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COMPILED BY: EQUIPMENT ENGINEERING AND ASSET MANAGEMENT (GENERAL MANAGER)	REVIEWED BY: SENIOR MANAGER (PROJECT MANAGER)	REVIEWED BY: SENIOR MANAGER (ASSET MANAGER)
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ACCEPTED BY: CHIEF FINANCIAL OFFICER	AUTHORIZED BY: CEO
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GENERAL ELECTRICAL EQUIPMENT

**SPECIFICATION HE8/2/2
[Version 4]**

February 1997

1. SCOPE

- 1.1. This Specification covers TPT's requirements for low voltage general electrical equipment and must be read in conjunction with the main specification.

2. FACTORY BUILT ASSEMBLIES (FBA) OF SWITCHGEAR AND CONTROL GEAR

This section shall be read in conjunction with BS 5486 Part 1 and /or IEC 439.

- 2.1. All electronic control modules, printed circuit boards, electrical control and protection equipment etc. shall be housed in robust enclosures with minimum protection of IP 55 for indoor and IP65 for outdoor usage and shall be designed to protect the equipment from mechanical damage as far as possible.

- 2.1.1. All enclosures used indoors shall be manufactured from mild steel and enclosures used outdoors shall be manufactured from 3CR12 or stainless steel, and shall be painted in accordance with Specification HE9/2/8.

- 2.2. All equipment shall be housed in a FBA in terms of the following:-

- 2.2.1. A multi-cubicle-type design shall be used;

- 2.2.2. The FBA shall be for in- or outdoor installation according to use;

- 2.2.3. The FBA shall be of the stationary type;

- 2.3. Protection against shock shall be by means of:

- 2.3.1. By using protective circuits;

- 2.3.2. By discharging of electrical devices;

- 2.3.3. Barriers or enclosures noting that:

Where it is necessary to make provision for the removal of barriers, opening of enclosures, or withdrawal of parts of enclosures (doors, casings, lids, covers and the like), this shall be in accordance with the following requirements:

2.3.3.1. Removal, opening or withdrawal shall necessitate the use of a key or tool;

2.3.3.2. All live parts which can accidentally be touched after the door has been opened shall be disconnected before the door can be opened. This shall be by interlocking the door or doors with a switch disconnecter so that they can only be opened when the disconnecter is open and that the disconnecter cannot be closed when the door or doors is/are open.

If, for reasons of operation, the FBA is fitted with a device permitting authorised persons to obtain access to live parts while the equipment is switched on, the interlock shall automatically be restored on re-closing the door or doors.

2.3.3.3. For withdrawable equipment:

The FBA shall include an internal barrier or shutter shielding all live parts in such a manner that they cannot accidentally be touched when the door is open. It shall either be fixed in place or shall slide into place the moment the door is opened. It shall not be possible to remove this barrier or shutter except by the use of a key or tool.

2.3.3.4. Where applicable, warning labels shall be used.

Where any parts beyond an enclosure need occasional handling (such as replacement of a lamp or a fuse-link), the removal, opening or withdrawal without the use of a key or tool and without switching off shall be possible only if the following conditions is fulfilled:

A second barrier shall be provided inside the enclosure so as to prevent persons from coming accidentally into contact with live parts not protected by another protective measure. However this barrier need not prevent persons from coming intentionally into contact by by-passing this barrier with the hand. It shall not be possible to remove the barrier except through the use of a key or tool.

2.4. It shall be possible for competent electrical personnel to perform the following operations while the assembly is in service and live:

Visual inspection of switching devices and other apparatus;

Adjusting and resetting of relays and releases;

Certain fault location operations, e.g. voltage and current measuring with suitably designed and insulated devices.

- 2.5. Accessibility for maintenance shall be provided by use of barrier protected sub-sections for each functional unit or group.
- 2.6. All panels shall have an internal fluorescent light as well as 230 V 3 point plug fitted.
- 2.7. Anti-condensation heaters shall be fitted when called for by the main specification.

3. AC CONTACTORS

- 3.1. Contactors shall comply with IEC 947-4-1/latest.
- 3.2. Contactors shall be chosen by taking the following factors into account:-
 - 3.2.1. Load to be switched;
 - 3.2.2. Utilization category, e.g. AC1, AC2, AC3, AC4, AC11;
 - 3.2.3. Electrical life (Clause 3.3);
 - 3.2.4. Short circuit immunity;
 - 3.2.5. Starting time;
 - 3.2.6. Mechanical life:- All contactors shall have a mechanical life of at least 10 million operations. (1 operation equals 1 make and 1 break).
- 3.3. The electrical life shall be not less than that laid out below for the following utilization categories:-

Utilisation Category	Electrical Life In Hours
AC 1	8 000
AC 2	6 000
AC 3	8 000
AC 4	2 500
AC 3/4	5 000

The category AC 3/4 is defined as one where the usual operation is in category AC 3 with more than 1% of total operations occurring in AC 4.

For the purpose of determining life in this category the percentage operations in category AC 4 shall be equivalent to the expected value, but shall in any case not be less than 20% of the total.

- 3.3.1. The duty class shall be at least class 3. Should the operating class exceed that of class 3, i.e. 300 cycles per hour, the actual value shall be used when computing the expected electrical life.
- 3.4. Block type contactors shall be used for all low voltage motor control applications.
- 3.5. The maximum thermal current rating shall be at least 1.25 times the rated full load current.
- 3.6. Auxiliary contacts shall be contained in a separate unit directly operated from the main armature.
- 3.7. Visual indication by means of a pin or protrusion that the contactor is energized must be provided.

4. **SWITCH DISCONNECTERS**

- 4.1. Switch disconnecters shall comply to BS 5419 and/or SABS 152.
- 4.2. The rating of the disconnector shall suit the system fault level and the breaking capacity of the associated moulded case circuit breaker (where used), or fuses, and shall be rated for fault make load break operation.
- 4.3. The mechanical endurance shall not be less than:-
 - 10 000 operating cycles for rated currents between 0 and 63 A;
 - 3 000 operating cycles for rated currents between 63 and 250 A;
 - 1 000 operating cycles for rated currents exceeding 250 A.
- 4.4. The electrical endurance in the appropriate utilization category shall not be less than 20% of the mechanical endurance.
- 4.5. Where the neutral link is external to the disconnector and is removable without first opening the disconnector it shall be labelled in terms of SABS 0142.
- 4.6. The disconnector shall be interlocked with the front cover of the enclosure in a way to prevent opening of the cover if the switch is "ON". The switch must be able to be switched on with the cover open, only by a competent electrician for maintenance purposes.
- 4.7. The disconnector shall be suitable for padlocking in the off position.

5. INDICATING INSTRUMENTS AND PROTECTION RELAYS

- 5.1. All indicating instruments shall be flush-mounted industrial type that comply with the relevant clauses of IEC 51-1, IEC 51-2, IEC 51-7, IEC 51-8 and IEC 51-9 and shall have a minimum accuracy of 3% or better and shall have a scale length of not less than 90 mm.
- 5.2. All scales except for thermal ammeters shall be linear and shall be marked in accordance with BS 3693 with the scale selected for the accuracy class.
- 5.3. All instrument glass shall be glare free.
- 5.4. All current operated instruments and protection relays shall be protected against continuous over current of up to 120% of the nominal value as well as short circuit currents that may be experienced.
- 5.5. Ammeters shall be marked with the ratios of the associated current transformer.
- 5.6. Ammeter full-scale deflection shall be 120% of primary current of the associated current transformer.
- 5.7. Voltmeter scales shall indicate 80%-120% of the nominal system voltage. Where 0-120% indication is needed the nominal voltage shall be approximately 75% of full scale. The nominal voltage shall be marked with a red line.
- 5.8. If required by the system or main specification ammeters shall incorporate a thermal maximum demand indicator with a time lag of 15 minutes. A built in saturation current transformer shall be provided to protect the indicator against the maximum fault currents that may be experienced. A resettable pointer shall be provided to indicate the maximum value reached.

6. CONTROL SWITCHES

- 6.1. Control switches shall comply with BS 4749.
- 6.2. "Emergency-stop" push buttons shall be of red colour, shall have one normally closed and one normally open contact and shall be of the mushroom head twist lock type and be lockable in the "off" position.
- 6.3. All push buttons shall have non corrosive appropriately engraved and anodized escutcheon plates fitted.

7. **LIMIT SWITCHES**

- 7.1. All "end" or "ultimate" limit switches (e.g. slow down, end of travel, maximum travel etc.) shall be of the rotary cam operated type, housed in an extremely rigid cast iron enclosure with a minimum protection of IP 55, with large roller levers of the spring return-to-neutral action. It is stressed that the entire limit switch must be of an extremely robust construction.
- 7.2. All limit switches shall be mounted in easily accessible positions to facilitate adjustment, maintenance and replacement.
- 7.3. Magnetic or inductive proximity type limit switches are preferred and are to be used wherever possible.

8. **RATING PLATES AND LABELS**

- 8.1. Rating plates complying with the relevant requirements of IEC 298 showing the following information shall be provided:-
 - 8.1.1. Manufacturer's name;
 - 8.1.2. Manufacturer's type number;
 - 8.1.3. Manufacturers serial number
 - 8.1.4. Portnet contract number;
 - 8.1.5. Year of manufacture;
 - 8.1.6. Rated values, etc.
- 8.2. Identification labels is required on or adjacent to all electrical control equipment, switches, relays, instruments, meters, fuses, MCCB's, test blocks, terminal strips etc. The text shall be in black letters on a white background and shall be at least 5mm in height.
 - 8.2.1. These identification labels shall correlate with the corresponding schematic and wiring diagram and the wording shall be in English.
- 8.3. All labels shall be of a corrosion resistant material and shall be securely attached.
- 8.4. Labels shall be placed adjacent to all fuses and circuit breakers to indicate their rating.

8.5. All switching devices shall be provided with labels that indicate ON, OFF, EARTH, as required. These labels shall be permanently marked with characters at least 10 mm in height, and shall be visible to the operator in a normal operating position, in a fixed position or located on a moving component of the switch that is visible through an opening and shall be as follows:-

8.5.1. I - white lettering on black background for the ON position;

8.5.2. O - white lettering on a green background for the OFF position;

8.5.3. Earth symbol in black on a yellow background for earth position.

9. **MOULDED CASE CIRCUIT BREAKERS**

9.1. Moulded case circuit breakers shall comply with SABS 156.

10. **FUSES**

10.1. Fuse links shall be of a high rupturing capacity type complying with SABS 172 and/or BS 88. Fifty percent spare fuse links of each size shall be supplied loose at handover of the equipment.

11. **RESISTANCE UNITS**

11.1. Resistance units shall be made up of standard modules (mill-banks). These shall be to Nema 26.5" dimensional standards and each bank shall be made up of grids of one size only. The grids shall be of the heavy duty stamped chromium steel or nickel chromium alloy corrosion resistant grid type. There must be a terminal tap on every second grid.

11.2. Modules must be easily removable without the need to dismantle any part of the enclosure.

11.3. All taps and terminations shall be clearly identified with relevant numbers, which must correspond to the numbering shown on the schematic and wiring diagrams.

11.4. The resistance banks shall be enclosed in robust well ventilated drip-proof enclosures with louvred side and rear fixed covers. All units shall be accessible from the front only by "lift-off" type doors. Exterior and interior surfaces of the enclosure shall be painted with a suitable heat-resistant paint.

11.5. The resistance enclosed shall be arranged for floor mounting and bottom entry of electrical cables.

- 11.6. When resistance enclosure doors are removed, all terminals on resistance tappings, the terminal blocks, cable terminations and the individual grid banks must be readily accessible.
- 11.7. Resistance units shall be mounted in accessible positions as near to their motion panels as is practical. Cast iron, sheradized mild steel, or wire wound resistances are not acceptable. All insulation used in the construction of the resistances must be fire proof and non-hygroscopic. Soldered joints must not be used in connection to resistances.
- 11.8. The resistances must be designed to at least Nema Class 174 P rating for hoist drives and Nema Class 94 rating for permanently connected resistances and shall be capable of prolonged operation in service without overheating.

NOTE: Resistances mounted in or on top of the control panels will definitely not be acceptable.

- 11.9. Resistance units shall be individually designated to indicate to which motion they apply.

12. **POWER FACTOR CORRECTION AND HARMONIC FILTERING EQUIPMENT (IF ASKED FOR IN THE MAIN SPECIFICATION)**

- 12.1. Capacitors must comply with BS 1650 or IEC 70 and shall have passed the routine tests specified.
- 12.2. Capacitors must be of the "dry" metallized film or paper "self sealing" type, impregnated with an non PCB, fully biodegradable non-toxic dielectric.
- 12.3. Each capacitor must be fitted with an external HRC fuse rated at 2 times capacitor full load current, for protection.
- 12.4. Capacitors must be fitted with discharge resistors to discharge the capacitor voltage to less than 50 V in one minute.
- 12.5. Inrush currents of capacitors must be kept to an acceptable level by using reactors or resistors. Details of actual and allowable inrush currents to be given in tender documents.

13. **WIRING AND CABLES**

- 13.1. All cables for fixed installations must comply with SABS 1507, except where special cables have otherwise been specified.
- 13.2. Steel wire armoured cables must be used where the possibility of mechanical damage exists.

13.3. Armouring of cables will not be used for earthing purposes or any return circuit but shall be bonded to earth. An earth conductor shall be provided in each cable for earthing purposes. If an earth core is not provided a separate, appropriately coloured, insulated earth wire shall be run.

13.3.1. Metallic structures shall not be used for any return or earthing circuit under normal operating conditions but all structures shall be electrically bonded together with welding type cables..

13.4. Spare cores and terminals for all control cables shall be provided as follows:

<u>Number of Conductors/Cables</u>	<u>Spare Cores</u>
3 - 6	1
7 - 12	3
Over 12	4

13.5. The standard method for numbering small wiring shall be as indicated in NRS 003, Annex A.

13.6. Colour coding of cables

13.6.1. Unless otherwise agreed to the colour of all auxiliary and control wiring (except earth wires) shall be grey. The colour of earth wires shall be green/yellow.

13.6.2. All three phase supplies shall be colour coded red, white and blue.

13.6.3. Single phase supply cables shall be blue for neutral and brown for live.

13.6.4. DC supply cables to motors, fields, magnets etc. shall be orange.

13.6.5. If the correct colour cables are not available cable ends may be marked with "air-shrink" or "heat shrink" type insulation material for ± 200 mm. Colour coding of cables with insulation or marking tape is not acceptable.

13.6.6. PLC specification on panel wiring colour code:
 220V AC: Live = Brown, Neutral = Blue and Earth =Green
 24 V DC power reticulation: 24+=Red, 0V DC =Black
 24 V DC Digital Inputs: Purple
 220V AC Digital Inputs: Grey
 24 V DC Outputs: White
 220 V AC Digital Outputs: Orange
 All Analog signals: White =+, Black
 Electrical control reticulation; Grey

13.7. Cable Installation on structures and in electrical rooms etc:

13.7.1. Except where otherwise specified, the entire electrical installation including the wiring, shall where applicable, be in accordance with the "Code of Practice for the Wiring of Premises" (SABS 0142-1978) or the IEEE Wiring Regulations for Electrical Installations.

- 13.7.2. The cables must be installed by the following methods:
 - 13.7.2.1. In cable ducts or hollow floors with covers;
 - 13.7.2.2. On structures, strapped to cable trays or in electrical conduits, with protection against mechanical damage where necessary.
 - 13.7.2.3. No loop-in wiring shall be permitted. All limit switch and field wiring shall return to junction boxes for re-marshalling.
 - 13.7.2.4. All cable glands shall be corrosion resistant glands of the "Posi" or "Pratley Envirogland", Exe type, or similar.
 - 13.7.2.5. Junction and connection boxes must be manufactured in glass fibre reinforced polyester with threaded brass inserts and earthing continuity rods, and must be suitable for threaded (minimum 8 threads) glands. The minimum enclosure protection must be IP65. Pratley "EZEE-FIT" or similar boxes will be preferred.
 - 13.7.2.6. The number and size of cables that may be accommodated in cable ducts, trays or conduits shall be in accordance with the manufacturer's recommendations and the temperature rise permissible for the cables used for the load that may be carried.
- 13.8. Internal panel wiring shall be in accordance with BS 158 and/or BS 162:
 - 13.8.1. All instruments and control wiring shall be carried out in minimum size of 1.5mm² cross section, with stranded copper conductors. Wires connected to current transformers shall have a minimum cross sectional area of 4 mm².
 - 13.8.2. The communication cores of screened cable shall have a minimum area of 1 mm².
 - 13.8.3. The wiring shall be done in a neat and orderly manner using any of the two methods below:
 - 13.8.3.1. In covered switchboard type wire channels or,
 - 13.8.3.2. Suitably strapped with approved strapping material.

13.8.4. When wiring is looped from the cubicle interior to the door or to the back it must be suitably strapped and enclosed in a flexible conduit.

13.8.5. Cable Trays:

13.8.5.1. Cable trays shall be of "Unistrut" or similar and equal manufacture and shall consist of butting sections made from stainless steel of minimum thickness of 1.2 mm. Cable trays shall be painted according to Specification HE9/2/8 for colour coding purposes.

13.8.5.2. Cable trays shall be bolted to structures on both horizontal and vertical runs at centres recommended by the number and mass of cables carried. Maximum distances 1.3. metre for steel.

13.8.5.3. Each section of metal cable tray must be provided with a stainless steel connection tab/lug at each end prior to being painted, for continuous earthing purposes.

13.9. Terminals and connections:

13.9.1. All terminal connections shall be done with good quality connectors and/or lugs and each wire end shall be marked with durable tags or clips on which shall be clearly and indelibly marked, the identifying code numbers of each wire, corresponding to the wiring diagrams.

13.9.2. The system of wire and terminal numbering shall be provided in the terminal boxes for possible additional wiring.

13.9.3. A minimum of 20% but not less than 4 spare terminals shall be provided in the terminal boxes for possible additional wiring.

13.9.4. Box type rail mounted terminals complying with EN 50035 with a pressure pad between the conductor and clamping screws shall be used. Cage clamp systems may also be used except in areas where high shock forces exist, e.g. on spreader beam or headblock equipment.

13.9.5. Moulding and insulation materials shall be resistant to flame or self extinguishing as required by IEC 216.

13.9.6. Access to all terminals shall be through doors, covers etc.

13.10. Flexible Connections:

- 13.10.1. Where wiring crosses from one structure to another and relative motion between the structures is possible, a welding type cable earth bond shall interconnect the two structures.
- 13.10.2. Flexible connections shall be made with heavy duty flexible cord using watertight terminators. Where the length of cable is greater than 1.6. metres a basket type cable grip shall be provided at each end.
- 13.10.3. Flexible cables shall run in free air and shall not contact other cables or structures.

14. **PROTECTION AGAINST CORROSION**

- 14.1. All enclosures, cabinets etc. shall be manufactured from 3CR12 or similar stainless steel sheeting, as called for in the main specification and shall be painted according to Specification HE9/2/8 for identification.
- 14.2. All fixing screws, bolts, nuts, washers, clips, terminals, brackets, etc. shall be stainless steel.

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END OF SPECIFICATION HE8/2/2 [Version 4]

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