

TRACTION INSTALLATION DIRECTORATE
कर्षण संस्थापन निदेशालय



सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
भारत सरकार, रेल मंत्रालय

TECHNICAL SPECIFICATION FOR
NUMERICAL CONTROL LOGIC RELAY (NCLR) AND
CONTROL PANEL FOR AUTOMATIC PHASE SWITCHING SECTION (APSS) FOR 25 kV SINGLE
PHASE 50 Hz AC TRACTION POWER SUPPLY SYSTEM OF INDIAN RAILWAY

Specification No. TI/SPC/PSI/NCLR/1190

ISSUED BY
TRACTION INSTALLATION DIRECTORATE RESEARCH DESIGNS AND STANDARDS
ORGANISATION

LUCKNOW - 226011

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Signature			
Designation	SSE(PR)	DDTI-2	DTI-3

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1.0 SCOPE

1.1 This specification covers, design, manufacture and supply of Numerical Control Logic Relay and Control & Relay Panel to be used in Automatic Phase Switching Section (APSS) in 25 kV Single Phase 50 Hz AC Traction Power Supply System of Indian Railway to facilitate automatic changeover of supply coming from different phases as soon as the Electric Loco/EMU negotiates the IOLs meant for phase separation. No neutral section is required in APSS for separation of different phase supply at SP and hence, Loco Pilot can run the train at desired speed without any hassle and stress and worrying about DJ ON/OFF Boards giving instructions for opening and closing of electric loco/circuit breaker (DJ) which were required in case of neutral section. Purchaser shall provide three insulated overlaps along with CBs, CTs & PTs at SP (or any desired location) associated with Automatic Phase Switching Section (APSS) built by 3 IOLs. Circuit Breaker rated for APSS operation will be provided as per RDSO specification No TI/SPC/PSI/LVCBIN/0120 with latest amendments.

1.2 The Automatic Phase Switching Section (APSS) may also be required in place of IOL in front of TSS/FP, to minimize the length of extended feed during abnormality in equipment of Automatic Phase Switching Section at a SP.

1.3 The control panel offered shall be complete with Numerical Control Logic Relay for functioning of Automatic Phase Switching, auxiliary relays, control switches, indicating LEDs, wiring and all other accessories and materials necessary for efficient control and operation of APSS at SP or any other desired post. Such accessories and materials shall be deemed to be within the scope of this specification whether specifically mentioned or not.

1.4 Relays other than Numerical Control Logic Relay (NCLR), shall be governed by their respective RDSO specifications.

1.5 This specification generally refers to double line sections. At Sectioning and Paralleling Post, each line shall be provided with 3 IOLs and each IOL bridging and opening will take place with the help of CB erected in SP Post /at any switching post. However, in case of the more number of lines, the purchaser shall furnish the layout drawings for the traction system. The quantity of the panels, relays and all equipment shall be as per the new drawings; however the design aspects of the each relays and individual panel equipment shall be same as per this specification.

The design drawings of the panel's physical layout, mimic diagrams if any etc. shall be approved by purchaser in advance under such condition.

2.0 TRACTION POWER SUPPLY SYSTEM

2.1 GENERAL SCHEME OF TRACTION POWER SUPPLY SYSTEM

2.1.1 Power is received from the grid network of the supply authorities at 220 kV/132 kV/110 kV/66 kV, at traction substations (TSS). 25kV power supply for traction is drawn through a single-phase step down traction transformer. The primary winding of this transformer is connected to any two phases of the incoming three phase lines and on the secondary side, either of the two terminals of the 25 kV winding is connected to the traction overhead equipment (OHE), while the other is solidly earthed and connected to the running traction rails.

2.1.2 Each transformer has its associated circuit breakers on the primary and secondary sides, with a separate set of 25 kV circuit breakers called "Feeder Circuit Breakers" for feeding the traction OHE lines.

2.1.3 Adjacent TSS are fed from different phases of the three-phase system in rotation. Neutral sections in front of sectioning and paralleling post (SP) are provided in the 25 kV OHE for segregating the different phases. These Neutral Sections are being converted in to overlap by using three IOLs and as such no neutral section will exist. In between the TSS and SP, sub-sectioning and paralleling posts (SSP) are provided for paralleling the UP and DN line OHE and also for sectionalizing and fault localization. The attached drawing No. ETI/PSI/702-1 at Annexure-E shows the general scheme for traction power supply system.

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2.1.4 The supply to the OHE can be switched ON/OFF through interrupters which do not open automatically on fault, but can be closed on to a fault. The fault is cleared by the feeder circuit breaker provided at the traction substation.

2.1.5 Normally power supply from a TSS extends upto the SP on either side of the substation, but in case of an emergency necessitating total shut down of the substation, power supply from adjacent TSS on either side of the failed substation can be extended upto the failed substation by closing the bridging interrupters at the two SPs. Also under certain emergency conditions the power supply can be extended beyond the failed TSS up to the next SP through feeder CB's of adjoining TSS.

2.1.6 If any other different traction supply arrangement is adopted due to special requirements (e.g. more than two transformer bays, parallel operation of transformers at TSS etc.) then same shall be advised by the purchaser.

3.0 NATURE OF TRACTION LOAD

3.1 The AC electric rolling stock is fitted, for conversion of ac to dc, with single-phase bridge-connected silicon rectifiers with smoothing reactor for feeding the dc traction motors. Typical percentages of harmonics present in the traction current with electric rolling stock are as follows:

Typical Harmonics Generated by IR's Electric Rolling Stocks

Sl. No	Harmonic No.	With Diode Rectifier	With Thyristor	With GTO/IGBTs
1.	3 rd harmonic (150 Hz)	15%	23%	3%
2.	5 th harmonic (250 Hz)	6%	14%	2%
3.	7 th harmonic (350 Hz)	4%	10%	0.5%
4.	9 th harmonic (450 Hz)	-	4%	0.35%
5.	11 th harmonic (550 Hz)	-	3%	0.4%
6.	THD's	16.64%	29.15%	3.68%

3.2 The average power factor of the conventional electric locomotive and electric multiple units generally vary between 0.7 and 0.8 lagging without compensation.

3.3 In big yards and loco sheds, a large number of locomotives stand idle with only the load of their auxiliaries, drawing fairly large reactive power. The load power factor is therefore, rather low.

3.4 Three Phase electrical locomotives and EMU'S have been introduced in Indian Railways. These types of locomotives and EMU'S are capable of regeneration during braking.

3.5 SHORT CIRCUIT APPARENT POWER OF THE SYSTEM

The short-circuit apparent power for various system voltages is as under, however the actual values shall be furnished by purchaser in consultation with supply authority:

Short Circuit Level

Highest system voltage KV	Short circuit apparent power MVA
52	200
72.5	3500
123	6000
145	10000

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245	20000
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3.6 AUXILIARY POWER SUPPLIES AT TRACTION SUBSTATIONS

The following power supplies are available at a traction substation.

- i) 110 V (+15% & - 30%) dc.
- ii) 240V +/- 20% ac, 50Hz +/- 3%, single phase from a 25/0.24 Kv auxiliary transformer.

4.0 SERVICE CONDITIONS

4.1.1 The control panel are intended for use in humid tropical climate in any part of India with the following atmospheric conditions:

1.	Max. ambient temperature	60 °C
2.	Min. ambient temperature	-10 °C
3.	Max. Temp attainable by an object exposed to Sun	70 °C
4.	Max. & Minimum relative humidity	100% & 22%
5.	Max. (Basic) wind pressure	200 kg/m ²
6.	Elevation above the mean sea level	To be considered for all complete Indian peninsula
7.	Vibrations	Max: 350 micron Average: 30 – 150 micron Time duration: rapidly varying time duration 15 – 70 ms.

4.1.2 The control panel shall be installed in masonry control cubicles at the SP Posts, which are normally unattended. The masonry control cubicles are situated close to the Railway tracks and hence the Panels are subjected to vibrations due to running trains.

5.0 GOVERNING SPECIFICATIONS

The main components covered by the specification shall conform to the following standard specifications (latest version), which shall be applied in the manner altered, amended or supplemented by the specification and Indian Electricity Rules where applicable.

Sl. No.	IS/IEC	Description
1.	IS 3231	Electrical relays for power system protection
2.	IS:8686	Static protective relays
3.	IS:1248	Direct acting indicating analogue electrical measuring instruments.
4.	IS:8130	Conductors for insulated electrical cables and flexible cords
5.	IS:2705	Current transformers
6.	IS:3156,BS:3938	Voltage transformers
7.	IS: 694	Control cable
8.	IS: 9224	HRC cartridge fuse
9.	IS: 6875	Control switch/ Push button
10.	IS: 5578/11353	Marking and identification of conductors and apparatus terminals

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11.	IEC 60947	Low voltage switchgear and control gear
12.	IS: 12083 I & II	Specification for Electrical relays, Contact performance & Insulation tests
13.	IEC 60898-2	Circuit breakers for ac and dc operation
14.	IEC 60255-1 (Part-I)	Measuring relays and protection equipment – Part 1: Common requirements
15.	IEC 60255-16	Electrical relays – Impedance measuring relays
16.	IEC 60255-12	Electrical relays – Directional relays and power relays with two input energizing quantities
17.	IEC 60255-5	Insulation coordination for measuring relays and protection equipment – Requirements and tests
18.	IEC 60255-21-1	Vibration test on measuring relays and protection equipment
19.	IEC 60255-21-2	Shock and bump tests on measuring relays and protection equipment
20.	IEC 60255-21-3	seismic tests on measuring relays and protection equipment
21.	IEC 60068-2	Environmental tests.
22.	IEC 60255-27	Product safety requirement
23.	IEC 60255-26	Electromagnetic compatibility requirement
24.	IEC 60529	Degrees of protection provided by enclosures (IP code)
25.	IEC 61810-2	Reliability.

All other components such as indication LEDs, terminal blocks, annunciator windows, MCBs, bell etc. shall conform to relevant IS specifications (latest version) and such specifications shall be duly mentioned by the tenderers in their offer.

Other related and linked specifications which should be read in conjunction with this specification are as under.

ETI/PSI/90 (6/95) with A&C 1&2	25 KV current transformer
TI/SPC/PSI/LVCBIN/0120	25 Kv single pole, double pole, pole mounted, outdoor vacuum circuit breaker (VCB) and vacuum interrupter (BM) for Indian Railway
ETI/PSI/120(2/91)	Code of practice of earthing
TI/SPC/RCC/SCADA/0130(Rev.2)	SCADA System for 25 kV ac Single Phase traction power supply on Indian Railway

6.0 DIGITAL CONTROL LOGIC RELAY

To operate Automatic Phase Switching Section a Numerical Control Logic Relay shall be used for switching of CBs to changeover the supply from Feed-A to Feed-B (vice versa) within 300ms

6.1 DESIGN FEATURES OF NUMERICAL CONTROL LOGIC RELAY (NCLR)

6.1.1 The normal zone of feed from a substation to SP varies between 20 and 30 km. Under emergency feed conditions, however, the zone would be extended up to the next substation or double the zone of normal feed. The NCLR shall be disabled/bypassed in case the CB2 is to be closed for extending the feed. Necessary interlocks and tele-signals in SCADA shall be provided.

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- 6.1.2 The NCLR shall be insensitive to power swings, heavy overloads and transient conditions including magnetic inrush current of locomotives/EMU's transformers and shall have strong immunity to variation for the arc resistance of the fault.
- 6.1.3 The NCLR shall be of modular form and to be contained in a metallic enclosure of suitable dimensions with terminals externally accessible. The NCLR shall be so devised that it can be mounted inside the control panel and can be easily interfaced with the existing scheme without tempering the panel wiring.
- 6.1.4 The proposed scheme is suitable to eliminate the flashover during the Panto bridging at IOL. The NCLR shall be suitable for operation from the current and potential transformers of the following particulars. The CT & PT are to be procured as per RDSO's latest specification.
- 6.1.5 It shall be possible to disable or bypass the NCLR by giving tele command from RCC through SCADA. Provision shall be made by providing necessary terminals for the same on NCLR.
- 6.1.6 The Numerical Control Logic Relay in the Control Panel at SP shall be complete with all parts and accessories for their efficient operation. Use of auxiliary relays (Self Reset type Tripping relays/contactors) external to the relay shall be included for circuit breaker tripping and closing. All such parts and accessories shall deem to be within the scope of this specification whether specifically mentioned or not.
- 6.1.7 The relays shall be of the draw-out (Plug-in), switch board type, back - connected and suitable for semi-flush or flush mounting, with dust-tight covers in dull black enamel finish. The enclosure class of module/relays shall be IP 54 as per IEC 60529.
- 6.1.8 The NCLR shall have in built contact multiplication function for each operation and monitoring function. For external connection one NO contacts to trip circuit breaker and one set of NO contacts shall be available for the purpose of tele signaling to RCC through SCADA and other for Annunciation at control panel.
- 6.1.9 The current coils/input module shall be rated for 5A for NCLR. The voltage coil shall be rated for 110 V ac. The current coils/input module shall be capable of withstanding 3 In continuously and short time rating shall be 20 In for 3 sec where In is rated current. The voltage coil shall be rated for 110V ac. The voltage coil shall be capable to withstand 1.15 times of rated voltage continuously and 1.5 times for 3 seconds.
- 6.1.10 The NCLR shall conform to the test voltage Class -III as per IS: 8686-1977/IS 3231/IEC:60255-5 or latest and product safety requirements as per IEC:60255-27.
- 6.1.11 It shall be designed for continuous service (auxiliary supply) voltage of 110 V dc and shall be capable of satisfactory operation for +15 % and- 30 % fluctuation in voltage.
- 6.1.12 It should be immune to distorted power frequency waveforms caused by the harmonics, phase shifts and transient faults and work on the principle of fundamental waveform extraction. The relays shall be immune to electro-magnetic interference and comply with IEC tests as mentioned in clause 12. The relay manufacturer shall study the effect of harmonics present in the existing Railway traction supply system and its effect on the relay pick up values & operating time of the relay and suitable methodology shall be adopted to eliminate the effect of harmonics.
- 6.1.13 The NCLR should have facility to record latest 5000 digital and logical status events with time stamped during the operation along with events of various tele-signals and telecommand received from RCC through SCADA in built memory provided. Data shall be retrievable directly to Laptop computer through RS 485 serial communication port or any other superior type of front end standard communication port with optical interface to limit EMI, accessories and firmware for communication through a suitable software supplied along with the Numerical Control Logic Relay to download and interpret the data stored.

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- 6.1.14 The numerical relay manufacturers shall provide full support for up gradation of the software time to time to maintain the satisfactory performance throughout the useful life of the relay.
- 6.1.15 NCLR shall have facility for clock synchronization through SCADA and locally through laptop/PC.
- 6.1.16 Operation counters shall be provided for each trip/close function with resetting facility.
- 6.1.17 The NCLR shall be compact in nature and every effort shall be made to minimize the hardwiring within the module and maximum components shall be on the PCB's. The SMT (surface mounted technology) PCB's shall only be used. Suitable conformal coating to be provided on the PCBs.
- 6.1.18 The contact multiplication shall as far as possible be done through software. For this purpose only one set of NO/NC auxiliary contact from each switchgear shall be terminated on the Control panel terminal block.
- 6.1.19 The design shall be fail-safe and adequate redundancy shall be provided.
- 6.1.20 The NCLR shall have self-diagnostic features. Suitable displays/contacts for confirming the module healthiness or defects shall be available for alarm at TSS and tele signal at RCC through SCADA. Trip contact fail shall also be available to trip circuit breaker.
- 6.1.21 NCLR shall have high contrast backlit LCD display of size at least 20x4 LCD characters for display of status, settings, on line parameter. The parameters of the module shall be settable through a membrane keypad. Manufacturer shall clearly indicate/furnish the sampling rate, accuracy and range of above measurements at the time of design & development to RDSO.
- Bright LEDs shall be used for display of relay healthiness/defect, trip indications and status of monitoring function.
- 6.1.22 The NCLR shall be capable to show on line current & voltage parameters on the LCD display. Manufacturer shall clearly indicate/furnish the sampling rate, accuracy and range of above measurements at the time of design & development to RDSO.
- 6.1.23 Provision shall be available to reset the indicating LEDs of NCLR from RCC through SCADA. For this purpose suitable NO/NC contact shall be provided in the relay.
- 6.1.24 The size of the module shall be suitable for flush mounting design for fitting on existing/new control and relay panels. The actual size shall be decided at the time of design approval.
- 6.1.25 The NCLR settings and stored data shall not be corrupted/erased/changed in the event of auxiliary power i.e. 110 V dc failure.
- 6.1.26 NCLR shall be capable of communicating with the SCADA System at RCC through RTU provided at TSS/SP or SSP based on standard IEC 60870-5-103 protocol for transfer of information stored to RCC through SCADA.
- 6.1.27 The NCLR should be capable of supporting following main functions of SCADA (even if some of these may be required in future).
- (i) User interface for the interaction with the control system and the controlled process.
 - (ii) Automatic supervision and control.
 - (iii) Alarm and event handling.
 - (iv) Data acquisition, calculating and reporting.
 - (v) Stored data retrieval at RCC through SCADA.
- 6.1.28 Suitable password protection shall be provided to avoid unauthorized changes in the settings.
- 6.1.29 The making & breaking capacity and rated current of output contacts of the NCLR shall be adequate to operate the associated output accessories/circuit breaker. Suitable snubber to be provided across the coil.
- 6.1.30 The NCLR shall also be capable to display I(current), V (voltage) of latest 100 events at relay LCD.

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- 6.1.31 The terminal code of the module shall be marked on the side or back of the NCLR, where they are visible easily.
- 6.1.32 The rating of terminals shall be 10 A continuous and 150 A for at least one second at 110 V D.C.
- 6.1.33 The modules shall be of industry standard design for continuous operation in the traction substation environment which besides the other environmental requirements being in the vicinity of the Railway tracks. The entire system may be considered as a protection system.
- 6.1.34 PROTOCOL MAPPING IN NUMERICAL CONTROL LOGIC RELAY (NCLR)

Indicative Protocol Mapping as per IEC 60870-5-103 form communication of NCLR with SCADA system shall be as under.

SYSTEM FUNCTIONS IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
End of general interrogation	-	8	255	0	10	GLB
Time synchronization	-	6	255	0	8	GLB
Reset FCB	-	5	129	2	3	According to main FUN
Reset CU	-	5	129	3	4	According to main FUN
Reset CU/Start/Restart	-	5	129	4	5	According to main FUN

STATUS INDICATION IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Healthy/Active	-	1	129	18	1	↑
LED Reset	-	1	129	19	1	↑
Local Parameter Settings (Change)	-	1	129	22	1	↑
BREAKER STATUS- 1 NC	X	1	129	24	1,9	↑↓
BREAKER STATUS- 1 NO	X	1	129	25	1,9	↑↓
BREAKER STATUS- 2 NC	X	1	129	26	1,9	↑↓
BREAKER STATUS- 2 NO	X	1	129	27	1,9	↑↓
BREAKER STATUS- 3 NC	X	1	129	28	1,9	↑↓
BREAKER STATUS- 3 NO	X	1	129	29	1,9	↑↓
RELAY BYPASS ENABLE/DISABLE	X	1	129	30	1,9	↑↓
STATUS SPARE	X	1	129	31	1,9	↑↓
Relay Fail	-	1	129	40	1	↑

SUPERVISION INDICATIONS IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
VT- 1 HEALTHY	X	1	129	32	1,9	↑↓
VT- 2 HEALTHY	X	1	129	33	1,9	↑↓

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FAULT INDICATION IN (MONITOR DIRECTIONS)

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Start/Pickup TRIP- CB- 1	X	2	130	64	1,9	↑↓
Start/Pickup TRIP- CB- 2	X	2	130	65	1,9	↑↓
Start/Pickup TRIP- CB- 3	X	2	130	66	1,9	↑↓
Start/Pickup VT- 1 DEAD	X	2	130	94	1,9	↑↓
Start/Pickup VT- 2 DEAD	X	2	130	95	1,9	↑↓
TRIP- CB- 1	-	2	129	123	1	↑↓
TRIP- CB- 2	-	2	129	124	1	↑↓
TRIP- CB- 3	-	2	129	125	1	↑↓
TRIP- VT- 1 DEAD	-	2	129	200	1	↑↓
TRIP- VT- 2 DEAD	-	2	129	201	1	↑↓

MEASURAND IN MONITOR DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Measurand supervision I- 1	-	9	129	148	2	↑↓
Measurand supervision I- 2	-	9	129	148	2	↑↓
Measurand supervision I- 3	-	9	129	148	2	↑↓
Measurand supervision V- 1	-	9	129	148	2	↑↓
Measurand supervision V- 2	-	9	129	148	2	↑↓

TIME TAGED MEASURAND IN MONITOR DIRECTIONS

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Switch-in Current - I- 1	-	4	129	149	1	↑↓
Switch-in Current - I- 2	-	4	129	150	1	↑↓
Switch-in Current - I- 3	-	4	129	151	1	↑↓
VT Voltage - V- 1	-	4	129	152	1	↑↓
VT Voltage - V- 2	-	4	129	153	1	↑↓

STANDARD INFORMATION NUMBERS IN CONTROL DIRECTION

SYSTEM FUNCTIONS IN CONTROL DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
Initiation of general interrogation	-	7	255	0	9	GLB
Time Synchronization	-	6	255	0	8	GLB

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GENERAL COMMANDS IN CONTROL DIRECTION

DESCRIPTION	GI	ASDU TYPE	FUN	INF	COT	COM
RCC RESET	-	20	129	19	20	↑
Relay Bypass Enable/Disable	-	20	129	116	20	↑↓
CB1 Open	-	20	127	123	20	
CB1 Close	-	20	127	125	20	
CB2 Open	-	20	131	135	20	
CB2 Close	-	20	131	136	20	
CB3 Open	-	20	131	141	20	
CB3 Close	-	20	131	142	20	

6.1.35 The_NCLR shall generally conform the tests to following standards

(i)	Dielectric Withstand	2kV, 50 Hz for 1 min between circuit to earth/circuit to circuit (IEC 60255-5, IS: 3231, IS: 12083 Pt.II)
(ii)	Impulse voltage test	5 kV, 1.2/50 micro seconds (IS: 8686/ IS: 3231/IEC-60255-5, IS: 12083 Pt.II)
(iii)	High frequency disturbance	IEC 60255-5, IS: 3231 part-I section-III <u>Longitudinal mode</u> 2.5kV, 1 MHz across auxiliary dc and current/voltage sensing terminals an earth. <u>Transverse mode</u> 1 kV, 1 MHz across auxiliary dc and current/voltage sensing terminals.
(iv)	Contact data	IS: 3231 part-I , IS : 12083 part-I
a.	Current carrying capacity	5 A, Continuously at 110 V DC/ 230 V AC
b.	Making & carry 250 V ac, 50 Hz for 3 seconds:	30 Amps
c.	Breaking: 220V, 50-60 Hz Cos Ø 0.4 220 V dc, L/R = 45 mili sec	5A 0.5 A
d.	Auxiliary power consumption at 110V DC	<15 W – De energised <30 W – Energised
e.	VA burden a) PTcircuit b) CTcircuit	Less than 5VA Less than 3VA
f.	Resetting time	150 ms to 200 ms

6.1.36 CURRENT TRANSFORMER as per RDSO's specification no. ETI/PSI/90(6/95) with latest amendments

1.	Rated system voltage (phase to ground)	Normal: 25 kV Maximum: 30 kV Minimum: 19 kV
2.	Rated transformation ratio	400-200/5 A
3.	Rated burden	60 VA
4.	Rated accuracy limit factor	15

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5.	Class of accuracy	5P class as per IS:2705 (Pt.III) 1981
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6.1.37 POTENTIAL TRANSFORMER as per RDSO's specification no. TI/SPC/PSI/PTs/0990 with latest amendments

1.	Rated system voltage (phase to ground)	Normal: 25 kV Maximum: 30 kV Minimum: 19 kV
2.	Rated transformation ratio	25000/100 V
3.	Rated burden	30 VA.
4.	Class of accuracy	6P class as per IS:356(Part 3): 1992

7.0 ROUTINE TEST LOGIC

7.1 Testing of Logic.

The NCLR shall be tested for the SEQUENCE OF OPERATIONS as per normal Feed.

7.1.1 Operating time test.

The operating time should be within error of $\pm 5\%$ of setting.

8.0 SEQUENCE OF OPERATION

The diagram of a typical traction Neutral Section replaced with 3 Insulated Overlaps at Sectioning & Paralleling Post (SP) is shown in Fig-1. One end fed from Substation A (Feed A) and other end from Substation B (Feed B).

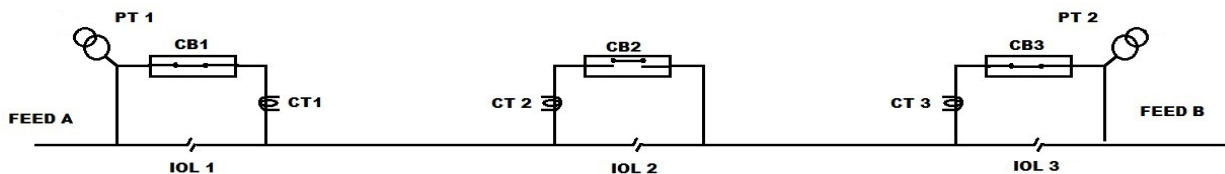


Fig1: DIAGRAM OF A TYPICAL IOL SWITCHING SECTION

The Automatic Phase Switching Relay (NCLR) is made to continuously monitor the parameters/status of the following equipment

- Potential Transformer Type I - 2 nos. One provided at Feed A and other provided at Feed B
- Current Transformers- 3 nos.
- Circuit Breakers- 3 nos.

The NCLR shall monitor current through three CT's for detecting the presence of traction load and changeover the supply from Feed A to Feed B and vice versa by controlling connected Circuit Breakers. The changeover of supply in IOLs in front of SP is controlled by three Circuit Breakers.

The NCLR shall facilitate automatic changeover of different phase supply to allow the loco to pass the Automatic Phase Switching Section comprising 3 IOLs so it is possible to run the electric train without reducing the speed or driver's intervention in doing DJ off/on. The DJ shall be in ON condition while crossing APSS.

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8.1 NORMAL FEED CONDITIONS

If all PT's were in healthy condition, CB1 and CB3 will be in close condition and CB2 will be in open condition allowing the locomotive to enter the 3 IOLs from both directions.

8.1.1 SEQUENCE OF OPERATIONS IF CT1 READS FIRST (Fig-2)

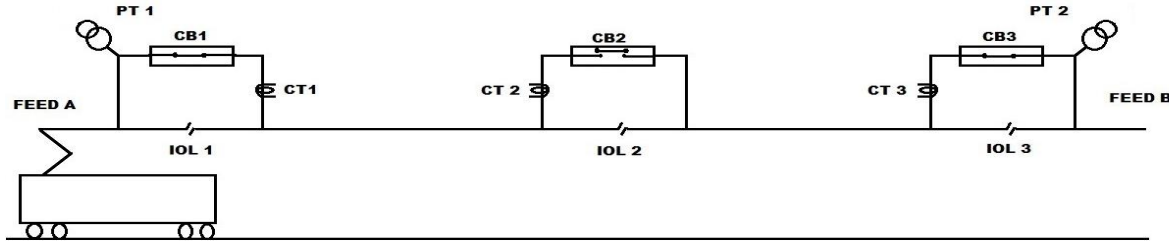


Fig2: DIAGRAM OF A TYPICAL IOL SWITCHING SECTION WITH LOCO IN FORWARD DIRECTION

Initially all CT's reads zero current as no loco is present in any IOL. When loco comes from feed A (forward direction) and approaching IOL1, CT1 starts reading. When CT1 reads above switching current setting, NCLR will open CB3 (after CB3 additional open delay). After analyzing condition of CB3, NCLR will close CB2 (after CB2 additional close delay). As loco continues its motion, CT2 starts reading on approaching IOL2. When CT1 & CT2 reads above the switching current setting, NCLR will open CB1 (after CB1 additional open delay). After analyzing condition of CB1, NCLR will close CB3 (after CB3 additional close delay) and the loco will be fed from feed B. When loco crosses the IOL3, CT3 current falls below the under current setting, NCLR will open CB2 (after forward under current delay + CB2 open delay) and closes CB1 (after CB1 additional close delay) after analyzing the condition of CB2.

CT1	CT2	CT3	CB1	CB2	CB3
0	0	0	1	0	1
1	0	0	1	0	1→0 (After additional CB3 open delay)
			1	0→1 (After getting CB3 open status+ CB2 additional close delay)	0
Final Condition			1	1	0
1	1	0	1→0 (After CB1 additional open delay)	1	0
			0	1	0→1(After getting CB1 open status + CB3 additional close delay)
Final Condition			0	1	1

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0	0	1	0	1	1
0	0	0	0	1→0 (After Forward Under current delay + CB2 additional open delay)	1
			0→1 (After getting CB2 open status + CB1 additional close delay)	0	1
Final Condition			1	0	1

8.1.2 SEQUENCE OF OPERATIONS IF CT3 READS FIRST (Fig-3)

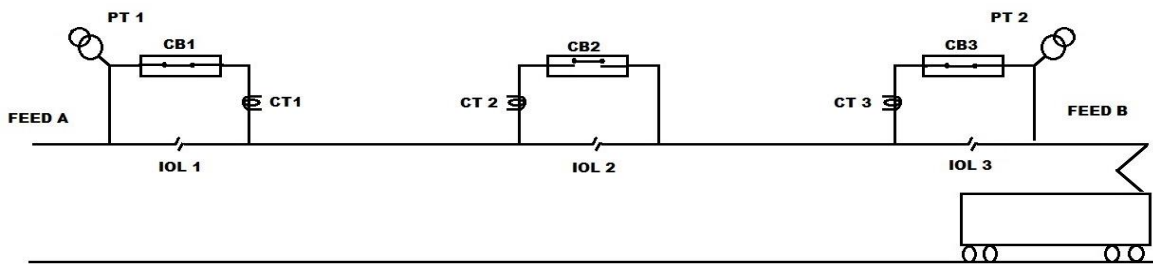


Fig 3

DIAGRAM OF A TYPICAL IOL SWITCHING SECTION WITH LOCO IN REVERSE DIRECTION

Initially all CT's reads zero current as no loco is present in any IOL. When loco comes from feed B (Reverse direction) and approaching IOL3, CT3 starts reading. When CT3 current reads above switching current setting NCLR will open CB1 (after CB1 additional open delay). After analyzing the condition of CB1, NCLR will close CB2 (after CB2 additional close delay). As loco continues its motion, CT2 starts reading on approaching IOL2. When CT3 and CT2 read above switching current setting, NCLR will open the CB3 (after CB3 additional open delay). After analyzing the condition of CB3, NCLR will close CB1 (after CB1 additional close delay) and loco will get feed from feed A. When loco crosses the IOL1, CT1 current falls below the under current setting, NCLR will open CB2 (after Reverse under current delay + CB2 additional open delay) and closes CB3 (after CB3 additional close delay) after analyzing the condition of CB2.

CT1	CT2	CT3	CB1	CB2	CB3
0	0	0	1	0	1
0	0	1	1→0 (After CB1 additional open delay)	0	1
			0	0→1 (After getting CB1 open status+ CB2 additional close delay)	1
Final Condition			0	1	1

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0	1	1	0	1	1→0(After CB3 additional open delay)
			0→1(After getting CB3 open status + CB1 additional close delay)	1	0
Final Condition			1	1	0
1	0	0	1	1	0
0	0	0	1	1→0(After Reverse Under current delay + CB2 additional open delay)	0
			1	0	0→1(After getting CB2 open status + CB3 additional close delay)
Final Condition			1	0	1

8.2 NCLR Bypass

Necessary potential free auxiliary contacts shall be made available to the NCLR for by pass the relay. Control supply for operating breakers shall be made available in NCLR bypass condition. A separate contact shall be provided in the NCLR to enable getting indication at RCC, that the NCLR is disabled. In addition, an indication for "NCLR disabled" shall be provided on the NCLR front panel. Warning to this effect shall be provided on NCLR.

8.3 PT Failure

NCLR operates under PT failure condition as follows

PT1	PT2	CB1	CB2	CB3
0	1	0	0	0
1	0	0	0	0
0	0	0	0	0

In case of any PT failure, NCLR shall open all CB's on the set delay without considering any other factors. In case of PT dead condition or DJ OFF condition, the loco pilot shall put down the pantograph.

8.3.1 On restoring of the PT after failure, the NCLR will restore the CBs status as defined in table given below.

8.3.1.1 Forward direction

State	NCLR condition before PT fail			Remarks	NCLR condition on restoring PT			Remarks
	CB 1	CB 2	CB 3		CB 1	CB 2	CB 3	

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1	1	0	1	Initial condition (no loco present in APSS)	1	0	1	Relay restores to initial condition after restoring of PT
2	1	1	0	Forward sequence started and loco crossed IOL1	0	1	1	Relay restores to 0 1 1 condition of forward sequence and allows loco to complete the sequence.
3	0	1	1	Loco crossed IOL2				

8.3.1.2 Reverse direction

State	NCLR condition before PT fail			Remarks	NCLR condition on restoring PT			Remarks
	CB 1	CB 2	CB 3		CB 1	CB 2	CB 3	
1	1	0	1	Initial condition (no loco present in APSS)	1	0	1	Relay restores to initial condition after restoring of PT
2	0	1	1	Reverse sequence started and loco crossed IOL3	1	1	0	Relay restores to 1 1 0 condition of forward sequence and allows loco to complete the sequence.
3	1	1	0	Loco crossed IOL2				

8.3.2 CB Fail & Sequence break conditions

8.3.2.1 The relay shall monitor the close/open status of circuit breakers during sequence operation. In case of a failure in circuit breaker or relay failing to sense the feedback from circuit breaker, relay shall open all breakers without considering any parameters after set delay.

8.3.3 NCLR Sequence Reset

8.3.3.1 Once sequence is started, the relay shall not sense the CT1(CT3 if reads first) till the sequence completes or after reset time.

8.3.3.2 NCLR relay should have sequence reset time setting up to 5 minutes in resolution of second.

9 CONTROL PANEL

9.1 The Numerical Control Logic Relay shall be mounted in the dedicated Control Panel provided in the TSS/SP. Apart from NUMERICAL LOGIC Controller Relay, Panel shall comprise of the following auxiliary relays:

SN	Name of Module	Function	Remarks

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1.	DC under and over voltage monitoring relay module as per RDSO Specification No. TI/SPC/PSI/PROTCT/6071 with A&C Slip No. 1	For Low and High Control Voltage (110V dc) and 240V ac alarm and trip	One module to be provided in case APSS is being controlled from SP. In case of APSS control from TSS, the DC under and over voltage monitoring relay module already available at TSS C&R Panel may be utilized.
2.	Master Trip Relay as per TI/SPC/PSI/PROTCT/6071 with A&C Slip No. 1	For circuit breaker opening	3 nos. Master Trip Relay or high duty contactor required in each panel
3.	Master Trip Relay as per TI/SPC/PSI/PROTCT/6071 with A&C Slip No. 1/Contactor	For circuit breaker closing	3 nos. Master Trip Relay or high duty contactor required in each C B for CB Opening

9.2 CONSTRUCTIONAL FEATURES

The panel shall be vertical, self-supporting, closed type steel construction. It shall be developed in such a way that optimum utilization of space on front, rear, side panels is made, and all-important hardware is on the front side panel.

The panel shall be accessed from rear or side of panels and for this, hinged type doors with locking arrangement shall be provided. Lifting hooks shall also be provided on the panel for loading of panel for transportation.

Panel shall be made as compact as possible due to space constraint at TSS/SP.

Any other construction of the panels may also be suggested by the panel manufacturers to RDSO, which may be considered based on the merits like savings, size, maintainability etc. of the proposed design.

9.3 The control panel shall have modular construction to facilitate ease of expansion and replacement. The instruments, control switches, main relays, and indicating lamps shall preferably be mounted on front side of the control panels. Equipment like balance protection relays, auxiliary relays, indications & control switches etc. shall be provided on front side of the panel. Terminal blocks, etc. may be mounted at suitable place inside the panel.

9.4 The design shall be keeping in view the ease of maintenance. The distribution and layout of the equipment on the panels shall be arranged by the successful tenderer with the approval of the purchaser to achieve a systematic and neat appearance. The manufacturer shall submit drawings of dimension details, circuits, terminals details, design and layout of equipment on the panels to RDSO for approval prior to manufacturing of prototype. All future panels shall be manufactured as per the RDSO approved drawing, designs keeping the requirement of the purchaser in the view based on the no. of lines and shall be verified by the purchaser.

9.5 The panel shall be fabricated from sheet steel of thickness not less than 3.0 mm for front, rear, doors and base panels, and not less than 2.0 mm for side, roof and door panels.

9.6 The bottom portion of the panel shall be provided with detachable type sheet steel covers (over trench portion) with suitable cable glands to facilitate entries of control cable from trenches to control panel. The panel shall be suitable for erection flush with the concrete floor by evenly spaced grouting bolts projecting through the base channels of its frame.

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- The panel shall be made in suitable sections to facilitate easy transport, handling and assembly at site.
- 9.7 Ribbed type rubber matting to ensure personnel safety of operating staff shall be provided on the floor in the front and back outside of the panel. Mat shall be continuous length, black color, minimum 1/4-inch thick, minimum three foot (3') wide and shall extend the full length of entire panel.
- 9.8 The size of panel shall be approved by RDSO at the time of design drawings approval of first prototype. The size of panel shall vary depending up on the number of lines and switching equipment at TSS/SP meant for APSS. The purchaser shall indicate its requirement in the tender clearly.
- 9.9 The C&R panel shall conform to IP 52 class to avoid ingress of vermin, insects, rats and dust and suitable for use in tropical humid climate.
- 9.10 All control and supply cables will be laid in a distribution trench running under the control panel. The cables will enter the board from the trench through suitable glands. The supplier will furnish detailed dimensions of the trench work required. Provision shall be made to seal the points of entry of cables to prevent access of insects and lizards into the board.
- 9.11 The sheet steel as well as other steel works shall be properly treated and then an under coat suitable to serve as base and binder for the finishing coat shall be applied. The exterior and base frame of the panel shall be coated with industrially accepted Siemens grey shade (RAL 7032 STR) and interior surfaces of the panels shall be epoxy powder coated of white color followed by a 2000c bake ovening. The finish shall be virtually scratchproof with all metal surfaces coated to a uniform thickness on the powder coat line.
- 9.12 To avoid rusting of the panels during service, the following pre-treatment through seven-tank process shall be ensured prior to painting:
- Degreasing
 - Rinsing (Water wash)
 - Pickling (Acid pickling)
 - Rinsing (Water wash)
 - Zinc Phosphating
 - Rinsing (Water wash)
 - Drying
 - Powder coating & curing
- If any painted surface gets damaged during transit, the surface finish shall be restored at site after erection by tenderer.
- 9.13 There shall be provision for operation in power down mode for the system for unmanned TSS/SP. In this case all the modules provided in panel including NCLR shall function as usual but the alarm, display and local acknowledgement features will remain out of circuit till the system is activated again. A separate front accessible ON/OFF switch shall be provided for this purpose.
- 9.14 All the modules and NCLR, dc and ac supplies, equipment in switch yard and other peripheral equipment, measuring instruments required for the control panel shall be hard wired in control panel. For all the external connections there shall be terminal blocks for terminating the connections.
- 9.15 A local/remote changeover switch shall be provided for each remote circuit breaker for changing over the control from local to remote and vice versa. The CB opening command initiated by the NCLR shall however open the circuit breakers directly irrespective of the position of the changeover switch.
- 9.16 Each CB shall be controlled by 3 position (trip- neutral - close) control switches having spring return to neutral feature and pistol grip handle or by push button for TRIP & CLOSE commands having 2 NO contacts each.

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9.17 An indicative list of the equipment to be provided on the control panels is at Annexure-D. Any additional equipment needed for satisfactorily working and adequate protection for SP equipment, which is not covered in annexure-D, shall also to be provided.

9.18 TERMINATION FOR THE PURPOSE OF INTERFACING OF CONTROL PANEL WITH SCADA

The successful tenderer shall provide necessary wiring and terminal blocks in control panel for inter connection with the SCADA RTU as mentioned below.

9.19 TELECOMMANDS FROM RCC

The Sectioning & Paralleling Post shall be un-attended type and the control of all circuit breakers, NCLR enable/disable, time synchronization of NCLR, shall be normally done from Remote control Center (RCC) through the SCADA system (to be provided by the purchaser under a separate contract). The operation of the controlled equipment shall only be possible when the associated local/remote selector switch on the control panel is kept in "Remote" mode.

For this purpose, the successful tenderer shall provide necessary wiring in the C & R panel including from each local/remote selector switch of the CB's to the terminal blocks for interconnecting to RTU. The purchaser shall indicate any additional requirement of tele commands wiring in its tender document.

9.20 TELE-SIGNALLING OF INFORMATION

The following information shall generally be tele-signaled to the RCC for monitoring the status of switchgears and various other events/alarms from SP Post in regard to APSS.

9.21 STATUS INDICATIONS OF SWITCHGEARS

i) ON/OFF status of circuit breakers

9.22 SUPERVISION OF 110 V D.C SUPPLY OF VARIOUS CONTROL CIRCUITS

Healthiness of 110 V dc supplies of various circuits is explained. The successful tenderer shall wire necessary contacts of each dc supervision relay up to the terminal blocks for inter-connection with the RTU.

9.23 CONTROLLER OPERATION

The operation of NCLR and different auxiliary relays involved in APSS including their health, are also required to be tele signaled to RCC.

In addition to above, the NCLR provided in the panel shall have number of other tele signals available (details of which shall be available in the relay design particulars). The successful tenderer shall wire all such contacts of each Digital relay and terminate on separate terminal blocks, for inter-connection with SCADA system RTU for future use.

Further there shall be provision of 1 nos. spare auxiliary relays individually having 2 NO + 2 NC contacts along with the necessary wiring in the panel for future use of any additional tele signals/contact multiplication.

9.24 TELESIGNAL OF LOW AND HIGH 110 VOLT DC CONTROL VOLTAGE

Contacts for tele signaling of low/high dc control voltage monitoring relay shall be wired up and terminated on the terminal block for inter- connection with SCADA system RTU.

9.25 TELESIGNALLING OF THE HEALTHINESS OF OHE AND INCOMING SUPPLY

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Healthiness of the OHE voltage shall be monitored through PT's, for this purpose, suitable terminals and wiring shall be provided in the panel for interconnection with SCADA system RTU. **TELEMETERING OF CURRENT & VOLTAGE TO RCC**

The SCADA system has been designed to telemeter analog parameters to RCC, necessary wiring in the panel up to the terminal blocks shall be provided by the successful tenderer for following parameters.

- a) Three current parameters of the OHE comprising three IOLs for construction of APSS, through transducers/suitable IED's taking reference from the 25 kV, 400- 200/5A or 1000-500/5 A CT provided at each IOL.
- b) Two-voltage parameter from the 25 kV/110 V PT provided at each end of the APSS through a voltage transducer/suitable IED's.

9.26 DC SUPPLY SUPERVISION

Provision shall be made for alarm and supervision of 110 V dc supply to various control, alarm and indication circuits. 110 V dc supply to control and relay panel is made available from 110V battery charger/batteries through distribution panel provided in the control room, to generally feed following separate circuits:

- 1) Control circuit for Circuit breakers installed for APSS
- 2) A common circuit for alarm and indication purposes.

Necessary provision for supervision of dc supply to each of the above circuits shall be made by using supervision relays. On failure of dc supply to any circuit, an LED (provided individually for each of the circuits) and alarm, both operated on 240 V, single-phase AC supply, shall come up. A push button, in series with each supervision circuit, shall be provided by the side of the corresponding dc fail indication LED in order to test the healthiness of the supervision circuit.

9.27 INDICATION LEDs

9.27.1 Low consumption, extra bright LED indicating lamps of approximately 20 mm diameter with insulated housing having group of good quality LEDs inside, suitable for panel use shall be provided. The LEDs shall be suitably wired to glow at 110 V dc supply.

9.27.2 The following color scheme shall be adopted for indication LEDs.

Indication for	Colour LEDs
Circuit breaker close (ON)	Red
Circuit breaker open (OFF)	Green
* 110 Vdc fail supervision.	Amber
*DC under / over voltage	Yellow
Line potential connected to 25 kV PT type-I	Red

* These LEDs shall normally remain extinguished and shall light up on 230V, 1 ph AC on the occurrence of an alarm or while manually testing the healthiness.

9.27.3 The followings indications shall be provided on Control Panel with alarm, which shall work on 230 V single phase AC.

- 9.27.3.1 DC supply fail (separate indication for each circuit)
- 9.27.3.2 Trip circuit unhealthy (separate indication for each CB)
- 9.27.3.3 DC under/over voltage.

9.27.4 TERMINAL BLOCKS FOR WIRING AND TESTING PURPOSE

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- 9.27.4.1 Terminal blocks for testing purpose shall be mounted conveniently inside the control panel so as to be easily accessible. The current rating of the contact shall be 10 A continuous and 150 A for at least one second at 240 V ac. or dc.
- 9.27.4.2 The current testing terminals shall be provided with short circuiting links or other suitable devices to short circuit the current transformer leads before interrupting the normal circuit for injection from external source for testing (applicable for secondary injection tests of relays).
- 9.27.4.3 The potential testing terminals shall preferably be housed in narrow recesses of the moulded insulation block to prevent accidental short circuits.
- 9.27.4.4 Vertical or horizontal pillar stack type terminal blocks, 1100 V class and not less than 30 A rating shall be provided for terminating outgoing ends of control panel wiring and the corresponding incoming tail ends of the control cables. Provision shall be made on each pillar for holding 20% extra connections. The terminal blocks shall have individual identification markings, which shall be either engraved or made indelible by any other means. Pillars of terminal blocks meant for connections of incoming control and indication cables shall be specially provided with identification labels indicating function(s) of each terminal block.
- 9.27.4.5 The terminals shall be of stud type suitable for terminating the ends of control wiring and outgoing cable ends through crimped terminal spade/lugs, which shall be securely tightened with nuts and spring washers. Suitable shrouds of unbreakable transparent material shall also be provided on each terminal block.
- 9.27.4.6 Terminal blocks connected to potential and current circuits shall not be placed adjacent to each other in a pillar. Where such segregation is not convenient due to any reason, a dummy spacer of insulating material of adequate thickness or a space terminal block shall be provided in between two such circuits. All CT input cable shall preferably be terminated at one place either the control side or relay side terminal block of the panel on one separate terminal block.

10 WIRING

- 10.1 All panel wiring shall be done with 1100 V grade PVC insulated single core, tinned annealed copper conductors for service in extremely tropical climate. The PVC wires shall conform to latest version/revision of IS: 694 and duly tested for flammability test as per IS: 10810 (Part 53)-1984. The wiring shall not be prone to attack by vermin, i.e. mice, white ants, cockroaches etc.
- 10.2 The size of wires in relay circuits connected to the current transformers shall not be less than 4 sq.mm copper and in potential and other circuits not less than 2.5 sq.mm copper.
- 10.3 The numbering and scheme of wiring for various circuits in the control and relay panel shall be in accordance with latest version of IS: 5578 and 11353. The following color scheme shall be adopted for the wiring in order to facilitate identification of circuits:

Colour of wire	Circuit	
Yellow	25 kV potential transformer circuit.	
Violet	25 kV current transformer circuit.	
Red (phase)	240 V a.c. auxiliary	
Black (neutral)	Supply circuits.	
Green	Earth circuit	
Grey	d.c. control circuits	PVC sleeves of colours, red for trip blue for indication circuit, yellow for alarm circuit green for relay and other inter connections to be provided.

A suitable plaque of durable material and indelible description giving the

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color scheme of wiring shall be provided inside the control panel to facilitate quick identification of circuits for maintenance purpose.

- 10.4 Wiring shall be suitably supported and clipped to the frame works. All wiring shall be neatly bunched with PVC tape or laced by thread. Where metal clips clamp a bunch of wire, the wires shall be taped together by one or two layers of PVC tape to protect them against mechanical injury. Wiring connected to the space heaters in the panels shall be provided with porcelain beaded insulation for a short distance from the heater terminals and heat resistant bushes of insulating materials shall be provided at the terminal housing outlets. No joints shall be permitted in the wiring.
- 10.5 The terminal ends of all wires shall be provided with numbered PVC ferrules. The ferrules shall be of white color with black lettering thereon. However, for trip circuits, ferrules of red color shall be used. At a point of inter- section where a change of number is necessary, duplicate ferrules shall be provided and marked with proper numbers.
- 10.6 End of all wires shall be provided with terminal lugs which shall be crimped. At terminal connections, washers shall be interposed between wire terminals and holding nuts. The connection studs shall project at least 3 mm from the lock-nut surface. Wire ends so connected at the terminal studs that no terminal ferrule gets masked due to the succeeding connections. The wire ends shall be suitably bent to meet the terminal stud at right angles with the stud axis; skew connections shall not be permitted.

10.7 MCB AND FUSES FOR CONTROL CIRCUIT

Suitable rating MCB's of reputed make preferably L&T, Havells, ABB, Siemens, Schneider etc. make shall be provided in all potential circuits. MCB's shall be mounted in the interior of the control board and at easily accessible places. The MCBs rating and the identification number, as assigned in the schematic diagram shall be indicated on the MCB. Suitable labels of engraved/print markings indicating the rating, identification number and the circuit in which used, shall also be provided.

10.8 SPACE HEATERS AND CONTROL PANEL LIGHTING

- 10.8.1 Suitable space heaters to operate on 240 V single phase ac supply with Thermostat and 'ON/ OFF' switches shall be provided inside the control board to prevent condensation of moisture in humid weather.
- 10.8.2 The interior and central corridors of control panel shall be adequately illuminated by 240 V ac, 20 watt LED. LED shall be controlled by door operated switches provided on the doors along with additional ON/OFF switches provided inside the panel.
- 10.8.3 One number 5 Amps, single phase, 3 pin plug sockets with switches shall be provided inside the control board at convenient points for use of portable lamps in control and relay panels.

11 EARTHING

- 11.1 All current free metallic bodies of equipment/relays etc. on the control board shall be earthed properly. Main earth circuit shall be of 25 x 3 mm tinned copper strip and individual connections of equipment/relays with main earth circuit shall be by means of 2.64 mm (12 SWG) tinned annealed copper bare conductor/strips, using tinned copper spade terminals/lugs. Sometimes as an alternate, PVC insulated stranded tinned copper wire of size equivalent to 2.64 mm (12 SWG) may be provided. Joints shall be avoided as far as possible.
- 11.2 In order to facilitate the earthing of secondary of CTs and PTs inside the control board, suitable earth links of adequate size made of tinned copper/brass shall be provided inside the control board at the appropriate points.
- 11.3 Multiple earthing of current/potential transformer circuits shall be avoided. Main earth connection in the form of 25x3 mm tinned copper strip for each panel shall be brought out to two terminals for connection to the general earthing system of the SP/FP.

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12 NAME PLATES/IDENTIFICATION LABELS

- 12.1 All relays, instruments and other electrical devices mounted on the panel shall have name plates with rating, serial number and manufacturer's name.
- 12.2 Identification labels of suitable size, indicating functions and numbering of respective equipment e.g. semaphore indications, relays, instruments and test blocks etc shall be provided on the exterior of control and relay panels. Similar labels shall also be provided for all switches, LED's and push buttons provided on the control and relay panels indicating their functions. The purchaser shall supply the scheme of numbering of various equipment in SP/FP.
- 12.3 All Indicating labels of adequate length and width made up of aluminum alloy sheet suitably printed with all inscriptions on it, made on the black background with white letters/figures using aluminum anodized screen printing, to provide clear and long lasting impression shall be provided. The inscription shall clearly convey the function of the device.
- 12.4 Bigger plastic/acrylic/Aluminium alloy steel plates about 50 mm wide, bearing suitable captions to identify the line and corresponding outgoing 25 kV CB to IOL, shall be provided on the top of each relay and control panel.
- 12.5 All the identification labels on the exterior of control and relay panels shall be secured with the panel in an elegant manner keeping aesthetic looks of the panels.
- 12.6 Identification labels shall also be provided in the interior of the control panel for such equipment and fittings, which are mounted inside the control panel, the labels of suitable size indicating function of respective equipment shall be provided.
- 12.7 The labels in the interior of the board under the equipment/relays shall be so provided that they are not obscured due to bunches of wire runs and any other obstructions. Painting of inscriptions shall not be permitted.
- 12.8 Generally labels shall be provided for following.

Sl. No.	Label description
i)	Main labels to be provided on the top panels.
ii)	Circuit labels to be provided at the bottom of the panels
iii)	Function label under the equipments.
iv)	Push button and indication LED labels.
v)	Equipment numbering labels.
vi)	Control & selector switch labels.
vii)	Labels under fuse and Links.
viii)	Reference labels (Interior of panel)
ix)	Terminal block pillar numbering labels.
x)	Terminal numbers on terminal blocks.
xi)	Function inscriptions on terminal blocks.

13 Major Components/ Equipment apart from Relays mentioned in Clause 7.0 to be incorporated in the Control and Relay Panel for APSS for single line

SI No.	DESCRIPTION	Qty
1	Circuit Breaker control switch, 3 position Spring return to neutral with pistol grip handle, non-lockable with 2 contacts each in OPEN and CLOSE positions and nameplate inscribed as OPEN-NEUTRAL-CLOSE	3 Nos in each panel

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2	Local-Remote selector switch, 2 Position stayput type, pistol grip handle, nonlockable with 2 contacts each in LOCAL and REMOTE positions along with nameplate inscribed LOCAL- REMOTE.	3 Nos in each panel
3	Indicating Lamp with bunch of LED's 22.5mm dia. rated for 110V DC RED BREAKER ON	3 Nos in each panel
4	Indicating Lamp with bunch of LED's 22.5mm dia. rated for 110V DC GREEN BREAKER OFF	3 Nos in each panel
5	Double Way Miniature Circuit Breakers (MCB) for NCLR-6A For Circuit Breaker - 10A For Tele Signalling & Indication - 6 A For 230 V AC CIRCUITS - 4A For Line PT CKT - 2A Double Way Miniature Circuit Breakers (MCB) for DC/AC monitoring relay-6A	2 Nos in each panel 3 Nos in each panel 1 No in each panel 1 No in each panel 2 Nos in each panel 1 No in each panel
6.	LED tube 20/14W, 240V AC for cubicle illumination	1 Nos in each panel

The make of above mentioned shall be declared in the SOGP at the time of submission of design and schematic drawing for approval for manufacturing of prototype. Supplier's original test certificate is to be produced to the representative of DG/TI RDSO or purchaser for verification at the time of prototype/ acceptance testing.

13.1 MASTER TRIP RELAY

NCLR as explained above shall open the corresponding feeder circuit breaker on sensing of current, through a high speed self-reset, electromagnetic type master tripping relay. The relay operating time shall not be more than 10 ms and its resetting time shall not be more than 100ms. The relay shall be capable of handling the current of the CB trip coil. The master trip relay shall have the mechanical endurance not less than 1,00,000 operations.

13.2 The location of various potential and current transformers in the circuits is indicated in the lay out drawings of SP/FP, given in the relevant tender papers. The drawings indicating the proposed scheme of connections at the SP for the instruments and relays are also given in the SP tender papers. The tenderer may however furnish alternative proposals, if any, for consideration of the purchaser.

14.0 TESTING

14.1 GENERAL

14.1.1 The first NCLR and control panel developed as per this specification shall be type tested by RDSO.

14.1.2 The manufacturer shall submit technical details, design drawings to the RDSO for approval. Only after approval of designs and drawings the manufacturer shall take up manufacture of the prototype NCLR or panels or both. It shall be clearly understood that any changes required to be done in the prototype as required by RDSO shall be done expeditiously.

14.1.3 Before giving the call to RDSO for inspection and testing of the prototype of the system, the manufacturer shall submit a detailed test schedule consisting of schematic circuit diagrams for each of the tests and nature of the test, venue of the test and the duration of each test and the total number of days required to complete all the tests at one stretch. Once the schedule is approved, the test shall invariably be done accordingly to this schedule. In case any dispute or disagreement arises between the manufacturer and RDSO during the process of testing as regards the type tests and /or the interpretation and acceptability of the type test results, it shall be brought to the notice of the Director General (Traction Installation), RDSO whose decision shall be final and binding.

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15.0 TYPE & ROUTINE TESTS

15.1 TESTS ON NUMERICAL CONTROL LOGIC RELAY (NCLR)

15.1.1 TYPE TESTS

The Numerical Control Logic Relay for APSS covered by this specification shall be type tested as per IS:3231, IS: 12083 IS:8686, IEC 61000 & IEC: 60255. The following type tests shall be carried out on the prototype relays by RDSO.

- i) Operating characteristics tests including verification of functions/features including operating time, reset time, operating and reset value.
- ii) Insulation resistance test- should be 10 mega ohm or more between the electric circuit and earth with 1000 V.
- iii) Measurement of burden (VA).
- iv) Measurement of power consumption (watts)
- v) Over load test.
- vi) Impulse voltage withstand test applicable to test voltage class III as per IEC 60255-27.
- vii) Temperature rise test
- viii) Effect of DC voltage variation (110 V DC +15 % / -30 %)
- ix) Making and breaking capacity tests of contacts.
- x) Dielectric test as per IEC 60255-27
- xi) Product safety requirements test as per IEC:60255-27.
- xii) Enclosure Protection Test IP 54 as per IEC:60529.
- xiii) Communication standard protocol as per IEC:60870-5-103
- xiv) Vibration test- as per IEC 60255-21-1, Class-I- Frequency 10-150 Hz, Acceleration $1g_n$ in all 3 axis, 20 sweep @ 1 octave/minute.
- xv) Endurance test-Mechanical endurance test for 10000 operations as per IEC 60255-1.
- xvi) Environmental test
 - a) Dry heat test as per IEC 60255-1/IEC60068-2-2 (This will test from +20 to +70 OC)
 - b) Dry heat test at maximum storage temperature as per IEC 60255-1/ IEC60068-2-2
 - c) Cold test as per IEC60255-1/IEC60068-2-1 (This will test from -25 to +25 OC)
 - d) Cold test at minimum storage temperature as per IEC 60255-1/ IEC60068-2-1
 - e) Change of temperature as per IEC60255-1/ IEC60068-2-14 (this will test from -25 to + 55 OC)
 - f) Damp heat test, steady state as per IEC 60068-2-78
 - g) Damp heat test, cyclic as per IEC 60068-2-30
- xvii) Electro agnostic Compatibility (EMC) tests
 - a) 1 MHz burst immunity test as per IEC60255-26 & IEC61000-4-18
:Common Mode : 2.5kV Differential mode : 1kV Duration : 2 sec
 - b) Electrostatic Discharge Test as per IEC60255-26 & IEC61000-4-2 Contact Discharge 6kVAir Discharge 8kV
 - c) Radiated, radio-frequency, electromagnetic field immunity test as per IEC60255-26 & IEC61000-4-3Frequency Range: 80MHz – 1000MHz,
Modulation: 80% AM @1kHz, Field Strength 10V/m
 - d) Electrical fast Transient or burst requirements as per IEC 60255-26 & IEC61000-4-4.

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- e) Surge immunity as per IEC 60255-26 & IEC61000-4-5.
- f) Immunity to Conducted disturbances induces by radio frequency field as per IEC60255-26 & IEC61000-4-6.
- g) Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests as per IEC60255-11 & IEC61000-4-29.
- h) Power Frequency Immunity Test as per IEC 60255-22-7 & IEC61000- 4-8 .
- i) A.C. ripples in D.C. auxiliary as per IEC 60255-26 & IEC61000-4- 17. -

Type tests for which facilities of testing are not available with the relay manufacturer shall be carried out at any reputed NABL accredited laboratories and test reports of the same shall be furnished to the RDSO.

15.1.2 If the prototype of the relays conforming to this specification has already been approved in connection with previous supplies to Indian Railways, fresh prototype testing of the relays may be waived off if it had passed the prototype tests earlier and no changes in the design or material used have been made.

15.1.3 Only after approval of the results of the tests on the prototype is communicated by RDSO to the manufacturer, he shall take up bulk manufacture and future supplies which shall be strictly with the same material and process as adopted for the prototype. In no circumstances material other than those approved in the design/drawings and/or the prototype shall be used for bulk manufacture.

15.1.4 ROUTINE TESTS

The following tests on the NCLR shall be carried out during routine tests by Railways/ inspecting agencies at the manufacturer's works as per this specification.

- Visual Checks
- Insulation Resistance
- Dielectric strength
- Setting range and Functional tests

15.2 TESTS ON CONTROL PANEL.

15.2.1 TYPE TESTS

(i) VISUAL CHECK:

General Check of the control panel in respect of dimension, finishing, construction, wiring & ferules verification lay out equipment on the panel, make and rating of instrument etc.

(ii) OPERATION TESTS:

Operation tests on all equipment to prove correctness of wiring of various circuits including indications and operation of relays etc.

(iii) POWER FREQUENCY HIGH VOLTAGE WITHSTAND TESTS:

Voltage test on the panels with all equipment and wiring for a withstand voltage of 2 kV (rms) to earth for one minute.

(iv) INSULATION RESISTANCE TESTS:

Measurement of insulation resistance by using 1000V megger of the complete panel wiring including CT, PT and control circuits with all equipment mounted on the panel.

(v) AUXILIARY POWER CONSUMPTION TEST

Measurement of power consumption of the control & Relay panel with all the relays in energized & de energized conditions.

15.2.2 ROUTINE TESTS:

The checks and tests as mentioned in clause No. 12.2.2.1 (i to iv) shall be carried out on the complete control and relay Panel by the purchaser or its representative.

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16.0 TECHNICAL DATA LITERATURE AND DRAWINGS

16.1 The manufacturer developing Numerical Control Logic Relay and its Panel covered vide this specification shall furnish the make, type and guaranteed performance, technical and other particulars for all equipment/relays/instruments etc. in the Performa attached as Annexure-C to RDSO along with the internal design details as per clause 16.4 below.

16.2 The tenderer shall furnish the technical specification and descriptive literature of various modules covering their operational aspects, instruments etc.. He shall also submit, along with the tender, the schematic diagram of switching and control scheme to enable the purchaser to make assessment of the proposal.

16.3 PARAWISE COMPLIANCE OF THIS SPECIFICATION SHALL BE SUBMITTED DURING DESIGN APPROVAL. In case of non-compliance of any clause, deviation along with justification shall be submitted. Wherever the tenderer deviates from the provision of the clause/sub-clause or offers any alternative equipment, he shall furnish complete details of the proposed deviation/alternative with his remarks to enable the purchaser to make proper assessment of the same. The successful tenderer shall, however, be required to obtain specific acceptance of the purchaser for any deviation/alternative proposed by them.

16.4 Successful tenderer shall be required to submit the following detailed dimensional drawings (including reproducible copies) in A4/A3 size. Two sets of same drawings shall be initially submitted to RDSO for scrutiny before prototype development. After approval of drawings and prototype test, the final approved drawings shall also be submitted to DG/TI RDSO in two hard copies for final approval.

- i) Dimensional drawing of NUMERICAL LOGIC Controller Relay
- ii) Dimensioned drawings of the control panel indicating front and rear views with the layout of instruments, mimic diagram, control switches, indication LEDs, push buttons, r and all equipments etc. clearly marked.
- iii) Exploded view of the rear and front panel indicating the disposition of various equipments inside the control panel.
- iv) Schematic diagram of d.c. control circuits for CBs for associated with Automatic Phase Switching Section .
- v) Schematic diagram of a.c. circuits showing connection of CT_s and PT_s and associated equipment.
- vi) Drawing showing the legend of various references/codes adopted for equipments, NCLR, aux. relays and all other accessories used in the control panel.
- vii) Drawing for name plates/identification labels engraving details.
- viii) Any other drawings considered necessary.

16.5 Only after all the designs and drawings have been approved and clearance given by RDSO to this effect, the manufacturer shall take up manufacture of the prototype for RDSO inspection. It shall be clearly understood that any changes required to be done in the prototype as required by RDSO shall be done expeditiously.

17.0 ERECTION TESTING AND COMMISSIONING

17.1 The erection and commissioning of NCLR and panel shall be done by the successful tenderer who shall arrange all tools, plants, instruments and other material required for the purpose at own cost. Tests shall be carried out during erection/commissioning of the panel at the site. The successful tenderer shall be required to submit to the purchaser the details of the checks and tests to be carried out during erection and commissioning. Tests shall be carried out on the relay and panel jointly with the purchaser's representatives to check the erection and commissioning of the relay.

17.2 The successful tenderer shall ensure necessary co-ordination with the manufacturers

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of switchgears and other field equipment like CT, PT etc with regard to terminal markings, wiring, scheme of protection, etc. He shall obtain the names of these manufacturers from the purchaser.

17.3 Three sets of the test report in hard copies and one soft copy shall be supplied by the manufacturer to the purchaser for records and reference.

17.4 The following test shall be carried out during erection/commissioning of the relays and panel at the site in presence of the purchaser's representatives to check the erection and commissioning of the relay.

- i. Phase Switching Time, operation time and reset time of the NCLR.
- ii. Measurement of insulation resistance of the complete panel wiring including wiring between CT, PT and control circuit with all equipment mounted on the panel, by using 1000 V tester. It should be $\geq 1M\Omega$.
- iii. Lead burden should be measured between current transformer and the relays to check any poor contact in the secondary circuit of CTs. Correctness of CTs and PTs polarity shall be ensured.
- iv. Check functioning of the control circuit, switches, push button, auxiliary relays, master trip relays, alarms, annunciations, indications etc. by operating the associated switchgear at SP without connecting OHE.
- v. All auxiliary relays should be checked at their pickup values and confirm that auxiliary relays reset when voltage and current supply is removed after operation.
- vi. Check the functioning and correctness of various tele command and tele signal circuits.
- vii. Check operation of NCLR with circuit breaker by injecting the primary current by using primary injection test kit. Measure the errors between operating value and set value. Conduct secondary injection test and measure the operating times and pick up values of the relays.
- viii. Operate NCLR manually and/or by injecting secondary current/voltage and ensure appropriate CB opening/tripping. There should be no mal operation of any circuits and in every tripping appropriate flag indication along with alarm/annunciation should appear.
- ix. Any other operational/functional test considered necessary for ensuring safe and correct working of C & R panel.

18.0 OPERATION, MAINTENANCE INSTRUCTIONS

18.1 The tenderer shall provide maintenance schedule and troubleshooting instructions for the relays and panel. The supplier shall supply free of cost 6 copies of the Instruction Manuals for operation and maintenance of the equipment to the purchaser.

18.2 The basic maintenance schedule along with the troubleshooting, diagnostic chart shall also be submitted to RDSO in two hard copies and one soft copy in CD for scrutiny and approval.

19.0 SPARES AND SPECIAL TOOLS

The tenderer shall quote separately for the spares recommended to maintain the equipment for a period of at least 5 years. The tenderer shall also quote separately for supply of special tools, if any, required for trouble free operation and maintenance. Spare parts/special tools as ordered shall be delivered along with the supply of relays & panels. The purchaser reserves the right to buy the special tools from the tenderer or not. The price quoted against spares and special tools shall be optional unless the same is especially specified in the tender document.

20.0 PACKAGING & FORWARDING

The tenderer shall ensure proper packaging of control and relay panels, Digital relays, electronic items and manuals, by using wooden crates, thermocol and polyethylene

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wrappings, so that there is no damage during the transit and there is no effect of humidity. The handling, loading and unloading instructions along with the list of packages, contents shall be sent to the consignee separately.

21.0 ISO REQUIREMENT

All the provisions contained in extant RDSO's ISO procedures laid down in document No.- QO-D-8.1-11 (Titled " Vendor- change in approved status") and subsequent versions/ amendments thereof, shall be binding and applicable on the successful vendor/ vendors in the contracts floated by Railways to maintain quality of products supplied to Railways".

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ANNEXURE-ALIST OF ABBREVIATIONS

Abbreviation	Full Form of the Abbreviation
ACTM	AC traction manual
APSS	Automatic Phase Switching Section
BT	Booster Transformer
C&R	Control and relay
CB	Circuit Breaker
CT	Current Transformer
NCLR	NUMERICAL LOGIC Controller Relay
DPR	Distance protection relay
IDMT ICT	Inverse Definite Minimum Time lag Interposing CT
IOL	Insulated Overlap
MTR	Master trip Relay
NC	Normally closed.
NO	Normally open
OCR	Over current relay
OHE	Over Head Equipment
PT	Potential Transformer
PTFE	Poly Tetra Fluoro Ethylene
RC	Return Conductors.
RCC	Remote control centre
RTU	Remote Terminal Unit
SCADA	Supervisory control and data acquisition system
SP	Sectioning Post
SSP	Sub Sectioning Post
TRD	Traction Distribution
TSS	Traction Sub Stations
WPC	Wrong Phase Coupling

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ANNEXURE-BDEFINITIONS & EXPLANATIONS

Item	Definition
Breaking capacity	The maximum current and volt- amperes that the contact is able to interrupt successfully under specified conditions without significant damage to contact.
Double ended feeding	The adjacent TSS are on same phase and are connected in parallel. There may or may not be a neutral section on SP for such feeding arrangement.
Making capacity	The maximum current and volt-amperes the contact is able to make successfully under specified conditions without significant damage to the contact.
Operating time	The time, which elapses from the appearance of the abnormal conditions, which cause the operation of the protection until the protection initiates tripping or alarm.
Protected zone	The part of an installation guarded by a certain protection.
Purchaser	The person / agency who has floated the tender for execution of the work on or behalf of the president of India.
Reclaim time	Reclaim time is the duration for which the auto reclosing mechanism remains ineffective after first reclosure of circuit breaker by auto-reclose, irrespective of re-occurrence persistence of fault. In other words, the breaker will not be reclosed second time by the auto-reclose device had the same tripped on fault again within the reclaim time after its first reclosure on the auto-reclose system.
Relay back-up	An arrangement, which provides an additional, relay using the same or different principle of operation from that of the main relay.
Remote back-up	An arrangement at the next station in the direction towards the source which trips after a delayed time if the CB in the faulty section is not tripped.
Sector	Distance between the TSS and the SP
Sub-sector	Distance between the TSS and the adjacent SSP/ SP or the distance between the SP and the adjacent SSP/SP
Tenderer	The vendor, supplier who intends to quote for the tender floated by the purchaser. The agency who shall quote for tender floated by the tenderer.
Time lag	Intentionally introduced time interval between start and completed operation of the protection.
Track circuit	It is the circuit providing passage of traction current through arrangement of track bonding.
Unit protection	A protective system, which is designed to operate for abnormal, conditions inside and remains stable for abnormal conditions outside a specified zone of the protective system.

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ANNEXURE-CSCHEDULE OF GUARANTEED PARTICULARS

The manufacturer shall be required to submit the following particulars to the RDSO along with the design drawings of the proto type.

A. SOGP for Numerical Control Logic Relay and its control panel

Sl. No.	Description	Manufacturer details	Unit
1.	Name of the manufacturer		
2.	Governing RDSO specifications		
3.	Are you an RDSO approved firm? Even for any other item.		
4.	Permitted range of dc voltage for different panel equipment.		
1.	Make and model number of NCLR module		
2.	Governing RDSO specification		
3.	Setting range of parameters with steps of Resolution		
4.	Operating time		
5.	Resetting time		
6.	Max. permissible errors in operating parameters		
7.	VA burden		
8.	DC power consumption		
9.	Number and type of communication ports		
10.	User interface type & its features		

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12.	Sampling rate of current and voltage		
13.	Down loading and analysis of stored data software		
14.	Digital data available in relay		
15.	Number of spare contacts available		
16.	Short time current rating of input coil (CT)		
17.	Permitted range of DC voltage		
18.	Contact ratings		
19.	Dimensions of NCLR in mm: Length Width Breadth Weight Cut out dimension		
20.	Any other specific feature of relay firmware and data analyzing software		
5.	VA burden of digital meters used in Panel		
6.	Type & make of annunciators used in Panel and their power consumption.		
7.	Type of LEDs life and power used in Panel, consumption		
8.	Type of terminal block, rating and make used in Panel		
9.	Type , make & power consumption of LED type semaphore arrangement used in Panel		
10.	Dimensions of Panel in mm Length Width Breadth Total Weight (approximate)		
11.	Are there any deviations to the RDSO specifications? If yes enclose clause wise deviations and reasons of deviations.		

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ANNEXURE-D

List of equipment to be provided on the control and relay panel given below is indicative. It may be noted that quantity of the equipment shall vary depending upon the purchasers requirements based on lay out (single/double/triple or more lines).

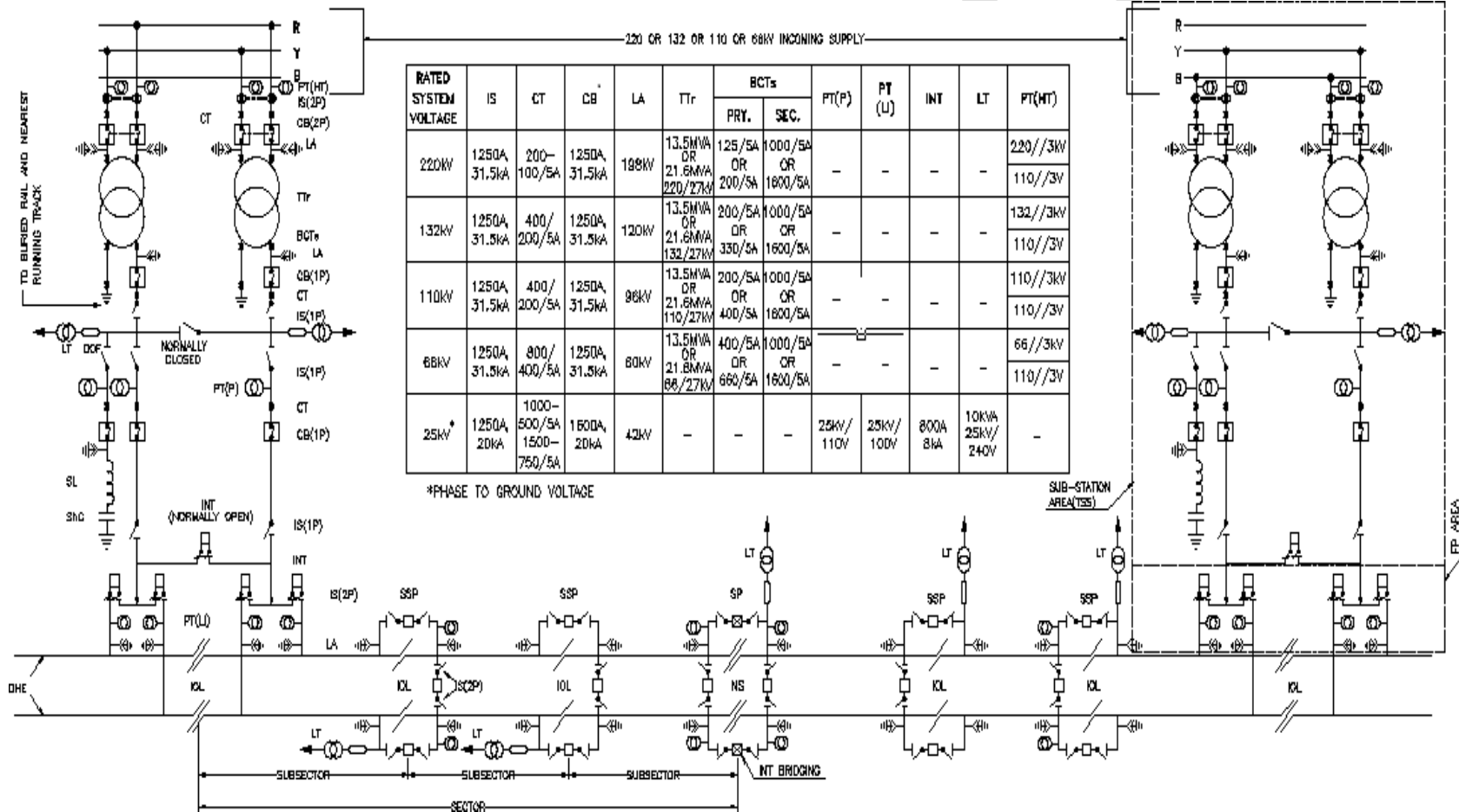
Purchaser shall clearly indicate the above so that tenderer can realistically assess the requirements of the equipments to be provided on C & R panels.

1. EQUIPMENT ON THE CONTROL PANEL

1.	Control switch (TNC) each for CB
2.	Switch each for Local/Remote Change over for CB
3.	Indication LEDs for close and open positions of each breaker, dc fail supervision, trip circuit fail, PT healthy, dc high/low etc.
4.	Cut-off switches for disconnection indication as per this specification
5.	Space heaters with Switches & thermostat (240 V AC.).
6.	240 V, 5A, 3 pin Socket& Switch.
7.	Cubicle illumination using LED lamp/tube/ batten with door switches.
8.	Terminal blocks
9.	HRC fuse and MCBs
10.	Earth links.
11.	Any other item considered necessary.
12.	Interposing CT
13.	Items defined in Clause 9.1 of this specification.

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GENERAL SCHEME OF TRACTION POWER SUPPLY SYSTEM



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NOTES:-

- 25KV SHUNT CAPACITOR BANK COMPLETE WITH CONTROL GEAR, PROTECTION RELAYS, SERIES REACTOR AND ACCESSORIES NECESSARY FOR ITS EFFICIENT OPERATION SHALL ALSO NEED TO BE PROVIDED AT THE RAILWAYS TRACTION SUB-STATION (TSS) WHERE IT IS SPECIFICALLY MENTIONED BY THE PURCHASER.
- FOR DETAILS OF EQUIPMENT AND ITS RATING ETC. LATEST EQUIPMENT SPECIFICATIONS AND THE SUB-STATION LAYOUT DRAWING SUPPLIED BY PURCHASER MAY BE REFERRED.
- THE RATING OF BUSHING CTs WOULD VARY ACCORDING TO THE TRACTION TRANSFORMER CAPACITY.

LEGEND:-

IS	ISOLATOR	LT	AUXILIARY TRANSFORMER
CT	CURRENT TRANSFORMER	ShC	SHUNT CAPACITOR
CB	CIRCUIT BREAKER	SL	SERIES REACTOR
LA	LIGHTNING ARRESTER	FP	FEEDING POST
BCTs	BUSHING CTs	SSP	SUB-SECTIONING AND PARALLELING POST
TTr	TRACTION TRANSFORMER	SP	SECTIONING POST
PT(P)	POTENTIAL TRANSFORMER (PROTECTION TYPE)	NS	NEUTRAL SECTION
PT(U)	POTENTIAL TRANSFORMER (LINE INDICATION TYPE)	IOL	INSULATED OVERLAP
INT	INTERRUPTOR	DOF	DROP OUT FUSE SWITCH
		IP	SINGLE POLE
		2P	DOUBLE POLE

THIS DRAWING SUPERSEDES DRG. No.ETI/PSI/702 AND 707.

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**GENERAL SCHEME OF
SUPPLY FOR 25kV
50Hz SINGLE PHASE
TRACTION SYSTEM**

JD/TI	Sd/-
	25.8.92

ADE/PSI	Sd/-
	25.8.92

REF:-

CROSS REF:-

DATE	MOD.	NATURE OF MOD.	INITIAL	R. D. S. O.				REV. F
12.04.91	'A'	REVISION NO. OF ABOVE DRAWING		DATE	NAME	ETI/PSI/702-1		
20.08.92	'B'	REVISION AND INLET	BA/-	DR.				
	'C'	INLET OF 13.8MVA TRANSFORMER ADDED		TC.		SCALE:- N.T.S.		
	'D'	POSITION OF B.C. & S.L. INTERCHANGED	BA/-	CK.				

		REVISION ON CAD (PTQ-IT)						
DATE	MOD.	NATURE OF MOD.	INITIAL					

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Annexure-F

Guideline for Railways regarding IOLs to be provided at Automatic Phase Switching Section (APSS):

1. Air gap clearance between two OHE of each IOL shall be 600 mm in place of 500 mm. All other design, construction of OHE will be as per existing guideline issued by RB and RDSO.
2. There shall not be any cross over OHE in APSS zone.
3. The minimum distance between two adjacent IOLs, according to 15 seconds time to accommodate the duty cycle of CB, will be 670 m for 160 KMPH and with a margin of 30 m, it can be kept approximately 700 m.
4. There will be two boards one indicating starting of APSS zone and other for indicating ending of APSS zone. APSS START will be provided before 50 m from IOL1 and APSS END will be at a distance of 50 m after IOL3.
5. Malfunctioning of APSS System:
In case of malfunction of APSS control system,
 - a. The Numerical Control Logic Relay gets by-passed.
 - b. All CBs (CB1, CB2 & CB3) status become open.
 - c. There will two flasher lights, provided on OHE in APSS Zone which gets activated to warn the loco pilot. The first & Second flasher light shall be provided at 500 m & 250 m before IOL1 of APSS respectively.
 - d. One warning board for lowering the pantograph before the first IOL of APSS is provided. Warning board for lowering pantograph shall be provided at approximately 100 m before IOL1 of APSS.
 - e. On observing flasher light flashing, the Loco Pilot will lower all the pantographs before pantographs lowering board and coast the train through the APSS. If the train stalls between the IOL1 and IOL3 of APSS zone, the loco pilots will contact TLC/TPC and will follow their instruction to clear the APSS zone.
 - f. If train passes through the APSS zone during coasting after lowering of pantographs, then, after observing the Pantograph Raise warning board which shall be provided at a distance of 50 m after IOL3, the loco pilot will raise the front pantograph.
 - g. Loco pilots training/counseling shall be done for the above.

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