONTROL PHILOSOPHY(STATION C&I)	REVISION NUMBER	05 DATE 03.09.15
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- e. Following signal exchange shall take place between MCC & DCS
- Drive Start & Stop commands.
 - Drive ON & OFF feedback.
 - MCC disturbed (Thermal O/L /Control supply fail/ EPB operated/ MCC switched off).

The above signal exchanges are diagrammatically represented in sheet no. 8.

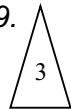
3 Solenoid Operated Drives (SOLV)



- Solenoid operated drives shall be operable from remote i.e. CCR only.
- Remote manual operation of all drives shall be done from OWS.
- Remote control commands i.e. open/close shall be generated from DCS and shall be issued to the respective solenoid through interposing relays located in Interposing Relay panels.
- Necessary process interlocks shall be realized in DCS.
- Following signal exchange shall take place between solenoid operated drive & DCS
 - Valve open & close command.
 - Valve status feedback by means of limit switches (open/close), wherever available.

The above signal exchanges are diagrammatically represented in sh. no. 9.

4 HT/LT Unidirectional Drives (Breaker operated) (HTUD/LTUD)



- Remote manual operation of Breaker operated drives shall be normally from remote i.e. Station DCS in main Control Room through OWS.
- Remote/Switchgear (SWGR) selection shall be realized from numerical relay mounted in switchgear.
- Following are the operational combinations for breaker operated drives:
 - SERVICE POSITION – Drive Operation (Start/Stop) shall be from CCR with Remote position.
 - TEST POSITION – SWGR Testing (Start/Stop) from SWGR/CCR.

For testing of switchgear trip/close switchgear shall be done from numerical relay HMI/relay front port. Provided R/S position in Numerical relay is in switchgear.

	DOCUMENT TITLE	DOCUMENT	
	DRIVE CONTROL PHILOSOPHY(STATION C&I)	NUMBER	
	PROJECT:	REVISION NUMBER	05 DATE 03.09.15
		SHEET	4 OF 13

- d. Remote control commands i.e. start/stop, pulse type, shall be generated from DCS and shall be issued to Switchgear through numerical relays located in respective Switchgear.
- e. The EPB shall be wired directly to switchgear. The Mushroom type EPB (stay put type), in SWGR supplier's scope, shall be provided with press to lock and turn to release type, keyless mechanism. Under its locked position, the drive operation shall be inhibited.
- f. Necessary electrical protections for the drive shall be realised at Switchgear, whereas process interlocks and protections are realised in DCS.
- g. Following signal exchange shall take place between switchgear and DCS: -
 - i. Drive Start & Stop commands.
 - ii. Drive ON & OFF status feedback.
 - iii. Master Trip Relay (86 Relay) operated.
 - iv. Emergency Stop PB operated.
- h. Current transducers (for FD fan, PA fan, ID fan, Mill Motors, MDBFP, CEP, ECW & ACW pumps only), 4-20mA types (in SWGR suppliers scope), shall be mounted in the SWGR for monitoring the current in DCS. Auxiliary power supply to these transducers shall be provided from the control power supply of the respective switchgear.
- i. Metering shall be part of numerical relay. The same shall be provided in SWGR which will be connected to DCS through serial link via data concentrator for transmission of soft signals to DCS including motor current, SWGR disturbed (Control supply failed or trip coil unhealthy), SWGR available (Selector switch in remote, Breaker spring charged, SWGR is service position)
- j. All command signals for HT Drives (Breaker operated) shall be redundant.

The above signal exchanges are diagrammatically represented in sh. no. 10.

B. SEQUENCE CONTROL PHILOSOPHY

- 1.0** Sequence control is envisaged for startup and shutdown of main drives and their associated drives from OWS. The drives can be operated manually or automatically through group/sub-group control and through process interlocks.

	DOCUMENT TITLE	DOCUMENT	
	DRIVE CONTROL PHILOSOPHY(STATION C&I)	NUMBER	
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1.1 Sequence Mode Operation

Sequence controls are organized hierarchically in accordance with the operation concept of the plant process. Accordingly following levels of sequence control exists.

- Functional group control
- Sub group control

Functional Group Control logic co-ordinates between functionally cascaded lower level sequence control logics. It performs following functions

- Mode of operation
- Sequential start/stop of sub group.

Sub Group Control performs sequence control strategies on main drive and related drives as required by the process and taking care of the healthiness of each drive e.g. BFP along with its recirculation valve, discharge valve and AOP in a sequence, will form sequence control logic for BFP.

1.2 Sequence Start Up Mode

- 1) **Automatic mode:** - In this mode of operation, once the sequence is initiated, it shall progress without involvement of the operator.
- 2) **Semi-automatic mode:** - In this mode of operation, once the sequence is initialized, the step progressing shall be displayed on the OWS. But the step execution command shall be interlocked and shall be sent by the operator via keyboard. It shall be possible to bypass and/or simulate one or more criteria to enable the program to proceed. This facility shall allow the program to be executed even if some criteria are not fulfilled. It shall be possible to put the system on the auto mode after operating it on semi-auto mode for some steps or vice-versa, without disturbance to the sequence operation.
- 3) **Operator test mode:** It shall be possible to use the sequential control in operator guide mode / test mode i.e. the complete system runs and receives input from the plant OWS but its command output is blocked. The whole program, in this case shall run in manual mode. This mode shall allow to practice manual operation using step and criteria indications. The actual protection shall remain valid during this mode of operation also.

	DOCUMENT TITLE	DOCUMENT	
	DRIVE CONTROL PHILOSOPHY(STATION C&I)	NUMBER	
	PROJECT:	REVISION NUMBER	05 DATE 03.09.15
		SHEET	6 OF 13

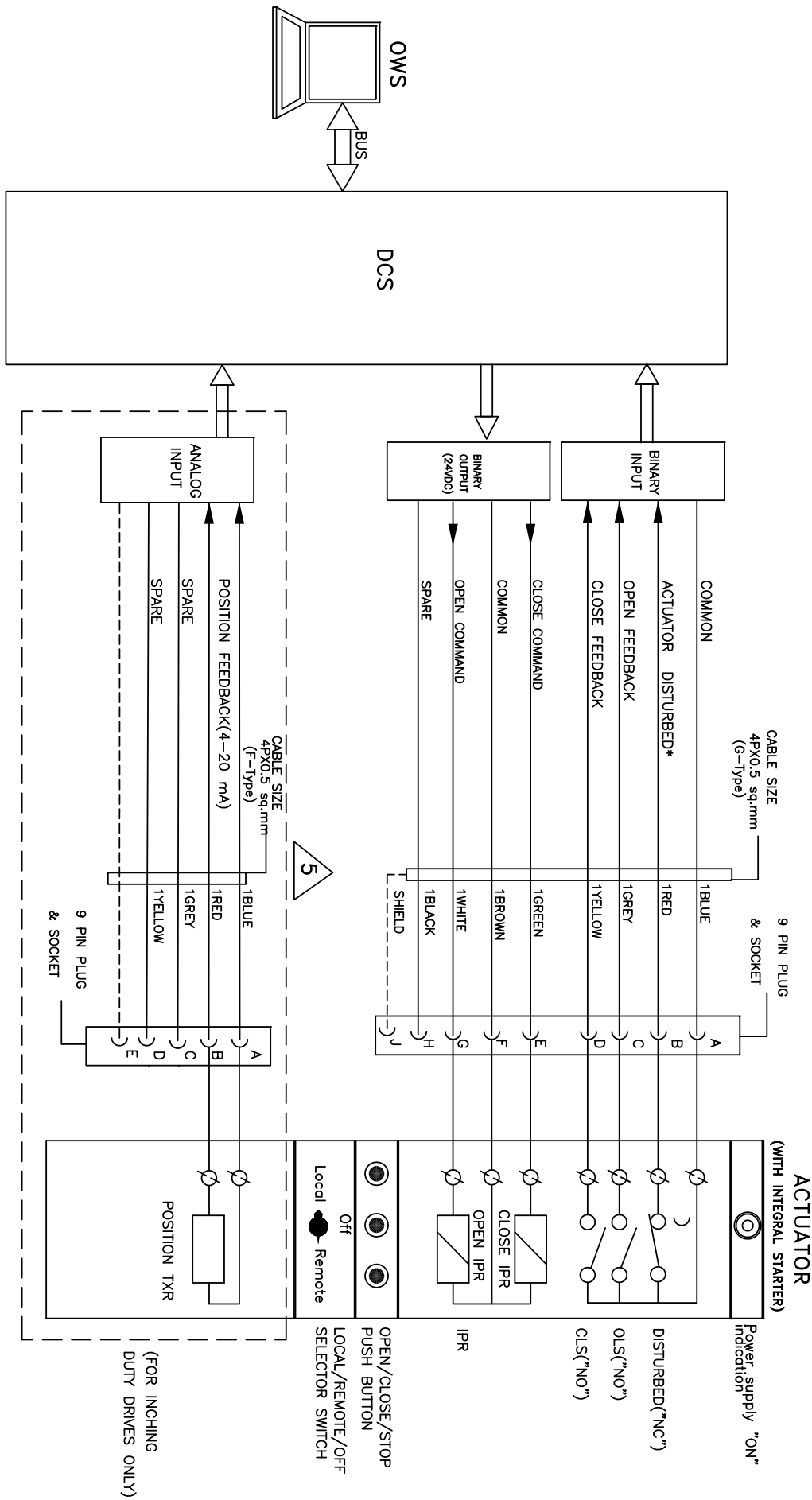
C. ANALOG CONTROL & MEASUREMENT PHILOSOPHY

1) Analog Drives Control

- 1.1 A drive control function residing in controller is used to position the pneumatically/electrically operated control valves. Interlock and protection Open/Close Commands, originating from field or generated internally in Control Logics (ACS), are interfaced with the drive control function residing in controller.
- 1.2 Control Valve actuator design shall take care of fail safe condition i.e. bringing valve to full open/full close or stay put mode, on signal (pneumatic/electric) failure.
- 1.3 Auto/Manual operator control and display for various control loops shall be provided through OWS, using Analog Displays.
- 1.4 Analog Displays have following functionality:
 - Auto/Manual selection with control device “Raise/Lower Buttons”
 - Set point indication with “Raise/Lower Buttons”
 - Indication for deviation between set point and measured value
 - Measured value indication
 - Final control element portion indicators

The above signal exchanges with DCS are diagrammatically represented in sh.no. 11,12 &13.

DCS INTERFACE FOR (BIDIRECTIONAL DRIVE WITH INTEGRAL STARTER) (BID/BIDI)



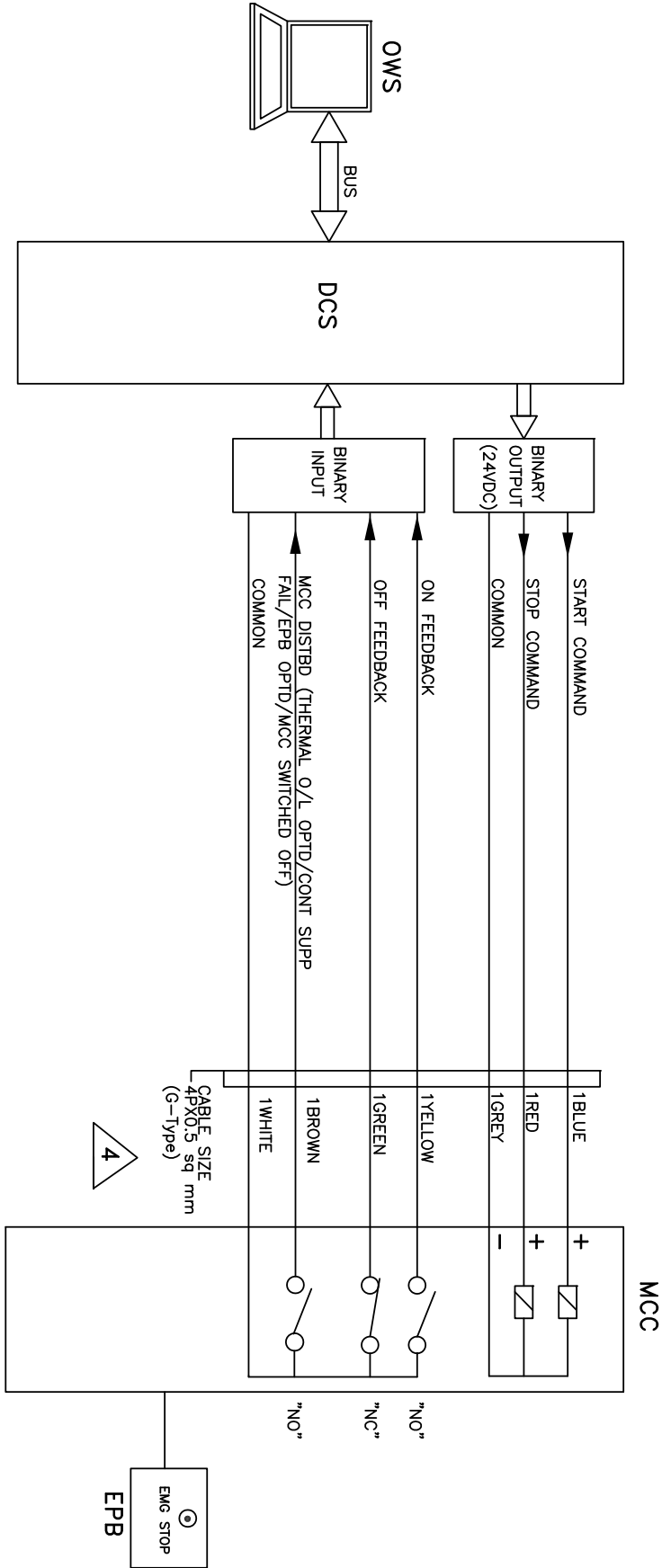
NOTE:

* DISTURBED=

Loss of Power supply (1 Phase/3 Phase)/
Loss of control supply/ Motor thermostat trip/
Thermal over load/
Local/Off/Remote Sel. switch in local or off mode/

		PROJECT:		DRG.NO.	
TITLE		DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE		DATE	03.09.2015
				REV.NO.	05
				SHT	7 OF 13

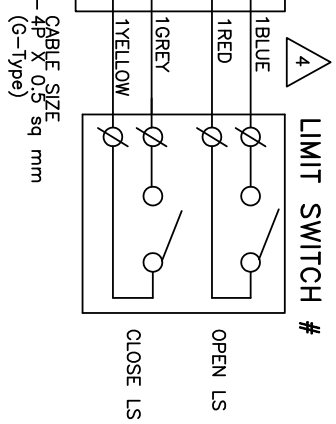
DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE (CONTACTOR CONTROLLED) (LTUD)



		PROJECT:		DRG.NO.	
TITLE		DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE		DATE	03.09.2015
				REV.NO.	05
				SHT	8 OF 13

The diagram illustrates the electrical interface between an OWS (Offshore Warning System) and a DCS (Data Control System). It shows two parallel control channels, each consisting of the following components and connections:

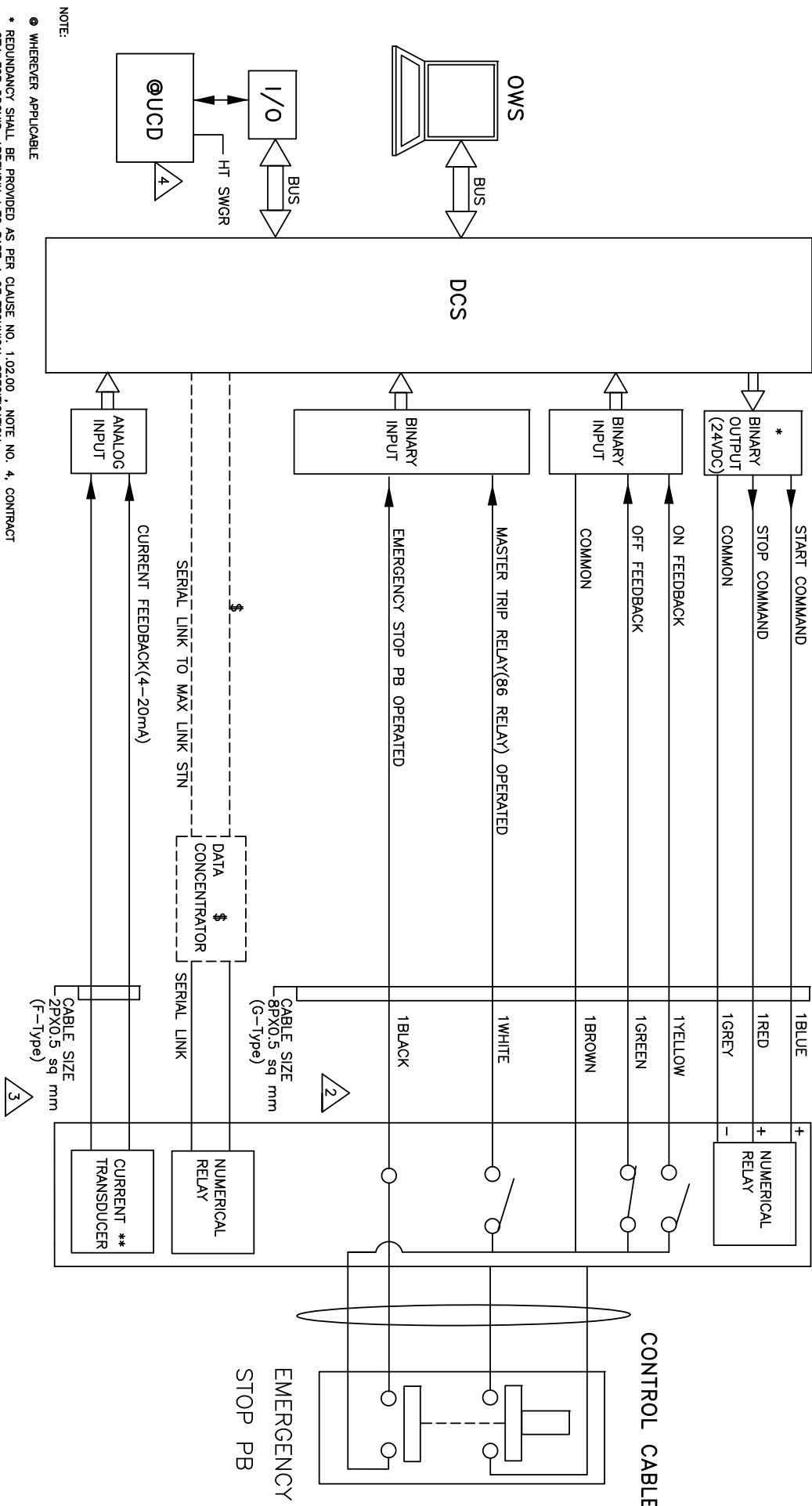
- DCS Output:** A signal line from the DCS to a **BINARY OUTPUT (24VDC)** module.
- Power Supply:** A **POWER SUPPLY** module connected to the binary output. It includes a **POWER SUPPLY FAULT ALARM** indicator (triangle with '4').
- Interposing Relay:** A relay controlled by the power supply, labeled **INTERPOSING RELAY**.
- Solenoid Coil:** The relay controls the **SOLENOID COIL**, which is connected to the **ENERGISE** line.
- Cable Specifications:** The cables connecting the DCS to the binary outputs and the solenoid coils are specified as **3C X 2.5 sq mm**.
- Grounding:** A common ground connection is shown for both channels, labeled **(G-type)**.
- Additional Labels:** The diagram includes labels for **IPR PANEL AT CER** and **CABLE SIZE MULTIPAIR (EDN SCOPE) (G-type)**.



- 

PROJECT:	DRG.NO.	1
	DATE	03.09.2015
TITLE	DDCMS INTERFACE FOR	
	SOLENOID DRIVE	
	REV.NO.	05
	SHT	9 OF 13

DCS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES (BREAKER OPERATED) (HTUD/LTUD) SWGR

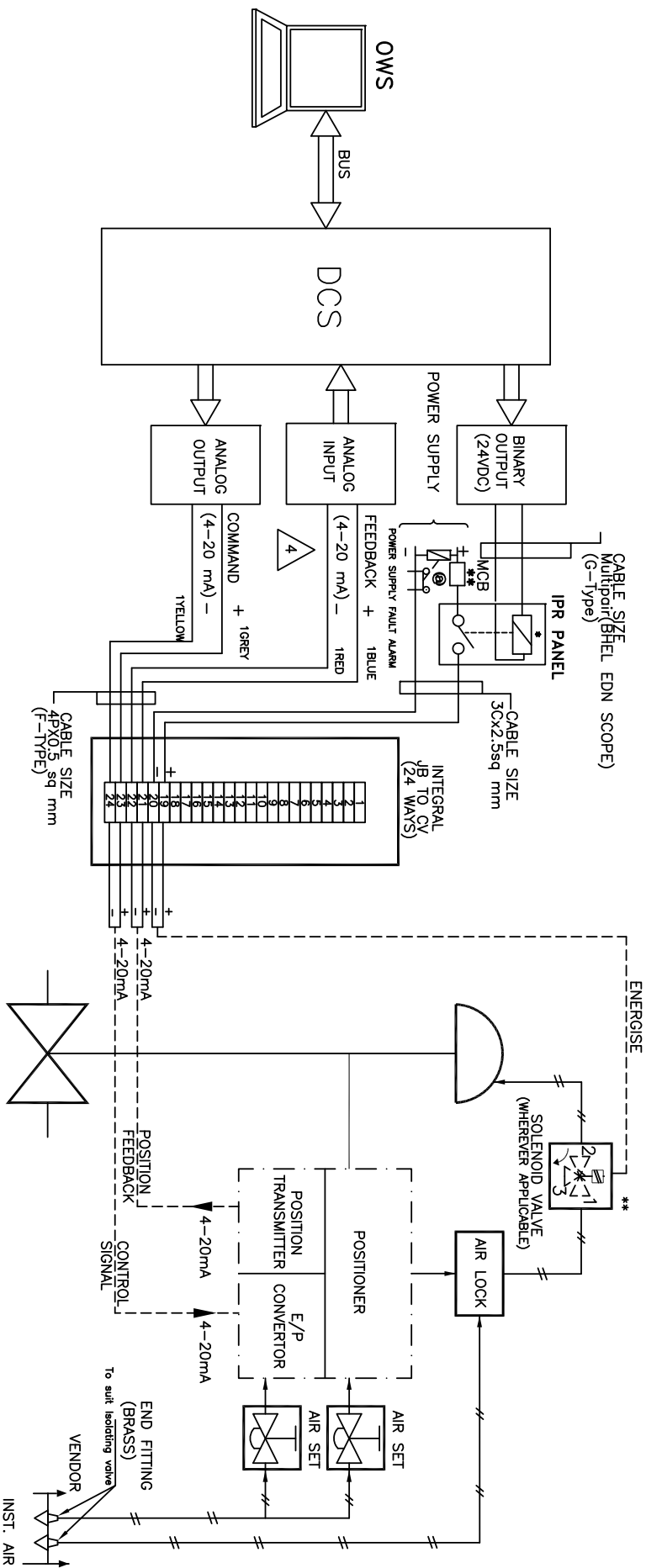


NOTE:

- WHEREVER APPLICABLE
- * REDUNDANCY SHALL BE PROVIDED AS PER CLAUSE NO. 1.02.00 , NOTE NO. 4, CONTRACT QTY. FOR DDCMIS, APPENDIX-1 TO PART-A OF TECHNICAL SPECIFICATION
- \$ DATA CONCENTRATOR & SERIAL LINK TO MAX STATION SHALL BE COMMON FOR HT/LT DRIVES (BREAKER CONTROLLED)
- ** SHALL BE APPLICABLE FOR FD, ID, PA, BFP, CEP, ECW, ACW, MILL MOTORS
- 1. EXACT NO. OF PORTS/LINKS BETWEEN NUMERICAL RELAYS & MAX LINK STATION SHALL BE AS PER THE APPROVED SWGR & DATA CONCENTRATOR DRAWINGS.
- 2. OVERLOAD ALARM, RELAY FAULT, SWGR AVAILABLE & SWGR DISTURBED SIGNALS ALONG WITH OTHER INFORMATION SHALL FLOW THROUGH SOFT LINK.

PROJECT:	
TITLE	DDCMIS INTERFACE FOR UNIDIRECTIONAL HT DRIVE
DRG.NO.	
DATE	03.09.2015
REV.NO.	05
SHT	10 OF 13

DCS INTERFACE FOR ANALOG DRIVE (MOD-P)



NOTES:

- * APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED.
- ** MCB SHALL BE PROVIDED FOR EACH SOLENOID
- ⑥ COMMON FOR ALL SOLENOIDS



PROJECT:

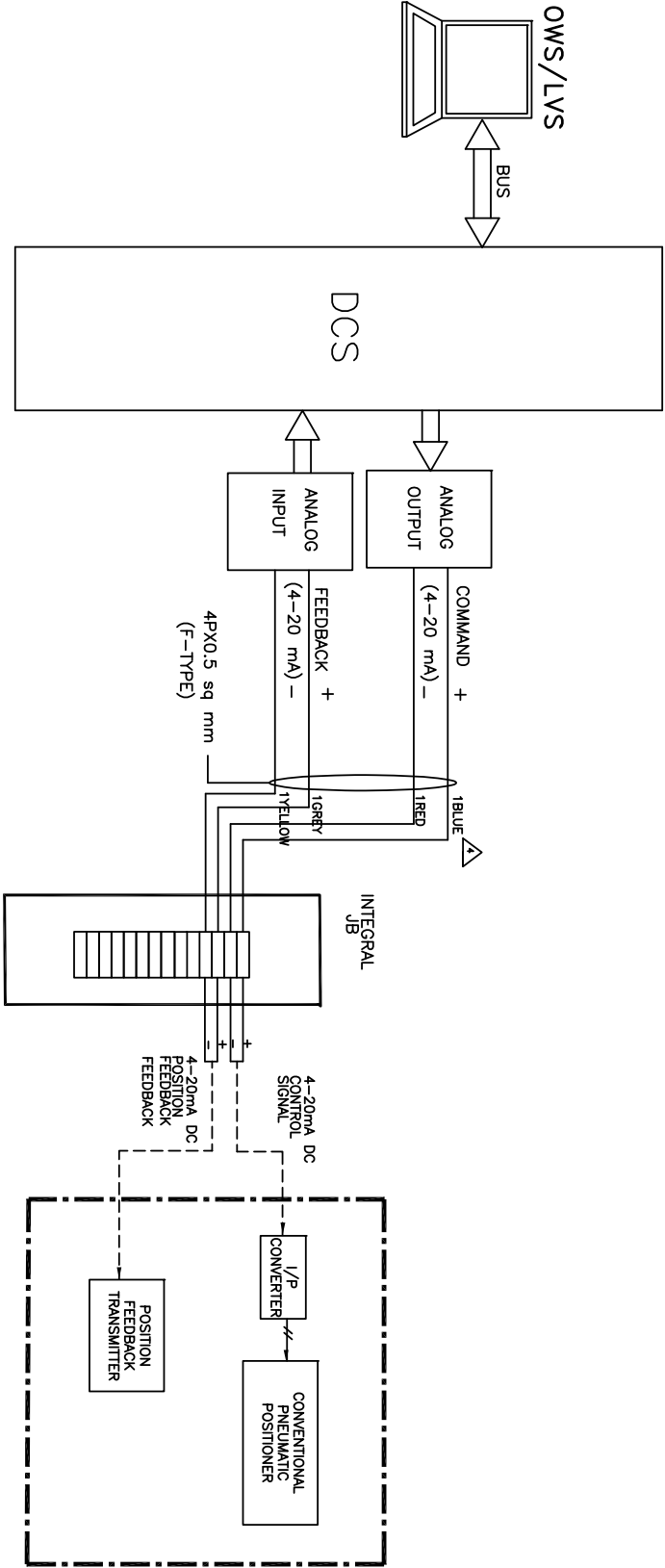
TITLE

TYPICAL HOOK-UP DIAGRAM

ANALOG DRIVE

DRG. NO.	
DATE	03.09.2015
REV. NO.	05
SHT	11 OF 13

DCS INTERFACE FOR MODULATING TYPE PNEUMATIC DAMPER



PROJECT:

TITLE DCS INTERFACE FOR MODULATING TYPE

PNEUMATIC DAMPER

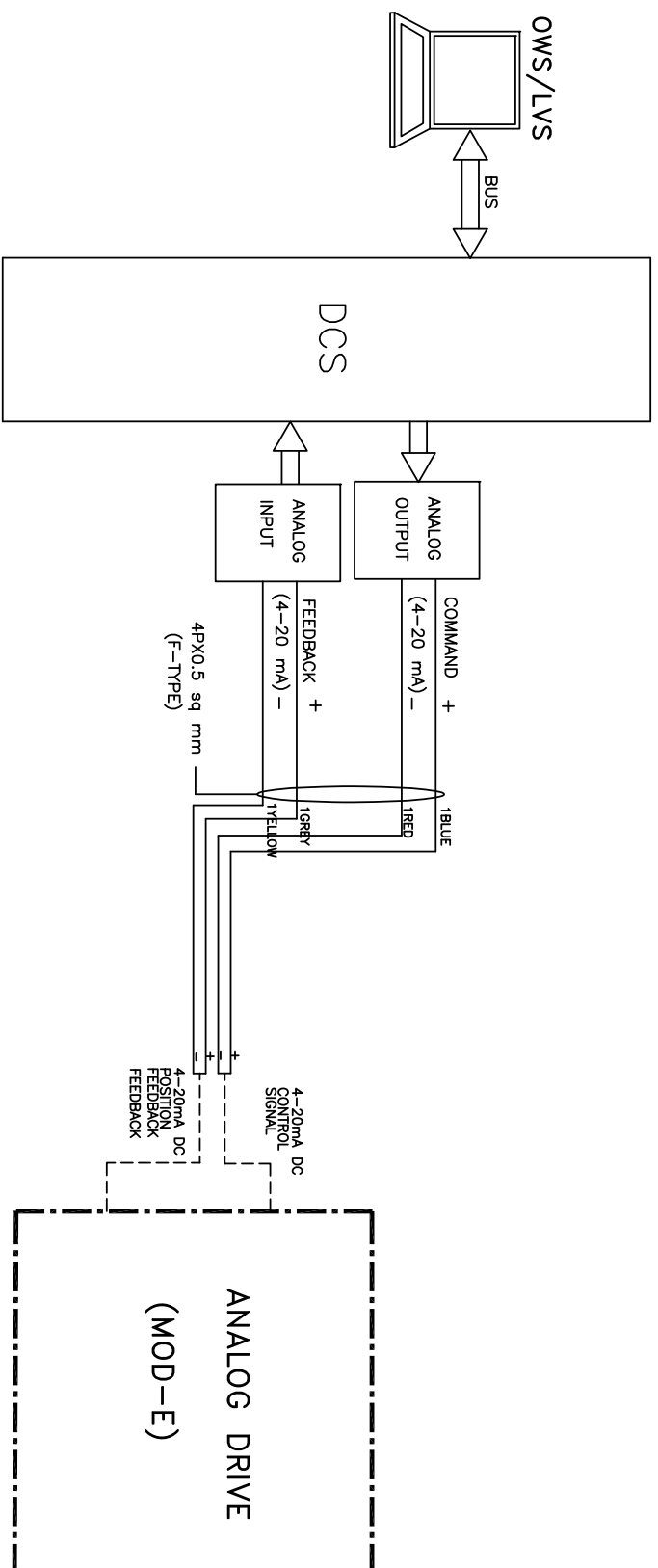
DRG.NO.

DATE 03.09.2015

REV.NO. 05

SHT 12 OF 13

DCS INTERFACE FOR ANALOG DRIVE (MOD-E)



	
PROJECT:	
TITLE	DCS INTERFACE FOR ANALOG DRIVE MODULATING ELECTRIC TYPE
DRG. NO.	
DATE	03.09.2015
REV. NO.	05
SHT	13 OF 13