

**PQC REQUIREMENT (Annexure-1)**

## 1. Experience Criteria

The OEM should have successfully designed and successfully done FAT for a network on IEC61850 with atleast 100 nos. of communicable relays before the techno commercial bid opening date of the project which is 30.08.2018.

Document required: Bidder to furnish MOM with customer/ Site or Customer email/ letter or any customer document for commissioning status.

## 2. Past Performance

The OEM should have manufactured, supplied and configured 100 nos. Numerical relays (IEC 61850 compliant) used for application in Feeder protection/Transformer protection/Motor protection in a power plant. These relays shall be in successful operation for atleast one year before the Techno commercial bid opening date of the project i.e. 30.08.2018.

Document required: Bidder to furnish unpriced P.O/ Invoice copy or relevant documents in support of supply and MOM with customer/ Site or Customer email/ letter or any customer document for commissioning status.

ANNEXURE-Z

| ITEM NO. | ITEM DESCRIPTION  | MATERIAL CODE | BOARD QUANTITY                              |                    |                     |                     |                     |                      |   |                     |                    |                     |                    |                     |  |  |  | TOTAL QTY |
|----------|---|---------------|---|--------------------|---------------------|---------------------|---------------------|----------------------|---|---------------------|--------------------|---------------------|--------------------|---------------------|--|--|--|-----------|
|          |   |               | MILESTONE-1<br>30.08.2023<br>WO 90006Q47602 |                    |                     |                     |                     |                      | MILESTONE-2<br>30.10.2023<br>WO 90006Q47605 |                     |                    |                     |                    |                     | MILESTONE-3<br>30.11.2023<br>90006Q47602 | MILESTONE-4<br>30.12.2023<br>90006Q47605 | MILESTONE-5<br>10.03.2023<br>90006V47605 |           |
|          |   |               | 11 KV STN<br>(OBE)                          | 11 KV STN<br>(OBF) | 11 KV UNIT<br>(SBA) | 11 KV UNIT<br>(SBB) | 3.3 KV STN<br>(OCE) | 3.3 KV<br>UNIT (SCA) | 11 KV CHP<br>(OBI)                          | 3.3 KV CHP<br>(OCC) | 11 KV AHP<br>(OBH) | 3.3 KV AHP<br>(OCB) | 11 KV FGD<br>(SBJ) | 3.3 KV FGD<br>(SCD) |  |  | SPARE                                    |           |
|          |   |               |   |                    |                     |                     |                     |                      |   |                     |                    |                     |                    |                     |  |  |  |           |
| 1        | NUMERICAL OVERCURRENT AND EARTH FAULT PROTECTION RELAY WITH CHECK SYNCH FOR INCOMER/BUSCOUPLER/TIE FEEDER AS PER IT-01 OF ANN-A | SG4900067008  | 4   | 4                  | 2                   | 2                   | 3                   | 3                    | 3   | 3                   | 3                  | 3                   | 3                  | 3                   |  |  | 4  | 40        |
| 2        | NUMERICAL OVERCURRENT AND EARTH FAULT PROTECTION RELAY FOR OUTGOING/TRANSFORMER FEEDER AS PER IT 02 OF ANN-A                    | SG4900067016  | 13  | 12                 | 14                  | 14                  |                     |                      | 11  |                     | 11                 |                     | 8                  |                     |  |  | 4  | 87        |
| 3        | NUMERICAL MOTOR PROTECTION RELAY AS PER IT-03 OF ANN-A  | SG4900067024  |   | 2                  | 6                   | 6                   | 5                   | 32                   |   | 29                  |                    | 12                  |                    | 11                  |  |  | 4  | 107       |
| 4        | NUMERICAL MOTOR DIFFERENTIAL RELAY AS PER IT-04 OF ANN-A  | SG4900067032  |   | 2                  | 6                   | 6                   |                     | 5                    |   |                     |                    |                     |                    |                     |  |  | 4  | 23        |
| 5        | NUMERICAL TRANSFORMER DIFFERENTIAL RELAY AS PER IT-05 OF ANN-A  | SG4900067040  | 2   | 2                  | 2                   | 2                   |                     |                      | 3   |                     | 3                  |                     | 4                  |                     |  |  | 4  | 22        |
| 6        | NUMERICAL UNDERVOLTAGE PROTECTION RELAY AS PER IT-06 OF ANN-A   | SG4900067059  | 1   | 1                  | 1                   | 1                   | 2                   | 2                    | 4   | 4                   | 4                  | 4                   | 4                  | 4                   |  |  | 4  | 36        |
| 7        | NUMERICAL RESTRICTED EARTH FAULT PROTECTION RELAY AS PER IT-07 OF ANN-A   | SG4900067067  | 8   | 8                  | 12                  | 12                  |                     |                      | 11  |                     | 11                 |                     | 8                  |                     |  |  | 4  | 74        |
| 8        | Metrosil suitable for 1 A rating as per IT-08 of Ann-A  | SG4900067075  | 8   | 14                 | 30                  | 30                  |                     | 15                   | 11  |                     | 11                 |                     | 8                  |                     |  |  | 4  | 131       |
| 9        | Stabilizing Resistor (0-1000 ohms) or (0-4000 ohms) as per IT-09 of Ann-A   | SG4900067083  | 8   | 14                 | 30                  | 30                  |                     | 15                   | 11  |                     | 11                 |                     | 8                  |                     |  |  | 4  | 131       |
| 10       | Ethernet Switch (16 Channel) as per IT-10 of Ann-A  | SG4900069027  | 8   | 8                  | 9                   | 9                   | 4                   | 8                    | 9   | 8                   | 9                  | 7                   | 7                  | 4                   |  |  | 4  | 94        |
| 11       | Data Concentrator Panel with cable and accessories as per IT-11 of Ann-A  | SG4900067091  |   |                    |                     |                     |                     |                      |   |                     |                    |                     |                    |                     | 2  | 3  |  | 5         |
| 12       | Human Machine Interface (HMI)/Work station (24") alongwith furnitiure as per IT-12 of Ann-A                                     | SG4900067105  |   |                    |                     |                     |                     |                      |   |                     |                    |                     |                    |                     | 2  | 6  |  | 8         |
| 13       | Relay parameterization equipments as per IT-13 of Ann-A   | SG4900067113  |   |                    |                     |                     |                     |                      |   |                     |                    |                     |                    |                     | 2  | 2  |  | 4         |
| 14       | Global Positioning System (GPS Clock) as per IT-14 of Ann-A   | SG4900067121  |   |                    |                     |                     |                     |                      |   |                     |                    |                     |                    |                     | 1  |  |  | 1         |
| 15       | Report Printing device as per IT-15 of Ann-A  | SG4900069000  |   |                    |                     |                     |                     |                      |   |                     |                    |                     |                    |                     | 1  | 3  |  | 4         |
| 16       | CAT6 or better LAN cable as per IT-16 of Ann-A  | SG4900069043  |   |                    |                     |                     |                     |                      |   |                     |                    |                     |                    |                     | 8000                                     |  |  | 8000      |
| 17       | Fibre Optic Cable (Single Mode) as per IT-17 of Ann-A   | SG4900069051  |   |                    |                     |                     |                     |                      |   |                     |                    |                     |                    |                     | 12000                                    |  |  | 12000     |
| 18       | UPS As per IT-18 of Ann-A   | SG4900069906  |   |                    |                     |                     |                     |                      |   |                     |                    |                     |                    |                     | 2  | 6  |  | 8         |

**ANNEXURE-A & B TO PRODUCT STANDARD SG12927**

|  |                       |             |             |
|--|-----------------------|-------------|-------------|
| ANNEXURE-A TO PRODUCT STANDARD SG12927_R05 |                       | REV.NO.- 00 | Page 1 of 7 |
| BHEL Bhopal                                | Project Specific Data |             |             |
| SWE  | PI No.: 240932333     | Enq. No.:   | PO No.:     |
| W.O. Nos. : 90006Q47602 & 05 SAGARDIGHI    |                       |             |             |

**1. Project Data**

| Work order No           | Project           | P.I NO. |
|-------------------------|-------------------|---------|
| 90006Q47602/90006Q47605 | SAGARDIGHI UNIT-5 |         |

**2. Site Condition**

| Ambient Temp<br>(min/max/design)<br>deg Celsius | Humidity<br>(%) | Altitude<br>(mtr) | Atmospheric<br>condition | Installation |
|---|-----------------|-------------------|--------------------------|--------------|
| 1.1/55/50                                       | >90             | <1000             | Highly corrosive         | Indoor       |

**3. Miscellaneous inputs (tick (√)/ Purchaser to indicate against the requirement)**

|    |   |   |
|----|---|---|
| a. | Auxiliary Supply for Relays                                     | 220V DC +10 & -15% Variation  |
| b. | Auxiliary Supply for Data Concentrator                          | 2 nos, 220V DC +10 & -15% Variation   |
| c. | Prot. CT Secondary  | 1A (√)/ 5A ( )/<br>Not Applicable ( )   |
| d. | Diff./REF CT Secondary  | 1A (√)/ 5A ( )/<br>Not Applicable ( )   |
| e. | Earth Fault CT secondary  | 1A (√)/ 5A ( ) /<br>Not Applicable ( )  |
| f. | Open Delta Voltage for Directional                              | 110/3VAC(√)/<br>Not Applicable ( )  |
| g. | PT Synchronization secondary voltage                            | 63.5VAC (√) / 110VAC ( )/<br>Not Applicable ( )   |
| h. | Relay shall have conformal coating                              | No (√) / Yes ( )  |
| i. | Motor diff Relay part of main motor Protection Relay            | No (√) / Yes ( )  |
| j. | Trafo diff Relay part of main trafo Protection Relay            | No (√) / Yes ( )  |
| k. | RTD/ BTD Inputs (Nos) (For Motor Protection)                    | No (√) / Yes ( ) & Nos ( )  |
| l. | Protocol for Communication of relays                            | IEC open Protocol (IEC-61850) (√)/ MODBUS-RTU ( )   |
| m. | Protocol for Communication of DC with Upper Level system        | MODBUS-RTU ( )/ OPC (ETHERNET BASED)/ IEC-60870-104 ( )/<br>Other(Shall be informed during detailed engg) |
| n. | No of rear communication port on numerical relay for Networking | 1 (one) ( )/ 2 (Two) (√)  |
| o. | Redundancy Protocol   | PRP(√)/ HSRP ( )/ Dual Ring w/o PRP ( )/Not Applicable ( )  |
| p. | Topology for Communication from Relay to DC/Ethernet switch     | Serial ( )/ Star (Redundant)  |
| q. | Topology for Communication of DC with HMI                       | Star (dual redundant link)  |
| r. | System Communication Architecture                               | Enclosed (√) & DRG NO: (12A05-DWG-E-0150, Typical)/<br>Not Enclosed ( )/<br>Not applicable ( )            |

**ANNEXURE-A & B TO PRODUCT STANDARD SG12927**

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| BHEL Bhopal                                | Project Specific Data |             |             |
| SWE  | PI No.: 240932333     | Enq. No.:   | PO No.:     |
| W.O. Nos. : 90006Q47602 & 05 SAGARDIGHI    |                       |             |             |

|     |  |  |
|-----|--|--|
| s.  | Metering Network architecture (if applicable)  | Enclosed (√) & DRG NO ( ) /<br>Not Enclosed ( ) /<br>Not applicable ( )  |
| t.  | Time Synchronization Required  | No ( ) / Yes (√)   |
| u.  | Distance between feeder for cable differential relay and size & type of cable  | Not Applicable (√) /<br>Applicable ( ) & Distance ,<br>Type  |
| v.  | Switchgear Control thru relay from HMI Required  | No ( ) / Yes (√)   |
| w.  | Switchboard wise Item break-up   | Enclosed (√) Annexure (Annexure-Z) /<br>Not Enclosed ( ) / Not applicable ( )  |
| x.  | Location of different Swbd or Switchgear Room Layout drawing   | Enclosed ( ) & Drawing No ( ) /<br>Not Enclosed ( <b>shall be informed during detail engineering</b> ) /<br>Not applicable ( )   |
| y.  | Integration of LT relays & Integration of HT & LT switchgear Energy meter and Multifunction meter through Data Concentrator. | Not Applicable ( ) /<br>Applicable(√), Type ( ) & Protocol of LT relays (IEC open Protocol (IEC-61850) ( ) /<br>MODBUS-RTU ( )) Necessary protocol converter shall be in bidders scope |
| z.  | Data concentrator Panel paint shade  | Powder coated, semi glossy, shade ( <b>shall be informed during detail engineering</b> ) /<br>Not Applicable ( )   |
|     | Data concentrator Panel Location   | In BTG building control room (Distance shall be provided later) / Not Applicable ( )   |
| aa. | HMI Console colour shade   | Powder coated, semi glossy, shade ( <b>shall be informed during detail engineering</b> ) /<br>Not Applicable ( )   |
|     | HMI Console Desk Top colour shade  | Powder coated, semi glossy, shade ( <b>shall be informed during detail engineering</b> ) /<br>Not Applicable ( )   |
|     | HMI Console location   | Main control room ___ from Data Concentrator panel/ Not Applicable ( ) ( <b>shall be informed during detail engineering</b> )  |
| bb. | Customer approved sub-vendor List for communication Network items  | Enclosed ( ) & Annexure (E) /<br>Not Enclosed (√) ( <b>shall be finalized during detailed engg</b> ),  |

**4.0 Following clauses of SG12927 Rev 04 not applicable for the project:**

|         |  |
|---------|--|
| Clauses |  |
|---------|--|

**ANNEXURE-A & B TO PRODUCT STANDARD SG12927**

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| BHEL Bhopal                                | Project Specific Data |             |             |
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**5.0 Protection & metering features required in relay (In addition to specified in SG12927 rev 04)**

| KEY FEATURES<br>↓  | Item- 001<br>(Tick the<br>reqmnt √) | Item- 002<br>(Tick the<br>reqmnt √) | Item-003 (Tick<br>the reqmnt √) | Item- 004 (Tick<br>the reqmnt √) | Item- 005(Tick<br>the reqmnt √) | Item- 006 (Tick<br>the reqmnt √) | Item- 007(Tick<br>the reqmnt √)    |
|--|-------------------------------------|-------------------------------------|---------------------------------|----------------------------------|---------------------------------|----------------------------------|------------------------------------|
| SHORT DESCRIPTION →  | O/C+ E/F                            | O/C+ E/F                            | MOTOR<br>PROTN                  | MOTOR DIFF                       | TRAFO DIFF                      | UNDER<br>VOLTAGE                 | RESTRICTED<br>E/F/ STAND<br>BY E/F |
| 3-Ph Directional Over current (67) with low set, high set and high set instantaneous | √                                   | √                                   |                                 |                                  |                                 |                                  |                                    |
| Directional Earth Fault (67N) with low set, high set and high set instantaneous      | √                                   | √                                   |                                 |                                  |                                 |                                  |                                    |
| Stand By Earth Fault (64S)   |                                     | √                                   |                                 |                                  | √                               |                                  |                                    |
| 3-Ph inrush current detector   |                                     |                                     |                                 |                                  |                                 |                                  |                                    |
| Neutral Displacement (64NDR)   |                                     |                                     |                                 |                                  |                                 |                                  |                                    |
| Under Frequency with time delay(81U)   |                                     |                                     |                                 |                                  |                                 |                                  |                                    |
| Over Freq with time delay (81O)  |                                     |                                     |                                 |                                  |                                 |                                  |                                    |
| df/dt element(4 Stages)  |                                     |                                     |                                 |                                  |                                 |                                  |                                    |
| Max. start time  |                                     |                                     | √                               |                                  |                                 |                                  |                                    |
| Motor Over Load pre-alarm  |                                     |                                     | √                               |                                  |                                 |                                  |                                    |
| Motor Re-acceleration  |                                     |                                     |                                 |                                  |                                 |                                  |                                    |
| Loss of load (37)  |                                     |                                     | √                               |                                  |                                 |                                  |                                    |
| Single Phasing (46)  |                                     |                                     | √                               |                                  |                                 |                                  |                                    |
| Under current  |                                     |                                     | √                               |                                  |                                 |                                  |                                    |
| Phase Reversal Protection (46R)  |                                     |                                     |                                 | √                                |                                 |                                  |                                    |
| Motor Stall protection   |                                     |                                     | √                               |                                  |                                 |                                  |                                    |
| Earth Fault thru CBCT (50N)  |                                     | √                                   | √                               |                                  |                                 |                                  | √                                  |
| Transformer Diff (87T) 2 Winding   |                                     |                                     |                                 |                                  | √                               |                                  |                                    |
| CB Fail Protection   | √                                   | √                                   | √                               |                                  |                                 |                                  |                                    |
| Trip circuit supervision   | √                                   | √                                   | √                               |                                  |                                 |                                  |                                    |
| Under voltage Protection   | √                                   | √                                   | √                               |                                  |                                 | √                                |                                    |
|  |                                     |                                     |                                 |                                  |                                 |                                  |                                    |
|  |                                     |                                     |                                 |                                  |                                 |                                  |                                    |

**ANNEXURE-A & B TO PRODUCT STANDARD SG12927**

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| ANNEXURE-A TO PRODUCT STANDARD SG12927_R05 |                       | REV.NO.- 00 | Page 4 of 7 |
| BHEL Bhopal                                | Project Specific Data |             |             |
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| KEY FEATURES<br>↓  | Item- 001<br>(Tick the reqmnt √) | Item- 002<br>(Tick the reqmnt √) | Item-003 (Tick the reqmnt √) | Item- 004 (Tick the reqmnt √) | Item- 005 (Tick the reqmnt √) | Item- 006 (Tick the reqmnt √) | Item- 007<br>(Tick the reqmnt √) |
|--|----------------------------------|----------------------------------|------------------------------|-------------------------------|-------------------------------|-------------------------------|----------------------------------|
| SHORT DESCRIPTION →  | O/C+ E/F                         | O/C+ E/F                         | MOTOR PROTN                  | MOTOR DIFF                    | TRAFO DIFF                    | UNDER VOLTAGE                 | RESTRICTED E/F                   |
| High Impedance Motor Diff. (87M)   |                                  |                                  |                              | √                             |                               |                               |                                  |
| Low impedance Motor diff. (87M)  |                                  |                                  |                              |                               |                               |                               |                                  |
| Bus Differential (87B)   |                                  |                                  |                              |                               |                               |                               |                                  |
| Check bus differential   |                                  |                                  |                              |                               |                               |                               |                                  |
| Cable Diff. prot. scheme (87F)   |                                  |                                  |                              |                               |                               |                               |                                  |
| Converter/Modem/Isolation Trf for cable differential (if reqd)                               |                                  |                                  |                              |                               |                               |                               |                                  |
| Restricted Earth fault (REF1)  |                                  |                                  |                              |                               |                               |                               | √                                |
| Restricted Earth fault (REF2)  |                                  |                                  |                              |                               |                               |                               |                                  |
| Breaker monitoring   |                                  |                                  |                              |                               |                               |                               |                                  |
| Synch-check (25)   | √                                |                                  |                              |                               |                               |                               |                                  |
| Metrosil (separate enquiry item)   |                                  |                                  |                              | √                             |                               |                               | √                                |
| Stabilizing resistance(separate enquiry item)  |                                  |                                  |                              | √                             |                               |                               | √                                |
| <b><u>Metering /Event Recording</u></b>  |                                  |                                  |                              |                               |                               |                               |                                  |
| 3-Ph MVA   | √                                | √                                | √                            |                               |                               |                               |                                  |
| 3-Ph MVAR  | √                                | √                                | √                            |                               |                               |                               |                                  |
| 3-Ph MVAH  | √                                | √                                | √                            |                               |                               |                               |                                  |
| <b>BINARY INPUT/BINARY OUTPUT BESIDES RELAY FAIL W/D CONTACT (min. 6/6 if not specified)</b> | 24/14                            | 16/12                            | 10/10                        | 3/5                           | 3/5                           | 5/8                           | 3/5                              |
| <b><u>No of CT/PT and their purpose</u></b>  | 4/4                              | 5/3                              | 4/3                          | 4/0                           | 7/0                           | 0/3                           | 4/0                              |
| <b><u>OFFERED RELAY MODEL</u></b>  |                                  |                                  |                              |                               |                               |                               |                                  |
|  |                                  |                                  |                              |                               |                               |                               |                                  |

**ANNEXURE-A & B TO PRODUCT STANDARD SG12927**

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| BHEL Bhopal                                | Project Specific Data |             |             |
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**6.0 Data concentrator/HMI and other Accessories**

|                 |   |
|-----------------|---|
| <b>ITEM-008</b> | Metrosil suitable for 1 A rating  |
| <b>ITEM-009</b> | Stabilizing Resistor 0-1000 ohms or 0-4000ohms  |
| <b>ITEM-010</b> | Ethernet Switch (16 Channel) as per clause B2.04.00 of SG12927, Rev 05  |
| <b>ITEM-011</b> | Data Concentrator Panel as per clause B2.03.00 of SG12927 along with port converter for EM/MFM integration as per Annexure B Clause No. 3.0 |
| <b>ITEM-012</b> | Human Machine Interface (HMI)/Work station (24") as per clause B2.05.00 of SG12927, Rev 05  |
| <b>ITEM-013</b> | Relay parameterization equipment as per clause B2.12.00 of SG12927, Rev 05  |
| <b>ITEM-014</b> | Global Positioning System (GPS Clock) as per clause B2.09.00 of SG12927, Rev 05   |
| <b>ITEM-015</b> | Report Printing device as per clause B2.07.00 of SG12927, Rev 05  |
| <b>ITEM-016</b> | CAT6 or better LAN cable as per clause B2.10.00 of SG12927, Rev 05  |
| <b>ITEM-017</b> | Fibre Optic Cable as per clause B2.11.00 of SG12927, Rev 05   |
| <b>ITEM-018</b> | Uninterrupted Power supply as per clause B2.08.00 of SG12927, Rev 05  |

**7.0 Set of Documents Required (For each project)**

| ITEMS  | Sets (along with the offer) | Sets (along with the supplies) | Sets (within 2 weeks of P.O placement) |
|--|-----------------------------|--------------------------------|--|
| Technical Leaflet/ literature, panel cutout, overall dimension drawing, complete model no, wiring diagram of Each item.                | 1                           | -                              | -                                      |
| User manual/Guide of Each item.  | -                           | 1                              | 8                                      |
| Routine test certificate   | -                           | 1                              | -                                      |
| Scheme, datasheet, FDS, System architecture, bill of material, OGA of data concentrator panel, OGA of furniture & HMI etc for approval | -                           | 1                              | 8                                      |
| QAP (Quality Approval Plan)  | -                           | -                              | 8                                      |
| SAT (Site Acceptance test procedure)   | -                           | -                              | 8                                      |
| FAT (Factory acceptance test procedure)  | -                           | -                              | 8                                      |

**ANNEXURE-A & B TO PRODUCT STANDARD SG12927**

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**ANNEXURE-B: VENDOR TO CONFIRM PROJECT SPECIFIC OTHER TECHNICAL REQUIREMENT**

| CLAUSE NO | SPECIFIC TECHNICAL REQUIREMENT  | COMPLIED YES/NO | REMARKS |
|-----------|---|-----------------|---------|
| 1.0       | Compliance of Clause 5.13.00 of Section-VII, Vol-II-F/1 - Technical specification of relays   |                 |         |
| 2.0       | The relay offered against It-01 shall be suitable for detection of earth fault currents at 5% (preferably 1%) of the CT rated current. Vendor to mention in the offer the setting available.  |                 |         |
| 3.0       | Vendor to submit undertaking for supply of spare parts and maintenance support for the equipment for atleast 15 years from the date of supply.  |                 |         |
| 4.0       | <b><u>Numerical Relay</u></b>   |                 |         |
| 4.1       | 1) The customer approved vendors for Numerical relay for the project are:<br>a) ABB, Vadodra<br>b) ABB, Bangalore<br>c) GE (Alstom) for MICOM series only<br>d) Siemens for SIPROTEC series only<br>e) Schneider for MICOM series only  |                 |         |
| 4.2       | 2) Technically cleared offer from any other vendor meeting the PQC requirement shall be forwarded to customer for acceptance. Price bid of customer approved vendor only shall be opened.   |                 |         |
| 5.0       | <b><u>Integration of HT/LT Switchgear Energy meter &amp; MFM with Data Concentrator.</u></b>  |                 |         |
| 5.01      | All the Energy meters/MFM of HT switchgear shall be connected in loop(s) and shall be further connected to Data Concentrator. The tentative quantity of board wise Energy Meters for HT switchgear are as under:<br><br>a) 11kv Unit Board (5BA) – 22 nos.<br>b) 11KV Unit Board (5BB) – 22 nos.<br>c) 11KV Station board (OBE) – 16 nos.<br>d) 11KV Station board (OBF) – 17 nos.<br>e) 11KV AHP board (OBH) – 13 nos.<br>f) 11KV CHP board (OBI) – 13 nos.<br>g) 11KV FGD board (5BJ) -10 nos<br>h) 3.3KV Unit board (5CA)- 34 nos.<br>i) 3.3KV Station board (OCE)– 7 nos.<br>j) 3.3KV AHP board (OCB) – 14 nos.<br>k) 3.3KV CHP board (OCC) – 31 nos.<br>l) 3.3KV FGD board (5CD) – 13 nos. |                 |         |



**ANNEXURE-A & B TO PRODUCT STANDARD SG12927**

|  |                       |             |             |
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| ANNEXURE-A TO PRODUCT STANDARD SG12927_R05 |                       | REV.NO.- 00 | Page 7 of 7 |
| BHEL Bhopal                                | Project Specific Data |             |             |
| SWE  | PI No.: 240932333     | Enq. No.:   | PO No.:     |
| W.O. Nos. : 90006Q47602 & 05 SAGARDIGHI    |                       |             |             |

|      |   |  |  |
|------|---|--|--|
| 5.02 | Bidder to consider necessary converter for converting data from RS485 to MODBUS TCP/IP & shall have following features (Make of converter shall be subject to customer approval during detail engineering)  |  |  |
| 5.01 | 2 nos of serial (RS485) port for interfacing with MFM/TVM and 2 nos of Ethernet port for interfacing with Ethernet switch.  |  |  |
| 5.02 | 10/100 MBPS Ethernet port   |  |  |
| 5.03 | Asynchronous Isolated serial Port   |  |  |
| 5.04 | RJ45 socket for Ethernet  |  |  |
| 5.05 | Screw Terminal for Serial Port  |  |  |
| 5.06 | Automatic detection of Devices  |  |  |
| 5.07 | Device configuration Utility  |  |  |
| 5.08 | Operating Voltage :220 V DC   |  |  |
| 5.09 | Baud Rate Supported:<br>1200,2400,4800,9600,19200,38400,57600,115200  |  |  |
| 5.10 | Enclosure: Metallic   |  |  |
| 5.11 | The quantity of convertors shall be calculated by taking care maximum Energy meters that can be looped in a meter. Cable between the convertor and the Ethernet switch shall be in the scope of bidder. The quantity of board wise Energy meters is tentative and if any additional hardware required to complete the system same shall be in bidder's scope. |  |  |
| 5.12 | For LT switchboards MFM/Energy meter integration, same shall be looped till the Ethernet switches and further integration with Data Concentrator shall be as per Clause 4.03.08 of SG12927, Rev 05.   |  |  |

**ENCLOSURES:**

1. Typical Architecture drawing - 12A05-DWG-E-0150
2. System Architecture for Relay and Energy Metering system - 12A05-DWG-E-0150
3. Clause 5.13.00 of Section VII, Vol II-F/1 for Numerical relays
4. Annexure-Z : Board wise relay quantity



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**SPECIFICATION FOR NUMERICAL RELAYS AND MV SWITCHGEAR SCADA SYSTEM**

**I) Objective:** This standard covers the technical requirement of Numerical relays and MV Switchgear SCADA System on Industry open communication protocol for power plant & distribution switchgear application.

**II) Product standard structure:** This technical specification has been divided in three parts

**A) Qualifying requirements:**

1. These requirements are from clause no A1.01 to 1.03. These requirements are to be met and the bidder's offer would be technically evaluated only when these clauses are complied. Deviation is not acceptable. Noncompliance of these points in any form will lead to rejection of the offer.

**B) Additional NIT conditions:**

These requirements are from clause no A2.01 to A2.08 describes the additional NIT conditions of enquiry.

**C) Scope of Supply:** These requirements are from clause no A3.00 describes the scope of supply of enquiry.

**D) Technical requirements:** This section have been divided in following parts

1. Technical specification of Numerical relays
2. Technical specification of Relay network system (Data concentrator, HMI, GPS, Printer, UPS, Relay parameterization device, Fiber Optic cable, 4-pair G-type cable & Ethernet switches.)
3. System performance requirement, functional requirement & System security
4. Engineering, Drawing/Doc, Service & training required at various stages of tendering & execution.
5. FAT/SAT of Numerical relay & Network System
6. Annexure-A clause 1 to 6 are project specific additional requirement.

**III) Bidder's Offer structure:** Bidder to submit their offers in SG12927 Rev. 04 format only else it shall not be evaluated. (Soft copy of the format shall be made available to bidder upon request). The bidder's offer should consist of following:

- i. Compliance to qualifying, additional NIT conditions & technical requirement clauses of SG12927
- ii. Compliance to Annexure-A of SG12927.
- iii. Compliance to Annexure-B of SG12927 (Project specific additional technical requirement, if applicable).
- iv. Bidder to offer their models meeting full requirement mentioned in Annexure-A, Clause 5.0
- v. Incomplete offers in any respect/offers in any other format shall be straight away rejected without any correspondence/clarification with/from the bidder.
- vi. **Deviation written at any place other than SG12927\_SGD / Annexure-A / Annexure-B shall not be considered.**

**IV) Acceptance Criteria:**

1. Visual checks for cracks and surface finish.
2. Availability of all routine test certificates.
3. Make & Type of relays as per PO Spec / OA approval / BHEL Engg document.
4. Verification from customer / BHEL engg approved datasheet.
5. Availability of BHEL/ Customer inspection report as per customer/ BHEL approved QAP of DC panel.
6. Guarantee Certificate
7. Compliance of BHEL/ Customer observations (If any) identified in inspection report

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| <u>A 1.00</u> | <u>Qualifying requirement</u>  | <u>COMPLIED</u><br><u>YES/NO</u> |
|---------------|--|----------------------------------|
| 1.01          | All Numerical Relays of the project shall be from one Original Equipment Manufacturer (OEM).   |                                  |
| 1.02          | The bidder shall confirm that all offered relays & networking items are type tested as per the latest edition of relevant National / International Standards. Bidder to submit Type test reports for customer approval if demanded. In case the customer finds any discrepancy or inadequacy during approval, same shall be resolved by supplier with customer with no binding on BHEL and without any price & delivery implication OR shall conduct type test without any delivery & price implication to BHEL. |                                  |
| 1.03          | Only proven relays shall be offered, which are in successful operation for two years from the date of techno commercial bid opening. Reference list indicating dates of commissioning shall be furnished along with the offer.   |                                  |
| <u>A2.00</u>  | <u>Additional NIT conditions</u>   |                                  |
| <u>2.01</u>   | All items shall be from one source & Order will be finalized on technically clear party based on total package L-1 price.  |                                  |
| <u>2.02</u>   | Bidder to provide unit price for all items & items covered under main items for addition and deletion at later stage.  |                                  |
| <u>2.04</u>   | The prices of relays ordered with discount shall be kept valid up to one year from the date of PO to take into account the addition / deletions of items up to a limit of $\pm 10\%$ during detailed engineering / drawing approvals and requirement of spares.  |                                  |
| <u>2.05</u>   | The offer shall be submitted in 2 bids. The bidder's technical representative shall first visit BHEL Bhopal and subsequently along with BHEL to customer for technical discussions and on the spot finalization of technical issues, if needed, within 2 weeks after technical bid opening. Exact date will be confirmed to bidder by BHEL.  |                                  |
| <u>2.06</u>   | All items shall be guaranteed/warranted for successful operation for a period of 5 years from the date of supply of last lot of all items against respective milestones for the project. Support and maintenance for the package, including onsite support shall be provided as and when required during the guarantee period by the bidder without any additional charges to BHEL.  |                                  |
| <u>2.07</u>   | The approval of BHEL/customer will not absolve vendors responsibility to meet technical specification requirement. BHEL/customer may reject the equipment if it does not comply with the specifications, when erected or fails to give complete satisfaction in service.   |                                  |
| <u>2.08</u>   | All items excluding Numerical relays shall be subjected to manufacturing clearance from BHEL. Bidder to start manufacturing after manufacturing clearance only. Delivery of these items shall be quoted accordingly.   |                                  |
| <u>A 3.00</u> | <u>Scope of supply</u>   | <u>COMPLIED</u><br><u>YES/NO</u> |
| 3.01          | The Bidder's scope of work shall include complete design, engineering, supply, testing and commissioning of the following.   |                                  |
|               | a) Communicable Numerical Relays   |                                  |
|               | b) Ethernet switches in Switchgear panels / data concentrator panels   |                                  |
|               | c) Cat6 or better Ethernet cable for connection of Numerical Relays to Ethernet switches in all MV Switchgears   |                                  |
|               | d) Optical Fibre Cable with fire-retardant outer sheath along with HDPE conduit (routing & laying excluded)  |                                  |
|               | e) Optical Fibre Cable termination equipment such as LIU, patch cord, etc. for the complete network including all MV Switchgears.  |                                  |
|               | f) Control cable glands for optical fibre and cat6 ethernet cable.   |                                  |
|               | g) Data Concentrator systems along with associated Ethernet switches and suitable gateways / switches for interconnection with the DDCMIS.   |                                  |
|               | h) HMI stations (Engineering or Operator Work stations), & suitable arrangement for integration of HMI to LVS in Control Room (LVS not in bidder's scope)  |                                  |
|               | i) GPS, Time synchronizing equipment, Digital Clocks & printers  |                                  |



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|                  |   |                        |
|------------------|---|------------------------|
|                  | j) Laptops & Interface cable for connection of Numerical relay front port to the laptops  |                        |
|                  | k) Integration of LT system Numerical Relays on MV Switchgear SCADA network, if applicable as per Annexure-A.   |                        |
|                  | l) All other equipment required to meet the intended specification  |                        |
| 3.02             | Though minimum items required for network LAN have been listed above. However, any additional hardware required for successful operation of network is also in bidder scope.  |                        |
| <b>B 1.00.00</b> | <b><u>TECHNICAL SPECIFICATION OF NUMERICAL RELAYS</u></b>   | <b><u>COMPLIED</u></b> |
|                  |   | <b><u>YES/NO</u></b>   |
| <b>1.01.00</b>   | <b>General Relay requirement</b>  |                        |
| 1.01.01          | All Numerical relays shall be of types, proven for the application satisfying requirements specified elsewhere and shall be subject to customer's approval. Numerical Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity to the satisfaction of the customer.   |                        |
| 1.01.02          | All Numerical relays located in the individual feeder shall have the complete protection, measurement & monitoring functionalities pertaining to the feeder. Control logics related to closing & tripping of the feeder, viz. upstream breaker interlock, protection (86) interlock of own & other associated feeders, synchronism check, tripping on bus no-volt, etc. shall be built in the feeder IED. The detail logic configurations shall be finalized during detail engineering. |                        |
| 1.01.03          | All characteristics curves as per IEC, IEEE/ANSI etc shall be available in the relay and shall be selectable.   |                        |
| 1.01.04          | Relays shall be suitable for flush mounting with dust tight degree of protection. Also the interior of the Numerical relays shall be suitable for harsh environmental operation.  |                        |
| 1.01.05          | Relays shall have Read & write set points & Tampering proof security system (Password protection).  |                        |
| 1.01.06          | All relays shall have LED & LCD display for display of settings, status, faults and events. LCD display shall be backlit and temperature compensated to 65 degree for contrast and legibility. All the relay shall have at least 8 nos Programmable LEDs.   |                        |
| 1.01.07          | Relay shall be suitable for 1A or 5A CT secondary as specified in <u>Annexure-A</u> .   |                        |
| 1.01.08          | Voltage (through PT) input to relay, shall be 110V +/- 10% .  |                        |
| 1.01.09          | Current operated relay shall have at least measurement of line current (Ir, Iy, Ib) and neutral current (Io)  |                        |
| 1.01.10          | Voltage operated relay shall have at least measurement of phase to neutral Voltage (Vrn, Vyn, Vbn), phase to phase Voltage (Vry, Vyb, Vbr), residual voltage (Vo), frequency.   |                        |
| 1.01.11          | Relay with current and voltage input shall have at least measurement apart from those required in current or voltage operated relay, 3-ph power, energy, & power factor.  |                        |
| 1.01.12          | Measurement accuracy shall be 1 % for rated RMS Current and voltage (20-120% of Rated primary).   |                        |
| 1.01.13          | Relay shall be suitable to accept both AC/DC supplies from 110V to 240V range unless otherwise specified in <u>Annexure-A</u> . Relay shall be capable of satisfactory Continuous operation between 70-120% of the rated voltage.   |                        |
| 1.01.14          | One minute power frequency withstand test voltage for all numerical relays shall at least be 2kV (rms)  |                        |
| 1.01.15          | Relay should have potential free digital output as specified in <u>Annexure-A</u> . Each shall be separately programmable for either hand reset or self-reset and for any protection functions. Making, carrying and breaking current ratings of contacts shall be adequate for direct breaker closing & tripping circuits.<br><b>If any two or more output contacts are having common terminal, shall be considered as 1 no output.</b>  |                        |
| 1.01.16          | All Numerical relays shall have freely programmable optically isolated binary inputs (BI) as per annexure A. Analog inputs shall be protected against switching surges, harmonics etc.  |                        |



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| 1.01.17 | 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 60% of the rated control supply voltage.  |  |
| 1.01.18 | Relay shall have built-in Lockout function (86) and shall be software selectable for self and hand reset feature.  |  |
| 1.01.19 | LBB protection shall be suitable for external initiation through binary input and shall have separate current setting.   |  |
| 1.01.20 | Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker /vacuum contactor operation.   |  |
| 1.01.21 | All protective numerical relay shall have <b>metering, control, status &amp; protection function</b> with non-volatile memory.   |  |
| 1.01.22 | 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.   |  |
| 1.01.23 | Relays shall have event-recording feature, recording of abnormalities and operating parameters with time stamping.   |  |
| 1.01.24 | Sequence of events shall have 1ms resolution at device level.  |  |
| 1.01.25 | 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       |  |
| 1.01.26 | The disturbance record shall have adjustable pre-fault and during / post fault time settings. It should be possible to save the record in a COMTRADE format for replaying by relay test kit. (Details to be spelt out in the offer)  |  |
| 1.01.27 | 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.  |  |
| 1.01.28 | All the numerical relays shall have local front port for communication through laptop and either one or two (as specified in annexure A) rear port for communication with the data concentrator over LAN. All Communication ports shall be integral part of relay. Separate external ports are not acceptable. |  |
| 1.01.29 | The numerical relays shall have capability of communicating simultaneously on both the redundant network rings (if applicable as per Ann-A) enable seamless switchover (PRP/HSRP refer annexure-A) to enhance the reliability of the communication system.   |  |
| 1.01.30 | It shall be possible to carryout open / close operation of breakers from a laptop by interfacing from the relay front port during initial commissioning.   |  |
| 1.01.31 | Current operated Numerical Relays shall be suitable for both residually connected neutral CT input as well as CBCT input. Relays with Check Synch feature shall have provision of two sets of voltage inputs (3Nos for bus voltage & 1No. for line voltage).   |  |
| 1.01.32 | Relay terminal shall be suitable for termination of two wires of 2.5/4 sqmm wire for CT, PT and AC circuit and two wires of 1.5sqmm wire for DC circuit. Special Lugs if required for use with the relays shall be supplied in adequate quantity along with the relays.  |  |
| 1.01.33 | 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 connections.   |  |
| 1.01.34 | All numerical relays shall have keypad / keys to allow relay setting from relay front. Preprogrammed or programmable key for Master trip (86) reset shall be provided on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote.         |  |
| 1.01.35 | Relays shall have self-diagnostic feature with continuous self-check for power failure, program routines, memory and main CPU failures and a separate dedicated output contact of any failure & on relay front for indication .  |  |
| 1.01.36 | Relays shall have at least two sets or groups of two different sets of adaptable settings.   |  |



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| 1.01.37 | Design of the relay must be immune to any kind of electromagnetic interference. All numerical relays shall comply with emission and immunity levels as per relevant IEC/EN.   |  |
| 1.01.38 | 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.  |  |
| 1.01.39 | All numerical relays shall be provided with a facility / port for time synchronization with GPS using 1-PPM / IRIG-B / SNTP input. It shall also be possible to synchronize the numerical relays with data from LAN over network protocol (SNTP). Time stamping of events, fault records, disturbance records shall be done at numerical relay itself with a resolution of 1 milli second. Also time stamped data from numerical relays shall be communicated to HMI and SAS. |  |
| 1.01.40 | All Numerical relay shall have earth fault setting of min. 10 mA with or without CBCT.  |  |
| 1.01.41 | It shall be possible to carry out Control of breakers and vacuum contactors through Numerical Relay from Switchgear SCADA on LAN. In addition, control of Breakers/Vacuum contactors shall be possible from DDCMIS via 24V DC signal to DI of Numerical Relays (if specified in Annexure-A).  |  |
| 1.01.42 | The numerical relay shall be able to provide supervisory functions such as trip circuit monitoring, circuit breaker status monitoring, and VT supervision. Trip circuit supervision shall be provided for all feeders to monitor the circuit breaker /contactor trip circuit both in pre-trip and post-trip conditions.   |  |
| 1.01.43 | Schematics requiring auxiliary relays / timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer functions shall be as required for the application. Timer functions shall be configurable for on & off delays as per requirement.  |  |
| 1.01.44 | 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 shall be available on the user interface  |  |
| 1.01.45 | The alarm / status of each individual protection function and trip operation shall be communicated to the Switchgear SCADA system.  |  |
| 1.01.46 | Additional GOOSE Controls shall be configured in the Numerical Relays for following functions. The response time of GOOSE interlocks shall be 10ms. (GOOSE Performance Class P1, MSG Type 1A)<br>a) Inter tripping<br>b) Reverse Blocking<br>c) Earthing Interlocks   |  |
| 1.01.47 | No separate earth bus shall be required for the relays. It shall be possible to connect the relay earth to the common earth bus in the switchgear panel which shall be connected to the plant earth mat.  |  |
| 1.01.48 | Any accessories/ additional items such as screened cable, special lugs, connectors etc required for proper functioning of scheme for which item is being procured shall be offered & supplied in adequate quantity along with the relays.   |  |
| 1.01.49 | i Cable Differential protection relay shall be provided with complete scheme & shall be suitable for 1KM (if not specified in the <b>Annexure-A</b> ) long pilot wire.  |  |
|         | ii Cable differential protection relay shall be suitable for type of cable specified in the <b>Annexure-A</b> .   |  |
|         | ii Necessary modem, isolation transformer intermediate equipment, connector for cable etc required for the proper functioning of scheme/ establishment of communication shall be supplied along with the relay.   |  |
| 1.01.50 | Increase in no. of Data concentrators, Ethernet switches or any other hardware due to increase in quantity of relays (eg - two relays Offered to meet the specification requirement in place of single relay) during detailed engineering stage (if required) shall be supplied without any price implication.  |  |



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| 1.01.51 | Add-on BI/BO module along with main numerical relay in order to meet the total BI/BO requirement as per specification is also acceptable. However, following feature shall be available in the BI/BO add-on module:  |  |
|         | i. Add-on module shall be communicable type.   |  |
|         | ii. 2.5mtr communication cable with connector at both ends to connect I/O module with main relay shall be supplied with each module for communication of module with main relay.   |  |
|         | iii. DC failure/communication failure or any other hardware failure alarm shall be available either in module or in main relay and shall be communicated to data concentrator/ DDCMIS.   |  |
|         | iv. Time stamping events/ disturbance records shall be available either in module or in main relay incase of any input or output operation of module.  |  |
|         | v. Programming of all the BI/BOs (BI/BOs of add-on module and numerical relays add together) shall be possible at one place only i.e either at Add-on module or at main relay.   |  |
| 1.02.00 | <b>Protections: Feeder Types &amp; Protections</b>   |  |
| 1.02.01 | <b><u>Motor Feeder Protections (Following min protection function shall be part of comprehensive motor protection relay. For additional protection function refer annexure A.)</u></b>   |  |
|         | <b>a) Thermal Overload Protection (49)</b> The relay shall have adjustable thermal curve as per parameters. Separate prior alarm and trip outputs shall be available.  |  |
|         | <b>b) Short Circuit Protection (50)</b><br>The relay shall have instantaneous short-circuit protection. Provision for blocking of short circuit protection shall be available to make relay suitable for contactor-controlled motors. The short circuit protection shall also have cold load pick up (doubling) / group-changeover feature to allow higher setting during motor start and lower setting during normal running condition.   |  |
|         | <b>c) Earth Fault Protection (50N)</b><br>The relay shall have instantaneous as well as time delayed earth fault protection. With CBCT the relay shall be suitable for detection of earth fault currents in the range of 1% (10mA). Provision should be provided to block earth fault element in case of phase current exceeding 4 times of full load current when used for contactor-controlled motors.   |  |
|         | <b>d) Negative Phase Sequence Protection (46)</b><br>The relay shall have negative phase sequence (unbalance) protection to protect the motor against overheating caused by phase unbalance / negative sequence current.   |  |
|         | <b>e) Locked Rotor Protection (50LR)</b><br>The relay shall have locked rotor protection to take care of stalling of motor during motor start up. The protection shall take care of the prolonged motor start up time under bus low-voltage conditions. The relay shall have provision to accept speed switch input to enable to use relay for applications where the safe stall time of motor is shorter than the start-up time of the motor.                                     |  |
|         | <b>f) Motor start monitoring &amp; Restart inhibit feature</b><br>The relay shall have a function block for monitoring motor start-up condition with suitable outputs for use in various logics. A thermal based restart inhibit feature with separate settings shall be provided. It shall be possible to configure the output of this function to block closing command during restart inhibit period. Estimated time to the next motor restart should be available for display. |  |
|         | <b>g) Number of starts limitation (66)</b><br>The relay should have repetitive start protection to protect the motor against overheating caused by too frequent start-up attempts. The output of this function block should be routed to restart inhibit output.   |  |
|         | <b>h) Under Voltage protection with time delay (27M)</b>   |  |





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|         |  |  |
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|         | The relay should have under voltage protection with built in variable timer. The protection should be sensed through bus VT voltage provided to relay.   |  |
|         | <b>i) Motor Differential protection (87M)</b><br>Differential protection for higher rated motors rating shall be provided with high stability circulating current differential protection with harmonic restraint having pick up setting range of 10 to 40 % of CT secondary. Requirement of High Impedance or Low impedance, refer <b>Annexure A.</b> ( This protection shall be in separate relay unless & otherwise specified in annexure A)  |  |
|         | <b>j) VT Fuse-fail protection (60)</b><br>Built in fuse fail protection should be available in relay, which should block under voltage protection in the event of fuse fail. The relay should have built in Lockout feature. Transformer Feeder Protections  |  |
|         | Relays shall also have at least measurement of Hour Run meter, start current & start time.   |  |
|         | If RTD/BTDS are specified in Annexure-A, the distance, If not specified between motor and switchboard may be considered as 1000m and the cable as 2.5sqmm, multi core, cu conductor cable.   |  |
| 1.02.02 | <b>Transformer Feeder Protections (Following min protections shall be part of main transformer feeder protection relay for additional protection function refer annexure A.)</b>   |  |
|         | <b>a) Three Phase Over current and Earth Fault protection (50 &amp; 50N)</b><br>The relay shall have instantaneous as well as time delayed over current and earth fault protections. The over current element should have the minimum setting adjustable between 250-2000% of CT secondary rated current. The short circuit protection shall also have cold load pick up (doubling) / group-changeover feature to allow higher setting during transformer charging (inrush) and lower setting during normal operating condition.<br><u>With CBCT, the relay shall be suitable for detection of earth fault currents in the range of 10mA secondary.</u>  |  |
|         | <b>b) Restricted Earth Fault protection (64R)</b><br>Restricted earth fault protection (64R) shall be provided with high stability circulating current principle having pick up setting range of 10 to 40 % of CT secondary.   |  |
|         | <b>c) Stand by earth fault protection (51N)</b><br>For transformers of rating 5MVA and above, definite time delayed Stand by earth fault protection shall be provided having a pick up setting range of 10% to 40% with a timer delay of 0.3 sec to 3 sec.   |  |
|         | <b>d) Transformer Differential protection (87T)</b><br>Differential protection for transformers (87T) of rating 5MVA and above shall be provided with stabilized biased differential relay. The differential protection shall be provided with harmonic restraint during switching and over fluxing condition. No ICT shall be provided either for ratio correction or for transformer primary and secondary correction. The necessary correction shall be programmable at offered numerical relay. Sensitive phase current and phase angle displays should be available to facilitate the commissioning and checking of the measurement circuit connection and vector group matching.<br>i) Transformer differential relay shall be suitable to achieve harmonic restrain during switching and shall take care of ratio error & transformer vector group without need for external ICT.<br>ii) Transformer differential standby earth fault element shall be suitable for restricted earth fault application also and vice-a-versa.<br>(This protection Function shall be in separate relay unless otherwise specified in annexure A) |  |
| 1.02.03 | <b>Protections for Incomers, Bus-couplers and Tie feeders. (Following min protections shall be part of main feeder protection relay for additional protection function refer annexure A.)</b>  |  |
|         | <b>a) Three Phase Over current and Earth Fault protection (50 &amp; 50N)</b><br>The over current element should have the minimum setting adjustable between 250-2000% of CT secondary rated current. The earth fault element should be suitable for residually connected CT input. The   |  |





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|                 | relay shall be suitable for detection of earth fault currents in the range of 5% to 10% of the CT rated current.  |  |
|                 | <b>b) Synchronizing Check (25)</b><br>Synchronizing check feature as a part of manual live change over and dead bus closing feature shall be provided.  |  |
|                 | <b>c) Bus No-volt</b><br>Bus no volt signal shall be configured in the relay for use in control logics. Other Protections and Control functions in the Relays.  |  |
| 1.02.04         | <b>Voltage Protection relay. (Following min protections shall be part of main feeder protection relay for additional protection function refer annexure A.)</b>   |  |
|                 | <b>a) Under Voltage protection with time delay (27/2)</b><br>The relay should have under voltage protection with built in variable timer. The protection should be sensed through bus VT voltage provided to relay.   |  |
|                 | <b>b) Over Voltage protection with time delay (59/2)</b><br>The relay should have under voltage protection with built in variable timer. The protection should be sensed through bus VT voltage provided to relay.  |  |
|                 | <b>b) Bus No-volt (27N/2)</b><br>Bus no volt signal shall be configured in the relay for use in control logics. Other Protections and Control functions in the Relays.  |  |
| <b>B2.00.00</b> | <b>TECHNICAL SPECIFICATION OF RELAY NETWORKING SYTSTEM</b>  |  |
| <b>B2.01.00</b> | <b>SYSTEM COMMUNICATION ARCHITECTURE</b>  | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.01.01         | The typical configuration of the intended system is shown in the Network Architecture diagram as specified in annexure A.   |  |
| 2.01.02         | The System architecture shall be flexible to allow future extensions. Required application features, spare capacity, spare ports etc shall be provided.   |  |
| 2.01.03         | All parameters on the relay are required to be available on LAN with separate address for each parameter and shall be simultaneously available on HMI and DDCMIS.   |  |
| 2.01.04         | Data concentrator & HMI: Overall and detailed Dynamic Single Line Diagrams for the entire Auxiliary Power Supply system shall be built in the Data concentrator / HMI system and manual control commands to all feeder & board IEDs shall be issued from the HMI. Trip selection for manual changeover and Station level logics shall also be included in the Data concentrator / HMI. Other functionalities of HMI shall include Sequence of Events, alarms, Trends, Reports, Upload of Disturbance Records (DR), Online monitoring of Ethernet rings, etc. Data concentrator shall have the necessary OPC server for communication of data from the Motor feeders to DDCMIS |  |
| <b>B2.02.00</b> | <b>SYSTEM PERFORMANCE REQUIREMENTS</b>  | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.02.01         | Latency: As the Switchgear SCADA system shall be controlling the entire Auxiliary Power Supply system and thereby the entire plant operation, requirement of speed is of utmost importance. The system shall be so designed and implemented as to provide data transfer speeds prescribed by IEC 61850-5. Latency calculations based on system design shall be submitted for review and approvals. Validation of the calculations shall be done during SCADA FAT and SAT.   |  |
| 2.02.02         | Reliability: All components shall be designed and configured to make the system highly reliable. Failure of any component shall be immediately announced and wherever possible, the system shall be made self-healing. Reliability analysis of the entire system considering the reliability of all individual components shall be carried out and the reliability analysis calculations shall be submitted for review and approval by the employer.  |  |
| 2.02.03         | Ease of operation: The system shall be user friendly with respect to engineering, configuration, operation & maintenance with built in tools for operator help.   |  |



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| 2.02.04         | Diagnostic tools: The system shall have necessary diagnostic tools to continuously monitor the system performance and provide feedback to the operator / engineer. Necessary software tools to track changes in the system shall be provided.  |  |
| <b>B2.03.00</b> | <b>DATA CONCENTRATOR</b>   | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.03.01         | Each Data Concentrator panel shall consist of the following:<br>a) Redundant Servers with hot standby facility (for both Control and Data)<br>b) Sleek foldable monitor with keyboard and mouse (VDU)<br>c) Hardware for smooth changeover between redundant servers like KVM switch, etc.<br>d) Ethernet switches for Station LAN and DDCMIS<br>e) Power supply modules<br>f) Monitoring devices for power supply and healthiness of various important equipment like server.<br>g) At least 4Nos (2 working + 2 standby) ventilation fans with monitoring<br>h) GPS Clock Display system<br>i) Arrangement for receiving and distributing auxiliary power supply to various equipment / circuits<br>j) Necessary hardware, application software and licenses shall be included in the scope of supply.<br>k) Any other equipment / device necessary for completeness of the system |  |
| 2.03.02         | The Data concentrators shall be provided to network the various switchgears at different locations through LAN system. Data concentrator shall provide gateway between Numerical relays, HMI and DDCMIS.   |  |
| 2.03.03         | Preferably, the Data Concentrator shall be capable of communicating on dual redundant Ethernet rings with necessary redundancy management if applicable as specified in Annexure-A.  |  |
| 2.03.04         | The data concentrator should be based on industrial hardware design operating on 64-bit Windows operating system and should allow monitoring and control the acquisition of the real-time data from numerical relays and should provide a framework for monitoring this data at HMI. Local VDU facility is for any kind of local maintenance activities from the Data Concentrator.  |  |
| 2.03.05         | Data concentrator should have capability of storing data. Facility should be available to store the data day wise and it should be able to take back up of data at any time without affecting the normal operation of the system. The minimum storage capacity of the Data Concentrator shall be 1TB at least to enable long time storage of events/data.  |  |
| 2.03.06         | Data concentrator shall have required number of Ports for connection to HMI having operators work station and engineering station PC.  |  |
| 2.03.07         | Data concentrator shall have dual redundant ports for communication to DDCMIS on protocol as specified in Annexure A.  |  |
| 2.03.08         | Digital display of time shall be provided on top of each Data Concentrator panel.  |  |
| 2.03.09         | Data concentrators shall be placed in a separate panel and shall be interconnected to each other with provision for communication with other system like DDCMIS over Ethernet LAN in line with the network architecture. Data concentrators shall be suitable for operation in harsh environment.  |  |
| 92.03.10        | A) Internal wiring of data concentrator panels shall be done with FRLS cable only.<br>C) Make of data concentrator panel and all fitments in data concentrator panel including Ethernet switch, data concentrator, GPS etc. is subject to customer's approval during drawings approval stage.<br>D) Ethernet switches, data concentrator and GPS shall be suitable for auxiliary DC supply. Necessary auto changeover scheme of auxiliary supply with diode bridge shall be provided at Data concentrator panel for changeover of two no of DC feeders.  |  |
| 2.03.11         | Failure of data concentrator shall be reported as alarm to HMI through software interrogation.   |  |



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| 2.03.12         | All the Data concentrator Panels shall be equipped with Anti vibration Pad of min 15 mm size. Neoprene/silicon Gasket, Exhaust Fans with Louvers and filters shall be provided in all data concentrator Panels.  |  |
| <b>B2.04.00</b> | <b><u>ETHERNET SWITCH</u></b>  | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.04.01         | Ethernet switches shall be 'substation hardened', industrial grade and shall comply with IEC61850 for communications and environment requirements. The Ethernet switches shall be of managed type with at least two (2)/Four(4) No of single mode Gigabyte Fibre optic cable ports and Sixteen / Eight Copper ports (as specified in annexure A) to achieve the LAN configuration indicated in the drawings. The Ethernet switches shall have features to support the dual redundant rings as shown in the architecture drawings, if applicable. These switches shall be mounted inside the switchgear Panels and shall be suitable for accepting dual redundant power supplies. The FO ports shall be Single-mode 1000Mbps ports. Copper ports shall be 10/100Mbps ports. |  |
| 2.04.02         | Necessary software for configuration and real-time network monitoring shall be provided along with the Ethernet switches. Network monitoring feature shall be integrated with the SCADA software to provide Complete network status on the HMI.  |  |
| 2.04.03         | Other than above, Ethernet switches required to be mounted on DC panels for completion of architecture shall be in bidder's scope of supply.   |  |
| <b>B2.05.00</b> | <b><u>HUMAN MACHINE INTERFACE (HMI/MMI)</u></b>  | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.05.01         | HMI (Human Machine Interface) shall consist of Operator Work Station (OWS) or Engineering Work Station (EWS). These shall include Server / PC, Ethernet switches for control, monitoring and connection to Station LAN, Power supply modules, etc.   |  |
| 2.05.02         | The Size shall be min 22" or larger unless & otherwise specified in annexure A.  |  |
| 2.05.03         | Operating system of HMI shall be 64-bit Windows based with necessary application software such as relay status monitoring data logging, event recording, annunciations, display of single line diagram electrical system parameters relay settings and monitoring. Manual Control commands from HMI shall be direct to Data Concentrator system to ensure fast operation.  |  |
| 2.05.04         | The display of OWS shall be integrated to Large Video Screen (LVS) of DDCMIS at Unit & Offsite control rooms. The exact arrangement for such integration (Through video output or TCP/IP) shall be finalized during detailed engineering. (LVS not in bidder's scope)  |  |
| 2.05.05         | The Main Features of HMI shall be:   |  |
|                 | a) The HMI shall have a graphical dynamic Plant Key Single Line Diagram to view the complete Auxiliary Power supply system status. This shall also include the status of the switchgears, measurement values, operation counters, graphical alarm representation, etc. Spontaneous changes of a state, typically opening of a circuit breaker from a protection, shall have a specific colour code.  |  |
|                 | b) All the Breakers with the status shall be clearly displayed along with values of currents, voltages, frequency, active and reactive powers, summated MW/MVAR.   |  |
|                 | c) High degree of security shall be provided to prevent unwanted operation of any equipment through Switchgear SCADA Systems.  |  |
|                 | d) Simultaneous switching of more than one device from the same or different Control Levels shall not be possible. The security features to achieve these requirements shall be clearly indicated.   |  |
|                 | e) Once a device is "Selected" for operation, the operator shall be able to recognize the "Selected" device on all the graphical and other displays. All other devices shall be blocked as long as a device is selected for operation.   |  |
|                 | f) The "execution" of a command shall be possible only if the device is not blocked and no interlocking condition is being violated. The interlocking scheme, if any shall be checked before releasing the "execute" command.  |  |
|                 | g) The operator shall receive suitable feedback about the successful or unsuccessful execution of the command.   |  |



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|                 | h) In case of unsuccessful execution, the reason for non-execution of command shall be indicated to the operator, which shall include details of the blocking condition in the interlocking logic.  |  |
|                 | i) The command for Breaker Close/Open from HMI shall be directly executed from the Data Concentrator System Controller to the individual feeder on IEC 61850 Network Ring.  |  |
|                 | j) In case of successful execution, the operator shall receive confirmation about the new switching position of the equipment depending on the command. The ability to override the interlocking shall also be available, subject to the security access.   |  |
|                 | k) Display of data from Owners DC Health Monitoring Systems.  |  |
|                 | l) Display the alarm list and enable acknowledgement and clearance.   |  |
|                 | m) Display the sequence of event list.  |  |
|                 | n) Display curves, either real time or based on archived data. Invalid information shall be clearly marked. Curves shall manage the time shifts.  |  |
|                 | o) Display Disturbance Recording file.  |  |
|                 | p) Printing of sequence of event list and reports.  |  |
|                 | q) The reports shall be freely configurable and user friendly.  |  |
|                 | r) Historical data and Trending shall include Digital Fault Records and Sequence of Event logs received from various IEDs.  |  |
|                 | s) Operations Log   |  |
|                 | t) Reports  |  |
|                 | u) Mass Storage Back up   |  |
| <b>B2.06.00</b> | <b><u>FURNITURE FOR HMI</u></b>   | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.06.01         | Industrial modular design Console for placing HMI, Printer, and UPS along with the swivel computer chair shall be in bidder scope of supply. The quantity of item shall be HMI wise.  |  |
| 2.06.02         | Furniture shall be of modular design having following minimum feature:<br>a. Compartment for CPU, UPS,<br>b. Tray for Keyboard,<br>c. Pockets on desk top for CPU/UPS/printer cable,<br>d. Good quality Swivel computer chair (2 nos per table).  |  |
| 2.06.03         | Furniture and desktop color shade shall match with the color shade of control room furniture and shall be informed during detailed engineering.   |  |
| 2.06.04         | Make & datasheet of furniture shall be finalized during detailed engineering.   |  |
| <b>B2.07.00</b> | <b><u>LASER PRINTER</u></b>   | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.07.01         | A4 size Colour Laser Printer with driver software for windows OS and necessary interface cables and accessories. The printer shall be suitable for connecting HMI, with 32/64MB memory, 8 to 10 ppm printing speed, IEEE-1284 compatible bi-directional parallel port and with resolution of 600X600 dpi or better. |  |
| 2.07.02         | Make & datasheet of printer shall be finalized during detailed engineering.   |  |
| <b>B2.08.00</b> | <b><u>UN-INTERRUPTED POWER SUPPLY</u></b>   | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.08.01         | UPS shall be powered up with 240V, 1 phase, 50 Hz AC power supply for HMI, printer. UPS shall have back up time of 1/2 hour.  |  |
| 2.08.02         | UPS shall have 20% extra capacity above total load requirement of data concentrator, HMI & GPS equipment.   |  |
| 2.08.03         | Make & datasheet of UPS shall be finalized during detailed engineering.   |  |
| <b>B2.09.00</b> | <b><u>TIME SYNCHRONIZATION AND GPS</u></b>  | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.09.01         | Time clock synchronization equipment shall be provided for the Station and all the clocks of the numerical relays, LAN system with data concentrator, etc., shall be time synchronized. The resolution  |  |



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|                 | of time synchronization shall be +/- 1.0 millisecond or better throughout the entire system. The antenna for GPS receiver shall be installed on top of the main TG Building. Necessary cable (with protective conduit, if required) for connecting the antenna with GPS receiver / clock shall be in bidder's scope.  |  |
| 2.09.02         | GPS shall receive coordinated Universal Time (UTS) transmitted through Global positioning satellite system (GPS) for time synchronization of all numerical relays/DC/HMI.   |  |
| 2.09.03         | GPS shall be completed in all respect including antenna, lightning arrestor, all cables, processing equipment etc.  |  |
| 2.09.04         | Clock synchronization shall be done for all the relays of the switchboard through respective data concentrator and HMI.   |  |
| 2.09.05         | All auxiliary systems and special cables (min.90mtr or as required at site) required for synchronization of various equipment shall be supplied and commissioned by the bidder.   |  |
| 2.09.06         | Make & datasheet of GPS shall be finalized during detailed engineering.   |  |
| <b>B2.10.00</b> | <b>LAN CABLE &amp; CONNECTOR</b>  | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.10.01         | Cat 6 or better cable shall be as per ISO/IEC 11801;EN 50288-3-1;IEC61156-5;EIA/TIA 568-B.2 for preparation of LAN network.   |  |
| 2.10.02         | Make & datasheet of cable shall be finalized during detailed engineering.   |  |
| <b>B2.11.00</b> | <b>FO CABLE &amp; CONNECTOR</b>   | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.11.01         | The Fibre optic cable shall be armoured, Single-mode, graded index OMI (ISO/IEC 11801) of Diameter 125µm core / cladding with max attenuation of 1.52 dB/km at 1310nm wavelength & 1.0 dB/km at 1550nm wavelength. The cable should be suitable for operation at 1310/1550nm. The outer Sheath/Jacket of the FO Cable shall be Fire retardant.  |  |
| 2.11.02         | Make & datasheet of cable shall be finalized during detailed engineering.   |  |
| <b>B2.12.00</b> | <b>RELAY PARAMETERIZATION DEVICE</b>  | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 2.12.01         | Laptop PC for each project shall be supplied preloaded with operating software, relay parameterization software, disturbance analysis software and any other software necessary for successful operation of the relays. Following function shall be made available on Relay parameterization equipment (Laptop PC) <ul style="list-style-type: none"> <li>Multiple Window based display parameters</li> <li>Downloading of events and disturbance records</li> <li>Analysis of disturbance records</li> <li>Event handling</li> <li>Generation and printing of Reports</li> <li>Relay parameterization thru front port of relay &amp; through data concentrator.</li> </ul> |  |
| 2.12.02         | Equipment shall be pre-loaded with the Licensed latest Windows Operating system & other related software to achieve above function.   |  |
| 2.12.03         | Equipment shall be of latest, upgradeable and proven one with latest processor available in the market.   |  |
| 2.12.04         | Equipment shall have 15" color LED screen, hard drive of min. 500GB memory, 4GB RAM & internal high speed modem as per latest configuration available in the market. USB Pen drive / micro SD card (2 nos.) of 16GB memory shall be provided along with each equipment.   |  |
| 2.12.05         | Equipment shall be supplied complete with following accessories: <ul style="list-style-type: none"> <li>carrying case,</li> <li>240VAC adaptor,</li> <li>Communication cord with port converter (if required) for relay communication.</li> </ul>   |  |
| 2.12.06         | Equipment shall have port for the following devices: <ul style="list-style-type: none"> <li>keyboard, mouse,</li> </ul>   |  |



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|                 | <ul style="list-style-type: none"> <li>External Monitor, Headphone out</li> <li>AC power,</li> <li>USB (min. 3 nos), RJ-11 and RJ-45</li> </ul>   |  |
| 2.12.07         | Equipment should have dual monitor support i.e. display on the laptop screen and on a digital projector (if connected) screen simultaneously.   |  |
| 2.12.08         | Equipment shall have plug and play built-in speakers & internet connectivity  |  |
| 2.12.09         | Quantity of cable shall be 2 nos or 3% of total relay quantity whichever is higher of each type of cable suitable for the offered relays. For eg If USB Port & RS232 both are offered in different relays minimum 2 nos of each should be offered.  |  |
| 2.12.10         | Although minimum specification of Laptop PC has been mentioned above, make & datasheet shall be subjected to customer approval during detailed engineering.   |  |
| <b>B3.01.00</b> | <b><u>SYSTEM SOFTWARE REQUIREMENT</u></b>   | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 3.01.01         | The bidder shall provide all licensed software packages required by the system for meeting the intent, functional and parametric and performance requirements of the specification. All licenses (except anti virus) shall be valid for the continuous service life of the plant.   |  |
| 3.01.02         | The Bidder shall furnish a comprehensive list of all such system/application software documentation. The developed application software dump /backup shall be submitted in Duplicate DVDs. Further Relay Configuration Files as commissioned shall be submitted in a DVD/ pen drive for backup.   |  |
| 3.01.03         | At least six licensed copies of necessary software for numerical relay configuration / setting /disturbance analysis and other utilities shall be supplied.   |  |
| <b>B3.02.00</b> | <b><u>SYSTEM SECURITY</u></b>   | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 3.02.01         | Security features shall be provided at each level for safeguarding against unauthorized access.   |  |
| 3.02.02         | An alarm message will be displayed at the HMI and recorded in the logs for any unauthorized access attempts. The bidder shall provide software locks / passwords to the Owner's engineers at site for all operating and application software at all levels.   |  |
| 3.02.03         | The system shall maintain a SYSTEM CHANGE log, recording all system changes made along with the identification of the person making the change, date, time and area of the system modified. The format and details of this log shall be finalized during detailed engineering.  |  |
| 3.02.04         | No single failure either of equipment or power source shall result in rendering any part /subsystem of system inoperative, except that the information related to failed part /component is not available.  |  |
| 3.02.05         | To ensure system security, the complete functionality of Switchgear SCADA System shall be divided into various system security levels, to be decided by customer during detailed engineering.   |  |
| 3.02.06         | The various system security levels and various user groups shall be defined by the customer during detailed engineering.  |  |
| 3.02.07         | Required Security features like Firewalls / Tunnelling may be provided for secure access of data from Switchgear SCADA to DDCMIS and other third party software /system.  |  |
| <b>B4.01.00</b> | <b><u>ENGINEERING</u></b>   | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 4.01.01         | Complete engineering including the following: <ul style="list-style-type: none"> <li>a) Development of soft logics as per approved schemes.</li> <li>b) Configuration of Feeder IED including Protection and Control logics</li> <li>c) Configuration of Board level IEDs (if applicable).</li> <li>d) SCADA Network Design based on reliability &amp; speed</li> </ul> |  |



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|                 | e) Configuration and application development of Switchgear SCADA Systems. Total SCADA application development as required for Integrated Control, protections and real time Monitoring.   |                            |
|                 | f) Configuration of upper level protocol interface and I/O lists for DDCMIS integration   |                            |
|                 | g) Integration of Owners DC health Monitoring system (if applicable).   |                            |
|                 | h) Configuration of additional relays in existing SCADA, if added within warranty / guarantee period even if commissioning is over.   |                            |
| 4.01.02         | Numerical relay configuration for all relays being supplied under the package shall be carried out in line with the approved schematics and shall be submitted for owner's approval.  |                            |
| 4.01.03         | Bidder shall furnish motor protection and motor differential relay Setting, stabilizing resistor and Metrosil calculations in the event of order.   |                            |
| <b>B4.02.00</b> | <b>DOCUMENTS &amp; DRAWINGS</b>   | <b>COMPLIED<br/>YES/NO</b> |
| 4.02.01         | Following minimum documents shall be submitted for customer / BHEL approval within 4 weeks of receipt of all inputs from BHEL.  |                            |
|                 | a) GA & Scheme of each data concentrator panel.   |                            |
|                 | b) GA & scheme of HMI console / printer table.  |                            |
|                 | c) System Architecture for complete network   |                            |
|                 | d) Network configuration for each DC  |                            |
|                 | e) Factory Acceptance test plan of Numerical Relays   |                            |
|                 | f) Factory Acceptance test plan of Networking system (SCADA)  |                            |
|                 | g) Site Acceptance Test plan for Numerical Relays   |                            |
|                 | h) Site Acceptance Test plan for Networking system (SCADA)  |                            |
|                 | i) IP addressing of complete system.  |                            |
|                 | j) Input / output list for DDCMIS   |                            |
|                 | k) Input / output list for SCADA  |                            |
|                 | l) Datasheets for Ethernet switch, GPS, laptop, printer, cables etc.  |                            |
|                 | m) Manufacturing Quality Plan for Data Concentrator Panel including makes of all major bought out items.  |                            |
|                 | n) Manuals of numerical relays, Ethernet switches & switchgear SCADA  |                            |
|                 | o) Functional Design Specification (Project specific write up on switchgear SCADA).   |                            |
|                 | p) Bill of Material of complete system & DC panels.   |                            |
| <b>B4.03.00</b> | <b>SERVICES</b>   | <b>COMPLIED<br/>YES/NO</b> |
| 4.03.01         | It is the Bidder's responsibility to configure each protection relay to provide the protection, control and monitoring facilities required as per approved schematic drawing preferable at bidder's works or else at BHEL works. A full set of relay configuration and setting files shall be included in the design and documentation submissions  |                            |
| 4.03.02         | The bidder shall provide support to BHEL personnel for programming, testing and demonstration of all functions of numerical relays during inspection at BHEL Bhopal works, free of cost without any ceiling on number of visits and number of man-days per visit. This support will be required separately during inspection of project. The support shall be provided to the satisfaction of customer.   |                            |
| 4.03.03         | The bidder shall provide support to BHEL/ customer personnel for programming, testing and demonstration of all functions of data concentrator, GPS, Ethernet switches, gateways and HMI during inspection at bidder's works and site for the project, free of cost without any ceiling on number of visits and number of man-days per visit. The support shall be provided to the satisfaction of customer.   |                            |
| 4.03.04         | The bidder shall do commissioning as mentioned above at site, to the satisfaction of customer without any ceiling on number of visits and number of man-days per visit. The commissioning shall include programming, testing, establishment of time synchronization and communication of all numerical relays with local PC and remote DDCMIS / SCADA and demonstration of all functions of numerical relays, Data concentrator etc. In case of any failures, free replacement shall be provided. The supplier shall depute their commissioning engineer along with relay test kit. |                            |





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| 4.03.05         | The point-to-point testing of all signals for the Switchgear network at the plant and protection equipment end and the terminal end (data concentrators/Controller and HMI Workstations) shall be the responsibility of the bidder. The protocol interface with DDCMIS shall be demonstrated at the time of FAT Testing of DDCMIS.   |  |
| 4.03.06         | Cat-6/Ethernet cables Wiring (Laying in switchgear panel), ferruling, termination & connectorization with RJ45 connector for connection of relays with Ethernet switches HT end shall be carried out by bidder's representative at BHEL or at site. All the tools required for Wiring, ferruling, termination & connectorization shall be arranged by bidder.  |  |
| 4.03.07         | Ferruling, termination, splicing & glanding of FO cable with connector & LIU for connection of relays, data concentrator, ethernet switch etc (connectorization) at HT end shall be carried out by bidder's representative as per site requirement at site. All the tools required for Wiring, ferruling, termination & connectorization shall be arranged by bidder.  |  |
| 4.03.08         | If integration of HT & LT relays is applicable as per Annexure-A, all hardware required (LIUs, Connectors/ patch cords, Dual power supply module, etc.) for the network integration of all HT & LT numerical relays are included in Bidder's scope. However, LT Ethernet switches, RJ45 cable for connecting the relays to Ethernet switches is not in bidder scope of supply. Bidder to confirm that LT Numerical Relays shall be integrated in line with the technical specification & the monitoring & metering information shall be displayed in the HMI system as well as made available for information exchange with DDCMIS.  |  |
| 4.03.09         | Drilling of gland plates at Switchgear Panel for the glanding shall be in bidder's scope.  |  |
| 4.03.10         | Bidder to ensure availability of spares and maintenance support for the type of relays and networking system components for at least fifteen (15) years from the date of supply. The bidder shall guarantee that before going out of production of the spares parts of the equipment covered in the package he shall give BHEL at least 2 years advance notice so that the latter may order his bulk requirement of spares if he so desires.   |  |
| 4.03.11         | The software supplier shall define if any hardware lock or key diskette floppy forms part of the Software, Any such device will be replaced, free of cost, if the same fails to operate during software usage.   |  |
| 4.03.12         | Bidders shall provide upgrades for all licensed software of the numerical relays, networking system components and HMI system under this package for the entire life of the system. Bidder shall also provide training CDs and Manuals of the numerical relays & SCADA system under this package.  |  |
| <b>B4.04.00</b> | <b>TRAINING</b>  |  |
| 4.04.01         | The bidder shall arrange for two nos of training workshop on system at site as per following schedule: One Workshop shall be organized before the commissioning of First MV Switchboard and the Second workshop shall be conducted before Unit Commissioning.  |  |
| 4.04.01         | Training at customer works (site) shall comprise of following areas:<br>a) Basics of Feeder, Transformer and Motor Protection for IEC 61850 Numerical relay and detail discussion on functions available in the relays.<br>b) Relay configurations and hands on practice of preparation of logics through relay software tools and relay Goose Logics.<br>c) Interfacing / communication of relay with software: uploading / downloading of logic.<br>d) Secondary injection testing of provided function blocks and guidelines for relay settings. DR downloading and analysis for Fault diagnostics<br>e) Switchgear SCADA - Structure and Architecture, Control, protection and monitoring concepts, Graphical User Interface, Single Line Diagram, Event List, Alarm List, Trends, Reports and System supervision. Basics and functions available in numerical relays with hands on practice on relay front end for Setting Changes, operators levels available in relay, enable / disable protections,<br>f) Common problems faced and trouble shooting |  |
| 4.04.02         | Training for 3 days shall be arranged by bidder (Relay Manufacturer) at BHEL Works also.   |  |





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|                  |  |  |
|------------------|--|--|
| <b>B5.01.00.</b> | <b>Factory Acceptance Tests (FAT) - Relay</b>  | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 5.02.01          | Factory acceptance test (FAT) of Numerical relays shall be carried out at BHEL/bidder's work as per approved FAT against each lot of supplies.   |  |
| 5.02.02          | FAT for 10% of offered lot of relays shall be witnessed by Customer (if specified in annexure A).  |  |
| <b>B5.02.00.</b> | <b>Factory Acceptance Tests (FAT) - Relay network System</b>   | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 5.02.01          | All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the bidder and BHEL/Customer representatives during manufacture, erection and on completion. Quality assurance system followed by manufacturer should preferably be in line with IEC 61850 Part 10. However, an indicative requirement of operational as well as FAT test (Integrated Test) is given in this Section.   |  |
| 5.02.02          | The FAT shall be mutually agreed upon and approved by BHEL/Customer during detailed engineering. The Factory Acceptance Tests (FAT) shall include all reasonable exercises which the combination of equipment and software can be expected to perform. These tests shall be divided into, as a minimum, but not limited to the following categories:<br>a) Pre power on checks<br>b) Power on checks<br>c) Hardware tests<br>d) Functional tests<br>e) Parametric tests<br>f) Specific tests on electronic hardware<br>g) Power failure auto-restart tests<br>h) Testing of interlocking |  |
| 5.02.03          | The Bidder shall submit a detailed FAT procedure for BHEL/Customer approval during detailed engineering stage based on the above guidelines. The test results obtained shall be properly documented by the Bidder and furnished in the BHEL/Customer approved format as decided during detailed engineering and submitted in the requisite number of copies with all annex.  |  |
| 5.02.04          | a) FAT of Networking system shall be carried out at network integrator's works. The Procedure for the same shall be finalized during detailed engineering stage.<br>b) Further, the numerical relay networking system shall also be tested with the DDCMIS for OPC connectivity during FAT of DDCMIS system. Bidder shall confirm to provide the support during above OPC connectivity testing.  |  |
| <b>B 5.03.00</b> | <b><u>COMMISSIONING AND SAT FOR NUMERICAL RELAYS &amp; SCADA SYSTEMS</u></b>   | <b><u>COMPLIED</u></b><br><b><u>YES/NO</u></b> |
| 5.03.01          | Complete Erection & Commissioning shall be in bidders scope.   |  |
| 5.03.02          | Site tests shall include all tests to be carried out at site upon receipt of equipment. It shall include but not be limited to testing calibration, configurations and pre-commissioning trials start up tests, trial operation and performance and guarantee tests. The bidder shall be responsible for all site / commissioning tests.   |  |
| 5.03.03          | The bidder shall maintain all tests, calibration records .   |  |
| 5.03.04          | The bidder shall maintain master checklists to ensure that all tests and configurations for all equipment/devices furnished under these specifications are satisfactorily completed.   |  |
| 5.03.05          | The site / commissioning tests shall be categorized under following categories:<br>a) Start up tests<br>b) Calibration and configuration checks<br>c) Pre-commissioning tests<br>d) Trial Operation<br>e) Availability Tests   |  |

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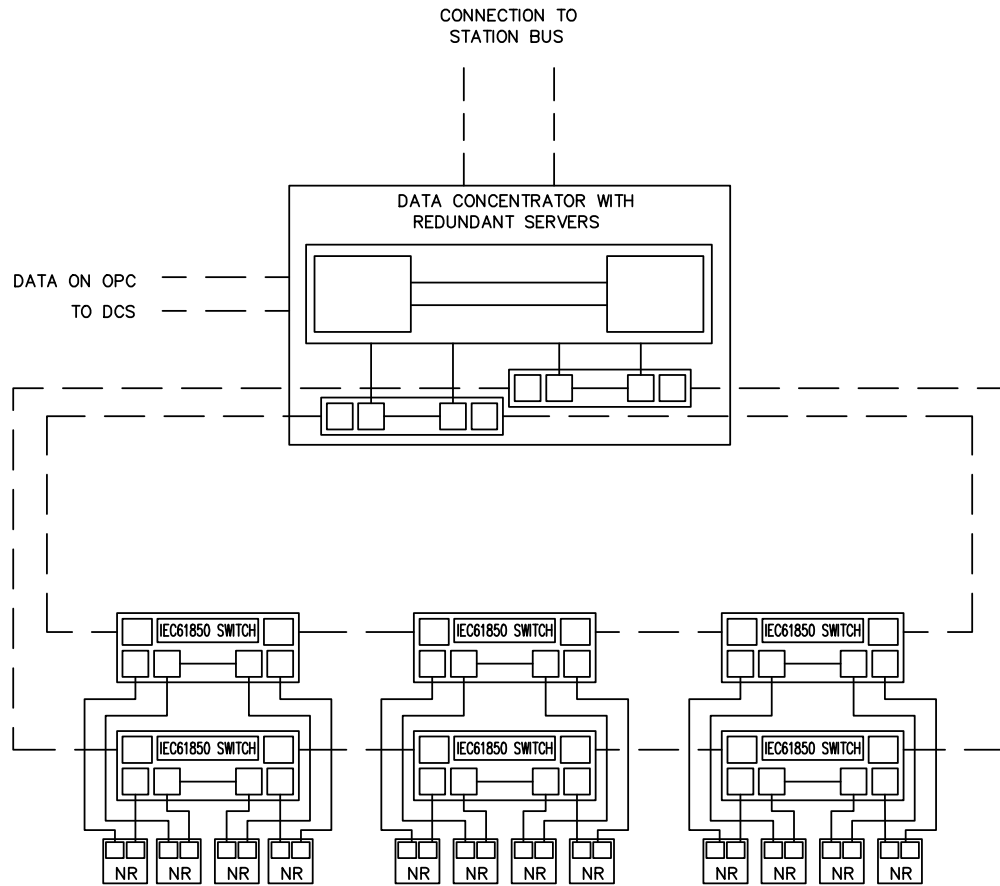
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5.03.06

The system will be handed-over to the BHEL/Customer for commercial operation after the site / commissioning tests have been completed to the satisfaction of the BHEL/Customer . A completion certificate will be issued by the BHEL/Customer to the bidder on successful commissioning of the relay & switchgear SCADA system. .


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**NOTES:**

1. THIS IS THE TYPICAL ARCHITECTURE OF A SINGLE RING. ACTUAL NUMBER OF RELAYS/PORTS/SWITCHES SHALL BE IN LINE WITH THE RELEVANT CLAUSES OF TECHNICAL SPECIFICATIONS. THE NUMBER OF DATA CONCENTRATORS & NETWORK RINGS SHALL BE AS PER THE OVERALL ARCHITECTURE SHOWN IN DRAWING NO 12A05-DWG-E-3101. TYPICALLY, EACH RING SHALL HAVE NOT MORE THAN 100 RELAYS.
2. NR-NUMERICAL RELAY WITH TWO REAR PORTS FOR COMMUNICATION ON IEC61850 COMPLYING TO PRP AS PER IEC62439-3 CLAUSE4, MOUNTED IN MV & LV SWITCHGEAR PANELS.
3. IEC61850 SWITCH-ETHERNET SWITCH ON IEC61850 PROTOCOL WITH 8/16 COPPER PORTS AND 2 SINGLE-MODE 1Gbps FIBRE OPTIC PORTS WITH "SC" CONNECTORS. MOUNTED IN MV & LV SWITCHGEAR PANELS.
4. EACH RELAY TO BE CONNECTED TO TWO IEC61850 SWITCHES THROUGH CAT5e ETHERNET CABLE.
5. LOOPING OF IEC61850 SWITCHES SHALL BE THROUGH FIBRE OPTIC CABLE LAID IN HDPE CONDUIT.
6. A SEPARATE RING SHALL BE PROVIDED FOR RELAY PANELS OF GENERATOR & STATION TRANSFORMER.

FOR TENDER PURPOSE ONLY

|        |        |       |      |          |   |  |  |                                   |     |
|--------|--------|-------|------|----------|---|--|--|-----------------------------------|-----|
|        |        |       |      |          | RING ARCHITECTURE FOR<br>SWITCHGEAR SCADA SYSTEM                                |  |  | DEVELOPMENT CONSULTANTS PVT. LTD. |     |
|        |        |       |      |          | WEST BENGAL POWER DEVELOPMENT CORPN. LTD.<br>WEST BENGAL, INDIA                 |  |  | CONSULTING ENGINEERS              |     |
| DS     | RD     | RD    | -    | 14.07.17 | SAGARDIGHI THERMAL POWER EXTENSION PROJECT<br>PHASE-III, UNITS # 5 (1 x 660 MW) |  | JOB NO. 12A05  | SCALE :                           | NTS |
| APPVD. | REVWD. | CHKD. | REV. | DATE     |   |  | DWG. NO. 12A05-DWG-E-0150  | REV. -                            |     |

14.07.2017

12A05-DWG-E-0150



## 5.12.00 Voltage Transformer

5.12.01 Voltage transformers shall be cast-resin, drawout type and shall have an accuracy class of 0.5. Voltage transformer mounted on breaker carriage is not acceptable.

5.12.02 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully drawout position.

5.12.03 Low voltage fuses, sized to prevent overload shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the switchgear is energised.

## 5.13.00 Relays

### I. General- A

- a) All relays & timers in the protection circuit shall be flush mounted with connection from inside. They shall have transparent, dust tight covers, removable from the front. They shall have built-in testing facilities. Except small auxiliary relays and timers all relays shall be drawout type.
- b) Relays shall be rated for operation on 1A secondary current and 110V secondary voltage to be decided by the bidder. Number and rating of relay contacts shall suit the job requirements.
- c) The Bidder shall furnish, install & co-ordinate all relays to suit the requirements of protection, interlock and bus transfer schemes as broadly indicated in the annexures and drawings. Application check shall be made on all motor protection relay motor characteristics furnished by the Owner. The result of such check shall be furnished for approval.
- d) It shall be the responsibility of the Bidder to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers / motor starters to provide satisfactory discrimination.
- e) All setting devices shall be accessible after removing the front cover. No relay shall be mounted on the rear side of PCC / PMCC panel.
- f) All relay coils and their auxiliary contacts (including un-enabled relays in Composite Numerical Relays, if any), including spare contacts will be wired up to the terminal blocks of respective panels for wiring to DCS and for future use. All unused terminals of relays shall also be fitted with screws.
- g) Parameterization and loading and downloading of data shall be possible from local HMI as well as from DCS.





- h) All numerical relays shall have front communication port for parameterization, loading and downloading of data thru' Laptop.
- i) All numerical relays and multi-functional meters shall be hooked up and connected with HMI thru' Fiber Optic cable.

## II. General- B

- a) All protective relays shall be of numerical microprocessor based multifunctional type having communication facility as shown in enclosed Dwg. No. 12A05-DWG-E-3101 (Network Scheme of Numerical Relays).
- b) All relays shall conform to the requirements of IS: 3231 / IEC: 60255 standards. The Numerical relays shall have communication, Metering and monitoring facility.
- c) Vendor shall ensure availability of spare parts and maintenance support for the equipment for at least 15 years from the date of supply.
- d) Any foreign relay manufacturer through his Indian partner or subsidiary company in India shall provide application, testing, commissioning and other necessary support for minimum 15 years. They shall also maintain adequate inventory of each type of relay or spares to meet the requirement arising during project execution and plant operation.

## III. Technical Requirement

### a) Auxiliary Power Supply

Unless otherwise specified, relay shall be suitable to accept both AC / DC supplies with range 110V to 240V with tolerance of  $\pm 20\%$ . The auxiliary power supply shall preferably be site selectable requiring no additional hardware.

### b) Basic Requirement and Constructional Requirement

- i) Relays shall be suitable for flush mounting on the front with connections from the rear. The enclosure shall be dust tight having degree of protection minimum as IP: 52.
- ii) Relay shall have draw out feature with plug in type PCB for easy replacement. In case of fixed type relay, the terminals shall be easily accessible for testing and commissioning.
- iii) Relay shall have self-diagnostic feature with indication of relay failure on relay front. However, while diagnostic circuit runs, it must not interfere in the main protective





relay circuit and allow working of main protective circuit continuously. Relay faults (self-diagnostic) shall be communicated and annunciated to HMI.

- iv) Design of the relay shall be such that it must operate selectively and with proper discrimination. It must be immune to any kind of electromagnetic interference. Vendor to submit all related type test reports for the offered model along with the offer.
  - v) Necessary auxiliary relays, timers, trip relays, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. No control relay, which shall trip the circuit breaker when relay is de-energized, shall be employed in the circuits.
  - vi) Numerical Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity to the satisfaction of the Owner.
  - vii) Time clock synchronization feature shall be provided for synchronization of clocks of numerical relay and metering LAN with data concentrator time clock. Required hardware and software interface to receive GPS/Time signal to achieve time synchronization shall be supplied by the contractor. The resolution of time synchronization shall be +/- 1.0 millisecond or better throughout the entire system.
- c) Display & Indication
- i) All numerical relays shall have keypad / keys to allow relay settings from relay front. In addition, relay shall have front port for downloading / uploading of relay settings from the PC / Laptop. All hand-reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable.
  - ii) All relays shall have LED / LCD display for settings, status, faults and events. LCD display shall be backlit and temperature compensated up to 65°C for contrast and legibility.
  - iii) As a minimum, the relay shall have LED indicating lamps for fault trip, relay healthy / unhealthy and control supply on.
  - iv) The relay shall have at least 6 programmable LEDs on relay front.





d) Software Security

Relay shall be provided with password protection against unauthorized write access. However, viewing of metering data, settings, and status and event data as read only parameters should be without password protection. All software shall be user friendly and latest up to date version.

e) Disturbance, Event Recording & Data Storage

Status, disturbance data and events shall be stored in non-volatile memory or memory backed up by battery. It should be possible to store minimum 50 events with date and time stamp, last 5 fault records and last disturbance record. When auxiliary power fails, it should be possible to see the latest state of display when power is restored. Also, in case of power supply failure lock out status of the relay should be stored and kept in memory to allow the working of interlock logic properly on restoration of the supply.

f) Trip Circuit Supervision & Lock out function

i) Relay shall have built in lockout function. Lock out feature shall be self reset or hand reset and shall be software selectable.

ii) Relay shall have built in trip circuit supervision function.

g) Input / Output Interface, Filters and Galvanic Isolation

h) Relay shall have at least 4 NO contacts each shall separately be programmable for either hand reset or self-reset. The contact rating shall be minimum 5A at 250V AC / DC.

i) Relay shall be made immune to capacitance effect due to long length cables.

ii) All IOs shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.

i) Serial Communication

i) All numerical relay shall have communications on three ports; local front port communication to laptop and a dual port on IEC 61850 to communicate with the data concentrator through LAN and Ethernet switches.

ii) All relays should be able to communicate with DCS system. Data shall be available at the DCS on request.

iii) Protocol adapted for communication to DCS should facilitate easy interface with world wide used open protocol like Modbus or IEC 103 protocols.





- iv) It shall be also possible for Relay Parameterization as well Downloading of Disturbance Records from PC /Laptop provided in Unit & Engineering Workstations located in Central Control Room of each unit. Necessary user friendly and latest software to be provided for this purpose. Communication protocol shall be selected from relay to PC to provide all information.
- v) One (1) set of Laptop by each Switchgear manufacturer, loaded with common support software and which will allow easy settings of relays in addition to uploading of event, fault, disturbance records, measurements from relay front communication port. The Switchgear supplier shall furnish CD's for the above relay parameterization as well as download of disturbance recorder for all relays of his supplied switchgear. Accessories like table/chair/desk/power socket etc. as required for all PC/Laptop should be supplied.

Refer Section-I of Vol.-II-F/1 for Relay and Energy Management System.

#### 5.14.00 **Secondary Wiring**

- 5.14.01 All boards shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and interlocking schemes.
- 5.14.02 Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, switches and other devices shall be wired up to terminal blocks.
- 5.14.03 Wiring shall be done with flexible, 1100 V grade, PVC insulated switchboard wires with stranded copper conductors of 2.5 mm<sup>2</sup> for control, current and voltage circuits.
- 5.14.04 Each wire shall be ferruled by plastic tube with indelible ink print at both end having terminal block no., terminal nos., destination no. as per approved Drawing.
- 5.14.05 Wire terminations shall be made with crimping type connectors with solder as insulating sleeves. Wires shall not be spliced between terminals.
- 5.15.00 **Terminal Blocks**
- 5.15.01 Terminal blocks shall be 1100V grade box-clamp type 10-mm<sup>2</sup> minimum with marking strips. Terminals for C.T. secondary leads shall have provision for shorting.
- 5.15.02 Terminal blocks used for interface with DCS via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.





