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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS



कर्षण संस्थापन निदेशालय

TRCATION INSTALLATION DIRECTORATE

TECHNICAL SPECIFICATION

PANTO FLASHOVER PROTECTION RELAY FOR 25 KV AC SINGLE PHASE 50 HZ
TRACTION

SPECIFICATION NO: TI/SPC/PSI/PROTCT/2984

ISSUED BY

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SPECIFICATION FOR Panto Flashover Protection Relay for single Phase 25 kv AC Traction System

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1.0 NEED FOR THE RELAY

1.1 Whenever there is a tripping of circuit breaker due to intermittent fault on one of the sides of the FP IOL and a electric train enters from live to dead section of the FP IOL, there shall be a heavy flash over when the panto leaves the IOL. Depending upon the intensity of current being drawn by the panto at that point of time, the extent of damage would be cutting of a few strands of catenary or parting of the OHE.

1.2 The various types of faults which can cause a CB tripping are as follows :

- a) A permanent fault, and the CB is unable to hold.
- b) A transient fault which may not reappear on the reclosure of the Circuit B reaker.
- c) An intermittent fault which may go on reappearing within short intervals (like a tree swinging and touching the OHE)

1.3 If there is a permanent fault on one side of the TSS resulting in tripping and pantograph bridges the IOL from the live end, the second feeder CB shall also trip under the normal fault conditions. In such an event there shall be no possibility of any damage to OHE due to flashover.

1.4 In case of transient faults, the quick reclosure of CB should obviate the problem but if the reclosure is delayed, the possibility of flashover will continue to exist.

1.5 The situation is worse in case of intermittent faults since in case of CB tripping a second time the TPC will go in for a fault isolation which will require sometime. If in the intervening period, a train enters the insulated overlap, when there was no fault on the other side of the OHE, heavy flashover will take place which could cause extensive damage to IOL.

1.6 The above problem can be taken care of, if both the CB's are tripped simultaneously. A logic for various such conditions in which tripping of both CB's of the FP IOL required can be generated by a microprocessor based logic/suitable static relay scheme and whenever such trippings are required the same could be identified.

2.0 PRINCIPLE OF OPERATION:

2.1 Refer figure at Annexure 7, the single line diagram of a typical traction substation. One side of the insulated overlap, say A or B can become dead while the other section say B or A is live, under any of the following conditions.


- a) Manual tripping of any of the feeder breakers.
- b) Feeder breaker tripped on fault and the dead time of auto reclose relay is in progress i.e. the feeder breaker is awaiting reclose command from the auto reclose relay.
- c) Feeder breaker receives trip command immediately after a reclosure due to an intermittent fault, and the autoreclose scheme goes to "lock out", without releasing further reclose commands, until the autoreclose relay is reset manually.

All the above conditions can take place either during normal feed condition or during feed extension from nearby substation. An indication type Potential Transformer, PT-1 to PT-4, 25 kV / 100 V, on either side of the overlap indicate OHE healthiness status continuously. The relay is made to continuously monitor the status of

- a) All the 4 PT's
- b) Feeder breakers FCB1 and FCB2
- c) Bus coupler interrupter BMC-1
- d) Line interrupters BM-1, BM-2, BM-3, BM-4.
- e) Feed, i.e. normal/extended.

22 Normal Feed Conditions

Referring to Annexure 7, during normal feed conditions for up and down lines of A & B sides of the overlap, the status of circuit breakers and interrupters shall be as follows:-

TTr1  Either of the Transformer or both the transformers
TTr2 may be ON.

BCI1, FCB1, FCB2 and BM1 TO BM4 Normally closed

BMC1 Normally open

Under the above normal feed conditions, the possible feed paths for “UP” and “DN” catenary wires from the TSS shall be as follows:

- | | | |
|---------|-------|---------|
| a) FCB1 | - BM1 | - DN(A) |
| b) FCB1 | - BM2 | - UP(A) |
| c) FCB2 | - BM3 | - DN(B) |
| d) FCB2 | - BM4 | - UP(B) |

In case any side of the overlap is dead, due to any of the feeder breakers being tripped, the PT output at that side gets dipped considerably. If PT delivers a normal output on dead line, which can only be due to bridging of the live line by the panto, the relays should sense this as an abnormal condition and release trip command to the feeder breaker, parallelly disabling auto reclose scheme, to prevent auto reclosing of this dead line.

23 Extended feed condition

Under extended feed condition i.e. in case the feed is extended to the failed TSS, the relay shall be disabled. This shall be recognised by the relay from the status of feeder interrupters BM1 to BM4, and coupling interruptor BMC1. Necessary potential free auxiliary contacts of feeder breakers and these interrupters will be made available to the relay for this purpose. A separate contact shall be provided in the relay to enable getting indication at RCC that the relay is disabled. Also an indication for “Relay disabled” shall be provided on the relay front panel. Warning to this effect shall be provided on relay.

3.0 SCOPE

3.1 This specification applies to design, manufacture and supply of panto flashover relay for the protection of OHE of 25 kV ac traction substation against the flashover due to panto bridging on the insulated overlaps as explained in **Clause 1.0**.

3.2 The relay shall be provided at TSS IOL where the length of the overlap of the IOL of the OHE is not less than 8m. (However 10m is preferable)

3.3 The relay shall be provided at 2 feeder CB sections as in Annexure 7.

3.4 The relay so developed is meant for regular use in field. Any deviations from the specifications proposed by the tenderer at the tender/prototype stage, to improve the performance, utility or efficiency of the equipment shall be considered on merits provided full details of the deviation & justification for the same are furnished by the tenderer to the satisfaction of the purchaser. This specification supersedes specification No. **TI/SPC/PSI/PROTCT/2983**

3.5 In 31st MSG, it was decided to provide testing jack facility in the Control & Relay Panel. It is to be developed in a such way that when testing kit is connected to the

testing jack, relay connections will get disconnected from main circuit automatically and connected to testing circuit. After testing and removal of testing kit from jack, relays will get reconnected to main circuit automatically.

3.6 The “Make in India” Policy of Government of India shall be applicable.

4.0 TRACTION POWER SUPPLY SYSTEM

4.1 General scheme of traction power supply system.

4.1.1 Power is received from the grid network of the state electricity board at 220kV/132kV/110kV/66 kV at individual traction substation (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 nominated phases of the incoming three phase lines or to the two incoming phase lines and on the secondary side, either of the two terminals of the 25 kV winding is connected to the traction overhead equipment, while the other is solidly earthed and connected to the running traction rails.

4.1.2 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.

4.1.3 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. 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 at Annexure-5 shows the general scheme for traction power supply system.

4.1.4 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.

4.1.5 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.

4.2 Nature of traction load and faults on the system.

4.2.1 The traction load is a frequently and rapidly varying one between no load and overload. The TSS equipment is subject to a number of earth faults/short circuits. On an average the number of faults/short circuits per month is about 40 but in exceptional cases the number could be as high as 120.

4.2.2 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. The rectifiers introduce harmonic currents in the 25 kV Power supply. On few locomotives there are controlled asymmetrical thyristor bridge and GTO Pulse width modulation devices, in place of silicon rectifiers. Typical percentages of harmonics present in the traction current with electric rolling stock are as follows:

TABLE -2: Harmonic Generated by IR Locomotives

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

4.2.3 The average power factor of the electric locomotive and electric multiple units generally varies between 0.7 and 0.8 lagging, without compensation.

4.3 Short circuit apparent power of the system

4.3.1 The short-circuit apparent power for various system voltages is as under:-

4.3.2 Table No. 3: Short Circuit Level

Highest system voltage kV	Short circuit apparent power MVA
52	200
72.5	3500
123	6000
145	10000
245	20000

4.4 Power supplies at traction substation

4.4.1 The following power supplies are available at a traction substation.

- i.) 110 V dc from a battery.
- ii) 240Vac,50Hz, single phase from a 25/0.24 kV auxiliary transformer.

4.5 Booster Transformers

4.5.1 In order to reduce inductive interference in adjacent telecommunication circuits booster transformers on certain sections of electrified track are installed in series with the 25 kV traction overhead equipment. The primary winding of the booster transformer is connected to the 25 kV overhead equipment and the secondary winding is in series with the return conductor (RC) which is strung close to the 25 kV overhead equipment. Booster transformer with a rating of 150 or 100 kVA provide necessary voltage to force the traction return current from the rail and earth to flow through the return conductor. The Booster transformers have a leakage impedance of about 0.15 Ohm each and are spaced about 2.66 km apart.

4.6 Protective relays at the traction sub-stations

4.6.1 For protection of transformer, substation equipment's, shunt capacitor bank feeders, the following relays are provided on control panels housed in the masonry cubicle at the traction substation (TSS).

4.6.1.1 Transformer Protection

- i) Differential relay
- ii) IDMT over-current relays for the primary (HV) as well as for the secondary (LV) side. The

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IDMT relay on the HV side is also provided with an instantaneous over-current element.

- iii) Instantaneous earth leakage relays on the primary (HV) side as well as on the secondary (LV) side.
- iv) High speed inter-tripping relay.
- v) Auxiliary relays for transformer faults i.e. Bucholz, excessive winding and oil temperature trip and alarm and low oil level alarm.

4.6.1.2 Over head equipment protection.

- i.) **Polygonal type** directional distance protection relay.
- ii) **Protection against wrong phase coupling.**
- iii) Instantaneous over-current relay.

4.6.1.3 Shunt Capacitor Bank Protection.

- i.) IDMT over-current protection relay with suitable settings.
- ii) Over voltage protection relay.
- iii) Under voltage protection relay with timer to enable the capacitors to discharge before re-closure.
- iv) Current unbalance protection.
- v) Internal fuse for each capacitor element.

4.7 For the purpose of calculation, the values of loop impedance with earth return for the OHE are taken as under:

TABLE 4 OHE Line Impedance

1.	One OHE without BT and RC	0.41 $\angle 70^\circ$ Ohms/km
2.	Two OHEs without BT and RC	0.24 $\angle 70^\circ$ Ohms/km
3.	One OHE with BT and RC	0.70 $\angle 70^\circ$ Ohms/km
4.	Two OHEs with BT and RC	0.43 $\angle 70^\circ$ Ohms/km

4.9 Traction Power Transformer

The percentage impedance of a 21.6 MVA, 220 or 132 or 110 or 66/27 kV single phase transformer is 12%. The traction transformers are designed to carry short time overloads as the traction loads may exceed 21.6 MVA for short periods. The impedance angle for the loads at the traction substation is nearly 37°

4.10 Nature of faults on the over head equipment (OHE) system.

4.10.1 OHE is subjected to frequent earth faults caused by failure of insulation, or by the OHE snapping and touching the rail or earth, or by a piece of wire dropped by birds connecting the OHE to earthed overlying structures, miscreant activities etc. These faults are cleared by the feeder circuit-breaker which operates on any one or more of the following relays :

- i) Distance protection relay.
- ii) Instantaneous over-current relay.

5.0 SERVICE CONDITIONS

5.1 The relays are intended for use in moist tropical climate with the following atmospheric conditions :

TABLE 5: Service Conditions

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1.	Max. temperature of air	70 ° C
2.	Min. temperature of air	-25° C
3.	Max. temperature attainable by an object exposed to Sun	70° C
4.	Max. relative humidity	100%
5.	Max. wind pressure	200 kgf/sq.m.
6.	Altitude	< 2000 m
7.	Average annual rain fall.	1750 to 6250 mm.
8.	Number of thunderstorm days per annum.	85 days.
9.	No. of rainy days per annum	120 days (Max.)
10.	Average No. of dust storm days	35 days per annum.
11.	Vibrations	Max: 350 micron Average : 30 - 150 micron time duration : rapidly varying time duration 15 - 70 ms.

5.2 The relays shall be installed in the control and relay panel at the traction substations which are normally unattended. The panels are situated close to the Railway tracks and hence the Panels are subjected to vibrations due to running trains.

5.3 Auto-re-closing of feeder circuit breakers.

A single shot high speed auto-re-closing scheme for 25 kV feeder circuit breaker (s) at AC traction sub-station has been adopted to facilitate re-closing of the 25 kV feeder breaker automatically once after a pre-set time delay after tripping of the circuit breaker on OHE fault. This feature will help in quick restoration of traction power supply to OHE if the fault is of a transient nature and thus protecting the OHE, catenary in particular, from consequent damages.

6.0 DESIGN FEATURES

6.1 The normal zone of feed from a substation to SP varies between 20 and 30 km. Under emergency feed conditions, however, the zone would extend upto the next substation or double the zone of normal feed. Under both the conditions the relay should be able to identify a situation where one side of the IOL situated at FP, being live with the other dead and the pantograph passes through. The relay under such conditions should originate a trip command to the feeder breaker connected to the live part of the IOL thereby eliminating the possibility of the flash over. The FPs feeding either sides of the IOL are equipped with 25KV /100V indication type potential transformers for OHE healthiness in the control and relay panel.

6.2 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. The enclosure class of module/relays shall be IP 54 as per IEC 60529. The measuring technique adopted should be based on digital numeric processing techniques. The analogue input received from PTs shall be transformed into a digital signal by using suitable A/D converter. The digital signal so obtained may be processed (with suitable signal analysis) to extract the various harmonic contents.

6.3 The numerical relays shall have in-built contact multiplication relays for alarm and trip conditions of CB. It shall be ensured that at least two (02) numbers of auxiliary contacts for indication/annunciation and tele-signaling functions are available.

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6.4 The relays shall conform to the test voltage Class -III as per IS: 8686–1977/IS 3231 or latest and product safety requirements as per IEC:60255-27.

6.5 The relay 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.

6.6 The proposed scheme would be disabled in case of extended feed conditions either from adjacent TSS or by closing interruptor BMC1. **For this purpose, suitable digital status inputs shall be configured in the panto flashover relay.**

6.7 The relay shall get disabled for a short duration of **set time** in order to cover the difference of time taken between the closing of main contact and auxiliary contact of the feeder CB of the TSS.

6.8 In order to bypass the relay i.e. disabling the relay, a set of tele command terminals on the relay shall be provided so that the same could be disabled from the RCC.

6.9 The relay shall be complete with all parts and accessories for their efficient operation. Use of auxiliary relays external to the relay shall be avoided wherever possible. All such parts and accessories shall be deemed to be within the scope of this specification whether specifically mentioned or not.

6.10 The numerical protection relays should have facility to record actual waveform of voltage along with all digital and logical status during fault condition. At a time up to 200 such waveforms. for voltage shall be storable and shall be retrievable through USB communication port /or any other superior type of standard communication port through a Laptop computer. The duration of each disturbance record for voltage shall be at least 50 cycles (45 prior to and 5 after trip executed by relay). The disturbance recorder shall be triggered, on every trip operation of relay.

6.11 Suitable software shall be supplied along with the numerical relays to download and interpret the fault waveform and other data stored in the relays. The software shall be capable of analyzing the peak, RMS, and average values of currents and voltage, dc component of currents, harmonic analysis of fault current waveforms. The accuracy of measurements shall be 1ms. for time, 0.1 KV for voltages and 0.1 KA for currents. The software shall also be capable of communicating with the relay and viewing and modifying the settings.

6.12 The numerical relays shall provide date and time stamping up to 1ms. level for each fault. Relay shall have facility for clock synchronization through SCADA.

6.13 The numerical relays shall be capable of storing minimum 5000 events serially with date and time stamp of 1ms. accuracy. The events definitions shall be configurable and generally include tripping of different protection elements, relay pickup, relay reset, relay blocked due to harmonics or any other restraints, CB trip, CB close, changed of status input, relay setting changed, trip circuit monitoring etc. The events shall be retrievable through an external laptop/PC.

6.14 Operation counters shall be provided for each protection function with resetting facility.

6.15 The numerical relays shall have compact form and every effort shall be made to minimize the hardwiring within the relays and maximum components shall be on the PCBs. Effort shall be made to implement SMT (Surface Mount Technology) PCBs wherever possible. Suitable conformal coating to be provided on the PCBs.

6.16 The design shall be fail-safe and while designing the numerical relays, adequate redundancy shall be provided in various functional elements.

6.17 The numerical protection relays shall have self-diagnostic features. Suitable displays for confirming the module healthiness or defects shall be available.

6.18 Numerical relays shall have high contrast backlit LCD display of size at least 20x4 LCD characters for display of relay status, settings, on line parameter current, voltage, resistance & reactance) etc. Bright LEDs shall be used for display of power ON conditions and trip/alarm indications of each relay element. The parameters of the module shall be settable through a membrane keypad.

6.19 Provision shall be available to reset the indicating LEDs of protection module from relay and from RCC through SCADA. For this purpose, suitable switch and NO/NC contact shall be provided in the module.

6.20 The relay settings and stored data shall not get corrupted/erased/changed in the event of auxiliary / control supply voltage i.e. 110 V DC failure.

6.21 SCADA system is available for Railway traction application. For its full utilization in controlling/ monitoring of protection system, numerical relays shall be capable of communicating with the RTU or other IED's based on standard IEC 60870-5-103 protocol for transfer of information stored in relays to the RTU. The relay shall have necessary hardware and firmware interface for this purpose.

6.22 Suitable password protection shall be provided on the relays to avoid unauthorized changes in the relay settings.

6.23 The module shall also be capable to display V (voltage), fault clearing time and fault date & time (wherever applicable) of latest 200 faults at relay LCD, if it is not possible to display these parameters simultaneously on LCD display, then these parameters may accommodate in two window and displaying by pressing scroll Key . The PTs provided at TSS may have different ratios, hence to display the actual value (line value) of Voltage, the PT primary voltage shall be settable in the range of 20000V to 30000V in steps of 500V. On line current, voltage, Reactance & Resistance shall also be displayed on relay LCD.

6.24 Suitable NO contact of each protection function shall also be available on the relay to block auto reclosure function of feeder protection relay through status input, the auto reclosure function already provided in other protection module.

6.25 The proposed scheme to eliminate the flashover during the panto bridging at IOL is indicated at Annexure-6. The relay shall be suitable for operation from the 25 kV potential transformers of the following particulars:

TABLE 6 PT Ratio

1.	Rated system voltage (phase to ground)	25 kV raising upto 30 kv and going down to 19 kV
2.	Rated transformation ratio	25000/100 V
3.	Rated burden	30 VA
4.	Class of accuracy	5 P class as per IS:2705(Pt.III) 1981

7.0 RATING AND OTHER PARAMETERS.

1.	Control Voltage	DC 110 \pm 22 V
2.	Power consumption	10 W De-energized 15 Watts Energized

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3.	Relay operating time	30±10ms Additional trip time delay setting also to be incorporated for each feeder breakers
4.	Rated VA burden of PT	0.5 VA, or less
5.	Overload Capacity of PT	1.2 times the rated voltage is supposed to the relay for 3 hours.
6.	Insulation Resistance	10 mega ohms or more between the electric circuits and the external case.
7.	Operating temperature range	-25 ⁰ C to +70 ⁰ C
8.	Dielectric Withstand	2kv, 50 Hz for 1 min between circuit to earth/circuit to circuit (IEC 60255-27, IS: 3231)
9.	Impulse voltage test	5 kV, 1.2/50 micro seconds (IS:8686/ IS:3231/IEC 60255-27)
10.	High frequency disturbance	IEC 60255-27, IS: 3231 Part-I section-III Longitudinal mode 2.5kV, 1 MHz across auxiliary dc and current/voltage sensing terminals an earth. Transverse mode 1 kV, 1 MHz across auxiliary dc and current/voltage sensing terminals.
11.	Contact data	
11.1	Test Voltage across open contact	1 kV DC for 1 min
11.2	Current carrying capacity	5 A continuously at 110 V DC/ 230 V AC
11.2.1	Make & carry for 3 seconds	30 A at 250 ac, 50 Hz for 3 seconds
11.3	Making : 250 V, 50-60 Hz	5 A
11.4	Breaking : 250V, 50-60 Hz CosØ 0.4 220 V, L/R = 45 ms	5A 0.5 A

8.0 TESTS

8.1 General

8.1.1 Only after all the design and drawings have been approved and clearance given by Research Design and Standards Organization (RDSO)/Chief Electrical Engineer(CEE) to this effect, the manufacturer shall take up manufacture of the prototype unit for RDSO inspection. It is to be clearly understood that any changes required to be done in the prototype unit shall be done expeditiously.

8.1.2 Before giving the call to RDSO/CEE for inspection and testing of the prototype of the equipment, 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 the test and the total number of the days required to complete the tests at one stretch.

8.1.3 Once schedule is approved, the tests shall be done accordingly. However, during the process of type testing or even later, RDSO representative reserves the right to conduct any

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additional test(s) besides those specified therein, on any equipment/sub- system or system so as to test the equipment to his satisfaction or for gaining additional information and knowledge. In case of dispute or any disagreement arises between the manufacturer and RDSO/CEE during the process of testing as regards the type test results, it shall be brought to the notice of the Director General (Traction Installation), RDSO/ CEE as the case may be, whose decision shall be final and binding.

8.1.4 In the event of the tests not being carried through to completion at one stretch for any reason attributable to the successful tenderer/ manufacturer and it is required for the representative of the purchaser/ Director General (Traction Installation), Research Designs And Standards Organization, Lucknow, to go again or more number of times to the works of the successful tenderer/ manufacturer or other place(s) for continuing and/or completing the test on the prototype(s) of the equipment, the successful tenderer/ manufacturer shall reimburse to the purchaser/ Director General (Traction Installation), Research Designs & Standards Organization, Lucknow. The cost of the representative having to visit the works or other place(s) for the test more than once. The cost as claimed by the purchaser/ Director General (Traction Installations), Research Designs & Standards Organization, Lucknow shall be paid through demand draft to the concerned accounts officer of the Purchaser/Director General (Traction Installation), Research Designs and Standards Organization, Lucknow, shall be advised to the successful tenderer manufacturer.

8.1.5 All type routine tests relevant to Panto flashover protection relays shall be conducted as per the latest version of IEC 60255-151, IEC 60255-27, IEC 60255-1, IS-3231 and IS: 8686 and as modified or amplified as under:

8.2 Type & Routine Tests

8.2.1 Type Tests

The protection relays 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 as per clause 8.3 including verification of all relay 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.
- 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.
- xi. Vibration test- as per IEC 60255-21-1, Clause-I- Frequency 10-150Hz,
- xii. Endurance test-Mechanical endurance test for 10000 operations.
- xiii. Environmental test
 - a. Dry heat test as per IEC 60255-1/IEC60068-2-2 (This will test from +20°C to +70°C)
 - b. Cold test as per IEC60255-1/IEC60068-2-1 (This will test from -25°C to 250°C)

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- c. Change in temperature as per IEC60255-1/IEC60068-2-14 (this will test from -25 to +55 OC)
- d. Damp heat test, steady state as per IEC 60068-2-78
- e. Damp heat test, cyclic as per IEC 60068-2-30
- xiv. EM Compatibility tests
 - a. 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 6kV, Air Discharge 8kV.
 - c. Radiated, radio-frequency, electromagnetic field immunity test as per IEC60255-26 & IEC61000-4-3 Frequency Range: 80MHz – 1000MHz, Modulation: 80% AM @1kHz, Field Strength 10V/m.
 - d. Electrical fast Transient or burst requirements as per IEC60255-26 & IEC61000-4-4.
 - e. Surge immunity as per IEC60255-26 & IEC61000-4-5.
 - f. Immunity to Conducted disturbances induces by radio frequency field as per IEC60255-26& IEC61000-4-6.
 - g. Power Frequency Immunity Test as per IEC60255-26& IEC61000-4-16.
 - h. A.C. ripples in D.C. auxiliary as per IEC60255-26 & IEC61000-4-17.

8.2.2 Type tests for which facilities of testing are not available with the relay manufacturer shall be carried out at any reputed & NABL accredited govt/ semi govt. approved laboratories and test reports of the same shall be furnished to the RDSO only after approval of the results of the tests on the prototype is communicated by

8.2.3 RDSO/Purchaser to the manufacturer, shall he take up bulk manufacture and future supplies of the relays 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.

8.2.4 Routine tests

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

- i. Visual Checks
- ii. Insulation Resistance
- iii. Dielectric strength
- iv. Setting range and Functional tests

8.3 LOGIC TESTS

The relay shall be tested for its operation under the following conditions of tripping: **CONDITION OF TRIPPINGS (LOGIC CHART)**

S.N	FCB 1	FCB 2	BM 1	BM 2	BM 3	BM 4	BMC 1	PT 1	PT 2	PT 3	PT 4	RELAY STATUS	FEED CONDITION
1	1	0	0	1	0	1	0	1	*	1	*	TRIPPED	NORMAL
2	1	0	0	1	1	0	0	1	*	1	*	TRIPPED	NORMAL
3	1	0	0	1	1	1	0	1	*	1	*	TRIPPED	NORMAL

4	1	0	1	0	0	1	0	1	*	1	*	TRIPPED	NORMAL
5	1	0	1	0	1	0	0	1	*	1	*	TRIPPED	NORMAL
6	1	0	1	0	1	1	0	1	*	1	*	TRIPPED	NORMAL
7	1	0	1	1	0	1	0	1	*	1	*	TRIPPED	NORMAL
8	1	0	1	1	1	0	0	1	*	1	*	TRIPPED	NORMAL
9	1	0	1	1	1	1	0	1	*	1	*	TRIPPED	NORMAL
10	1	0	0	1	0	1	0	*	1	*	1	TRIPPED	NORMAL
11	1	0	0	1	1	0	0	*	1	*	1	TRIPPED	NORMAL
12	1	0	0	1	1	1	0	*	1	*	1	TRIPPED	NORMAL
13	1	0	1	0	0	1	0	*	1	*	1	TRIPPED	NORMAL
14	1	0	1	0	1	0	0	*	1	*	1	TRIPPED	NORMAL
15	1	0	1	0	1	1	0	*	1	*	1	TRIPPED	NORMAL
16	1	0	1	1	0	1	0	*	1	*	1	TRIPPED	NORMAL
17	1	0	1	1	1	0	0	*	1	*	1	TRIPPED	NORMAL
18	1	0	1	1	1	1	0	*	1	*	1	TRIPPED	NORMAL
19	0	1	0	1	0	1	0	1	*	1	*	TRIPPED	NORMAL
20	0	1	0	1	1	0	0	1	*	1	*	TRIPPED	NORMAL
21	0	1	0	1	1	1	0	1	*	1	*	TRIPPED	NORMAL
22	0	1	1	0	0	1	0	1	*	1	*	TRIPPED	NORMAL
23	0	1	1	0	1	0	0	1	*	1	*	TRIPPED	NORMAL
24	0	1	1	0	1	1	0	1	*	1	*	TRIPPED	NORMAL
25	0	1	1	1	0	1	0	1	*	1	*	TRIPPED	NORMAL
26	0	1	1	1	1	0	0	1	*	1	*	TRIPPED	NORMAL
27	0	1	1	1	1	1	0	1	*	1	*	TRIPPED	NORMAL
28	0	1	0	1	0	1	0	*	1	*	1	TRIPPED	NORMAL
29	0	1	0	1	1	0	0	*	1	*	1	TRIPPED	NORMAL
30	0	1	0	1	1	1	0	*	1	*	1	TRIPPED	NORMAL
31	0	1	1	0	0	1	0	*	1	*	1	TRIPPED	NORMAL
32	0	1	1	0	1	0	0	*	1	*	1	TRIPPED	NORMAL
33	0	1	1	0	1	1	0	*	1	*	1	TRIPPED	NORMAL
34	0	1	1	1	0	1	0	*	1	*	1	TRIPPED	NORMAL
35	0	1	1	1	1	0	0	*	1	*	1	TRIPPED	NORMAL
36	0	1	1	1	1	1	0	*	1	*	1	TRIPPED	NORMAL
37	*	*	0	0	*	*	*	*	*	*	*	DISABLE D	EXTENDE D
38	*	*	*	*	0	0	*	*	*	*	*	DISABLE D	EXTENDE D
39	*	*	*	*	*	*	1	*	*	*	*	DISABLE D	EXTENDE D

1- Denotes Breaker or Interrupter closed / PT delivers output / Feed normal 0 - Denotes Breaker

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or Interrupter tripped / Feed extended.

* - Denotes 1 or 0 status need not be cared or considered.

EXTENDED FEED CONDITION

Under extended feed condition (refer clause 2.3) the relay should be disabled

9.0 RATING PLATE

9.1 The rating plate shall contain the following information:

- 9.1.1 Name and Type
- 9.1.2 Rated voltage.
- 9.1.3 Rated frequency.
- 9.1.4 Rated control voltage
- 9.1.5 Year and month of manufacture
- 9.1.6 Manufacture number
- 9.1.7 Name or abbreviation of manufacturer.

10.0 ERECTION AND COMMISSIONING TESTS

10.1 The erection and commissioning of relay shall be done by the successful tenderer who shall arrange all tools , plants , instruments and other material required for the purpose at his own cost. Tests shall be carried out during erection/commissioning of the relay 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 in the presence of the purchaser's representatives to check the erection and commissioning of the relay.

10.2 Three sets of the test report shall be supplied by the manufacturer to the purchaser for records and reference.

11.0 TECHNICAL DATA AND DRAWINGS

11.1 The tenderer shall furnish guaranteed performance data, technical and other particulars for the equipment offered in the proforma attached as Annexure-4.

11.2 The tenderer shall furnish their compliance or otherwise against each clause/sub- clause of the technical specification. If the tenderer wishes to deviate from the provision of any clause/sub -clause, he shall furnish the full details with justification for such deviation.

11.3 The tenderer shall also furnish descriptive pamphlets and specimen calculations for the recommended relay setting. The range of setting available, calibrated in terms of single track OHE, shall be clearly stated and adjustments available for intermediate setting explained.

11.4 Successful tenderer shall be required to submit detailed outline dimensioned drawings and cut out drawings for the equipment offered as specified by tenderer in schedule of guaranteed performance (Annexure 4)as per railways standard in sizes of 210 mm x 297 mm or any integral multiple thereof.

12.0 OPERATION , MAINTENANCE INSTRUCTIONS & TRAINING

12.1 The relay shall be a maintenance free relay generally not needing any maintenance, however the tenderer shall mention a maintenance schedule which shall be detailed enough to

guarantee failure free service of the relay to the tenderer. The supplier shall supply free of cost 2 copies to the consignee of the Instruction Manuals for operation and maintenance of the equipment. The manuals shall contain full particulars of various components, full dimensioned drawings and circuit diagrams.

12.2 During the course of the development of the relay i.e. till such time the relays field trials have not proven successful the relay specification remains a prototype specification. The tenderer shall train free of cost 2 of the associated engineers/supervisors for 7 days in the maintenance, operation, relay setting procedure, trouble shooting and commissioning of the relay. This training shall be 3 days at manufacturer works and four days at the relay installation site.

12.3 The tenderer shall quote separately for maintenance tool, kits and test instruments if any required for satisfactory operation of the relay . The tenderer shall quote for spares require for the relay for 5 years of trouble free operation beyond the warranty period. The purchaser reserves the right to buy the kit from the tenderer or not.

12.4 The Successful tenderer shall develop a maintenance schedule and a trouble shooting chart for effective, reliable and trouble-free relay operation. The basic maintenance schedule along with the troubleshooting, diagnostic chart shall be submitted to RDSO and approved by RDSO prior to commissioning of the relay for the first time at the sight.

13.0 WARRANTY

13.1 The relay supplied against a purchase order/contract in which this specification is quoted, irrespective of origin individual equipment (imported / indigenous) shall be guaranteed for trouble - free and satisfactory performance for a period of 18 months from the date of supply or 12 months from the date of commissioning, whichever period is earlier, details of warranty clause, the extent of responsibility and other relevant aspects shall be included in the purchase order or the contract. The tenderer shall furnish detailed terms and conditions in this regard in his offer.

13.2 The successful tenderer shall make necessary arrangement for closely monitoring the performance of the relay through periodical (preferably once in four months during the warranty period) visits to the relay installation TSS for on the spot detailed observations. Arrangements shall be also be made for spare parts modules and other items to be kept readily available with the manufacturer/ supplier / successful tenderer to meet exigencies warranting replacement so as to put back the relay in service without unduly affecting the operations of the TSS.

ANNEXURE 1

LIST OF ABBREVIATIONS

Abbreviation	Full Form of the Abbreviation
A	Amperes
BT	Booster Transformer
GTO	Gate Turn Off Thyristors
IDMT	Inverse Definite Minimum Time lag
IOL	Insulated Overlap
LCD	Liquid crystal Display
LED	Light emitting diode
MSG	Maintenance Study Group.
MTBF	Mean Time Between Failure
NC	Normally closed.
NO	Normally open
OHE	Over Head Equipment
RC	Return Conductors.
SP	Sectioning Post
SR	Self Reset
SSP	Sub Sectioning Post
TrD	Traction Distribution
TRS	Traction Rolling stock
TSS	Traction Sub Stations

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ANNEXURE 2

DEFINITIONS & EXPLANATIONS

Item	Definition
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.
Purchaser	The person / agency who has floated the tender for execution of the work on or behalf of the president of India.
Relay	Panto flashover protection relay.
Operation time	Period of time from a fault occurs till the output- contact of the relay closes.
Making capacity	The maximum current and volt -amperes the contact is able to make successfully under specified conditions without significant damage to the contact.
Breaking capacity	The maximum current and volt - amperes that the contact is able to interrupt successfully under specified conditions without significant damage to contact.
Normally open contact (NO)	A contact which is open when the relay is de-energised.
Normally closed contact (NC)	A contact which is closed when the relay is de-energised.
Contract	Means the contract resulting from the acceptance by the purchaser of the tender either in whole or part
Equipment	Means all or any equipment considered necessary by the purchaser engineers for the satisfactory operation as a whole of the installation including structure, foundations etc.
Railway	Means Railway(s) in whose territorial jurisdiction the work is to be carried out and includes the Government of India, Ministry of Railways (Railway Board), and /or general manager of the railways concerned

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ANNEXURE 3

GOVERNING SPECIFICATIONS

The Panto flashover relays and components thereof shall, unless otherwise specified shall conform to generally to the latest edition of Specifications mentioned below:

<u>IEC 60255-151:2009</u>	Single input energising quantity measuring relays with dependent or independent time.
IEC 60255-27:2007	Insulation tests for electrical relays
IEC 60255 -1:2009	Measuring relays and protection equipment.
IS-2705 (Pt.III)	Protective current transformers
IS 3231	Electrical relays for power system protection
IS 8686	Static protective relays
RDSO spec No. TI/SPC/PROTCT/6071	Control and relay panel for 25 kV ac traction system.

The above specifications shall be applied in a manner altered, amended or supplemented by this specification and the latest Indian Electricity Rules wherever applicable.

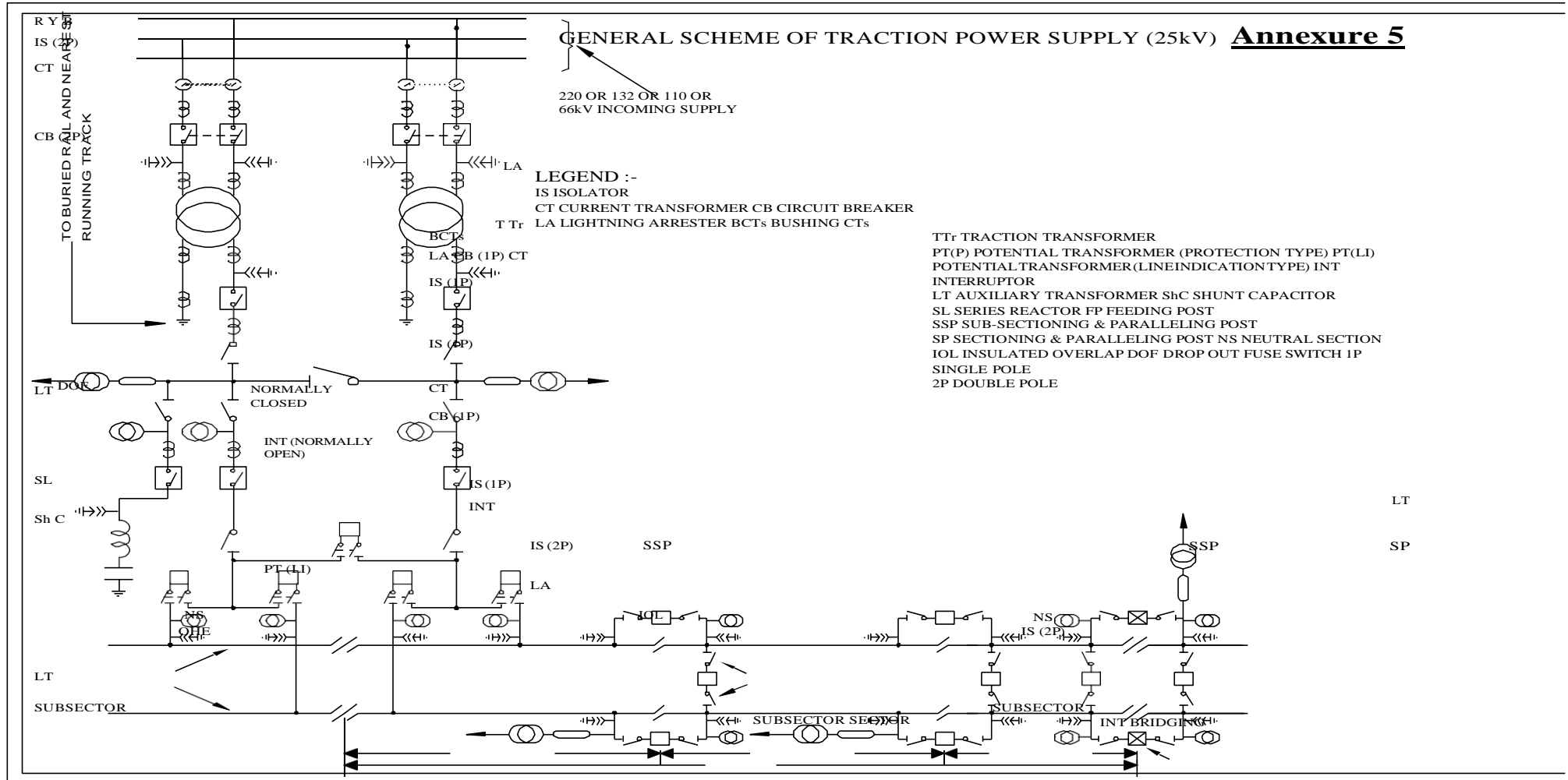
Any deviations from the specifications proposed by the tenderer at the tender/prototype stage, to improve the performance, utility or efficiency of the equipment shall be given due considered provided full details of the deviation are furnished by the tenderer to the satisfaction of the purchaser. In such cases the tenderer shall quote according to the specification as well as with the deviations from the specifications.

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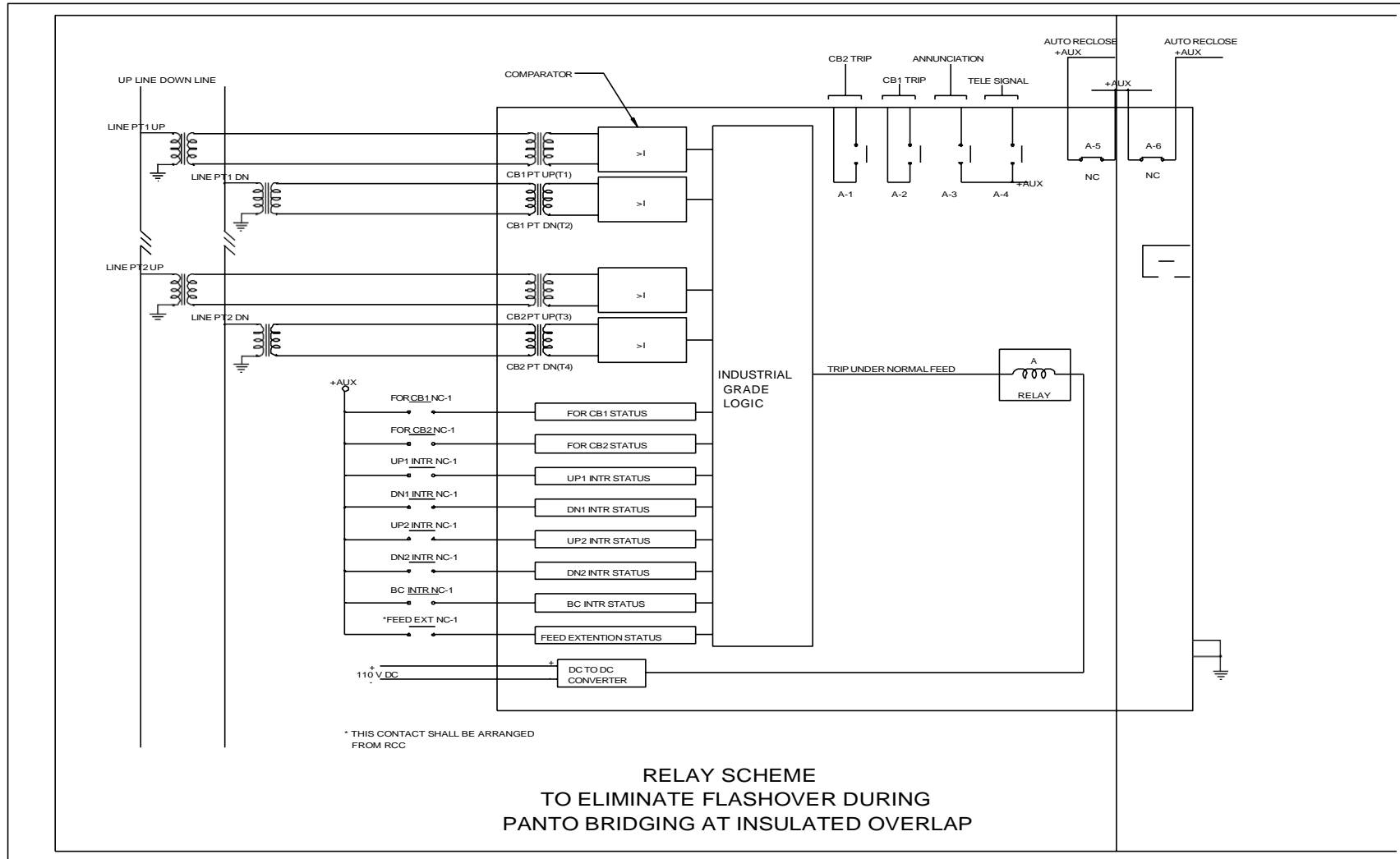
ANNEXURE 4

SCHEDULE OF GURANTEED PERFORMANCE

S. No.	Description	Manufacturer details	Unit of measurement
1	Name of the manufacturer		
2	Country of origin		
3	Standard governing specification		
4	Manufacturer's type designation		
5	Rated voltage		Volts(ac)
6	Rated frequency		Hz
7	Permissible variation in frequency		%
8	Rated control voltage		Volt DC
9	Permissible variation in control voltage		%
10	Operation time		
11	Rated VA burden		VA
12	Power consumption of control circuit		Watts
13	Temperature rise at rated voltage		°C
14	Impulse and power frequency withstand voltage values		kVp & kVrms
15	Resetting time		milli Sec
16	Rated current carrying capacity of contacts		Amps
17	Rated breaking capacity of contact		Amps
18	Rated making capacity of contact		Amps
19	Number of spare NO and NC contacts		
20	Is the relay draw out ? type	Yes/No	
21	Are test terminals /test switches provided ?	Yes/No.	
22	Dimensions:		
22.1	Length		Mm
22.2	Width		Mm
22.3	Breadth		Mm
23	Weight of the relay		Grams
24	Rated Vibration withstand		Microns

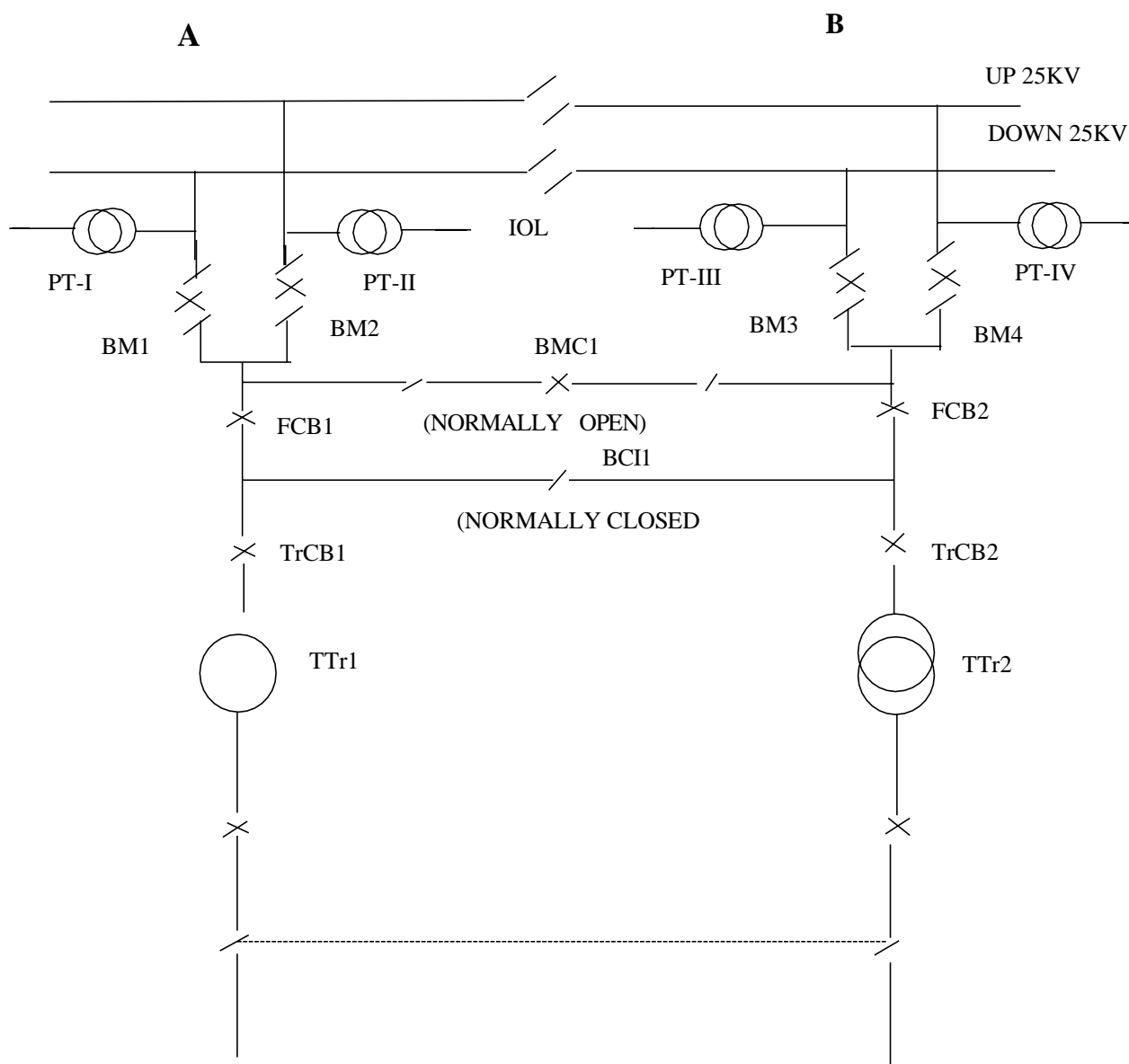


ANNEXURE 5



ANNEXURE-7

SINGLE LINE DIAGRAMME OF A TYPICAL TRACTION SUBSTATION



220/132/66KV INCOMING SUPPLY

220/132/66KV INCOMING SUPPLY