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1. SCOPE

- 1.1. This specification covers Portnet's requirements for medium voltage switchgear and control gear to be installed in sub-stations and is based on the various NRS (Rationalized user specifications) referred to. All potential electrical suppliers of the equipment must be in possession of the relevant NRS specifications.

2. GENERAL REQUIREMENTS

- 2.1. All equipment shall be suitable for service in the system and environmental conditions specified in the main specification.
- 2.2. Medium voltage cables shall comply with NRS 013/latest and pilot cables with NRS 011/latest except where special cables have otherwise been specified.
- 2.3. General electrical equipment must comply with Portnet Specification HE8/2/2.
- 2.4. Routine as well as type test certificates of all equipment certified by a recognised testing authority shall be supplied in duplicate.
- 2.5. The pollution level (IEC 186) shall be taken as medium (creepage distance of 20mm/kV) for all equipment installed indoors or inside enclosures with a minimum protection of IP55. For equipment installed outdoors the pollution level shall be taken as "Heavy" (creepage distance of 25 mm/kV).
- 2.6. Enclosures for cable termination in air shall comply with NRS 008.
- 2.7. Mini-substations shall comply with NRS 004.
- 2.8. Insulated bushings shall comply with SABS 1035.
- 2.9. Battery chargers shall comply with NRS 026.
- 2.10. Definitions in this specification are according to NRS 040-1, High voltage operating regulations (Definitions).
- 2.11. Work on medium voltage equipment shall be carried out in accordance with the Safety Instructions: High-Voltage Electrical Equipment of Spoornet.

3. MEDIUM VOLTAGE SWITCHGEAR PANELS

These clauses are based on the requirements of NRS 003 and highlights Portnet's preferences for alternatives given therein.

3.1. Metal enclosed ring main units shall comply with NRS 006.

3.2. General:

3.2.1. The type of switchgear to be used for the equipment will either be circuit breakers, switch-disconnectors or switch-fuses, as specified in the main specification and shall be suitable for the specified fault levels and suitably rated for the equipment they feed.

3.2.2. Each switchgear panel shall be a self-contained unit with a minimum degree of protection of IP3X for indoor use and IP55 for outdoor use or as specified in the main specification.

3.2.3. Access to equipment installed inside panels (e.g. current transformers, cable terminations etc.) shall be such that removal and replacement thereof can be conveniently carried out with the panels in situ, by removal of barriers or covers fixed with screws (not self tapping).

3.2.4. Anti-condensation heaters shall be provided to ensure that no condensation can occur in any of the compartments. A switch shall be provided to control the heaters.

3.2.4.1. The heaters shall be supplied from 110 V AC.

3.2.4.2. The wiring from the heater elements to connection terminals shall be high temperature insulation covered, with a suitable compression-type gland.

3.2.5. Panels shall have the following equipment or as specified in the main specification:-

3.2.5.1. Isolating and switching devices;

3.2.5.2. Medium voltage contactors;

3.2.5.3. Striker pin trip feature for HRC fuses;

3.2.5.4. Voltage transformer/s;

3.2.5.5. Current transformers;

3.2.5.6. Ammeter and volt meter with selection switch as well as phase rotation indicator;

- 3.2.5.7. Protection relays, instruments, control fuses, push buttons etc mounted on the front of the panel;
 - 3.2.5.8. Busbars;
 - 3.2.5.9. Earthing devices;
 - 3.2.5.10. Normal/test switch and circuitry for testing of the panel without the medium voltage present.
- 3.2.6. Where fixed type switchgear is installed and the switchgear is fed from a common busbar, a disconnecter shall be installed on the incoming side of the switching device.
- 3.2.6.1. These panels shall be provided with an armoured glass window to visually inspect the state of the disconnecting and switching devices.
 - 3.2.6.2. A notice bearing the following inscription shall be provided adjacent to the operating mechanism of the disconnecter:-

"DO NOT OPERATE UNDER LOAD"
- 3.2.7. Voltage transformer operated or DC battery operated switching devices as required by the main specification must be offered.
- 3.2.8. Trip and live circuit indication shall be provided on the front of the switchgear panel.
- 3.2.9. Continuous neon lamp or light emitting diode indication for switching device shunt trip healthy shall be provided on the panel.
- 3.2.10. All joints and tees in busbars shall be made with hot-dipped galvanized high tensile steel bolts, nuts and washers.
- 3.2.11. High voltage and low voltage equipment shall be housed in separate compartments.
- 3.2.12. The busbars shall be contained in a separate compartment. For air insulated equipment this compartment shall be easily accessible and shall be fitted with removable panels secured by means of an adequate number of screws. (Not self tapping).
- 3.2.13. SF6 switching devices shall be fitted with a pressure gauge to monitor gas pressure.
- 3.2.14. Each switchgear panel shall be provided with a suitable panel pack ("P" pack), jointing pack ("J" pack) as well as switchboard accessories pack ("S" pack).

3.2.15. Only one test pack for each type of switching device supplied shall be provided for testing the switching device in the isolated position.

3.3. Circuit-breaker panels:

3.3.1. The circuit-breaker shall be of the vertical or horizontal isolating, draw out truck type, as specified in the main specification.

3.3.2. Circuit-breakers shall be of the sulphur-hexafluoride (SF₆) or vacuum type.

3.3.3. Both the cable as well as busbars shall be provided with fault-make earthing facilities, unless otherwise approved.

3.3.4. The breaker panel shall be provided with the necessary over current and earth fault current transformers and associated digital protection relay and control equipment for short circuit, overload and earth fault protection.

3.4. Switch-disconnector panels:

3.4.1. Integral type circuit test facilities shall be provided.

3.5. Switch-fuse panels:

3.5.1. Integral three-pole earthing facilities to earth both sides of the switching device shall be provided, unless otherwise approved.

3.5.2. Fuses shall be of the air-insulated, cartridge striker pin type.

3.5.3. Integral type circuit test facilities must be provided.

3.6. Cable termination compartments:

3.6.1. Cables shall terminate in air-insulated compartments complying with NRS 008.

3.6.2. Insulated gland plates with substantial copper earthing strips connected to the earth terminal shall be provided for termination of cables.

3.7. Current transformers:

3.7.1. Current transformers shall comply with IEC 185.

3.7.2. Current transformers shall have the following minimum accuracy classes:-

3.7.2.1. Indicating instruments - 3.

- 3.7.2.2. Protection purposes - 10P10.
- 3.7.2.3. Metering purposes - 0.5.
- 3.7.3. The secondary rating of the transformer shall be either 1 or 5 amp as required by the protection or metering equipment.
- 3.7.4. Core balance current transformers used for earth fault protection shall have an injection test winding.

3.8. Voltage transformers:

- 3.8.1. Voltage transformers shall comply with NRS 030 (IEC 186).
- 3.8.2. Dry type voltage transformers of the withdrawable type shall be provided in switchgear panels for the provision of 110 V AC or DC control voltage as well as 110 V AC anti-condensation heater supplies and for voltage instrument indication and phase rotation, or as required by the main specification.
- 3.8.3. Voltage transformers shall have the following minimum accuracy classes:
 - 3.8.3.1. Indicating instruments - 3;
 - 3.8.3.2. Protective systems - 6P;
 - 3.8.3.3. Metering - 0.5.
- 3.8.4. The primary of the voltage transformer shall be connected to the busbar side through high-voltage fuse-links.
- 3.8.5. Secondaries of voltage transformers shall be protected by MCCB's mounted on panel doors.
- 3.8.6. The rating of the transformer shall be suitable for the connected load but shall be a minimum of 100 VA per phase.
 - 3.8.6.1. In the case of solenoid closing mechanisms the voltage transformer shall be capable of closing the switching device twice in quick succession without overheating.
 - 3.8.6.2. Where DC closing circuits are used the voltage transformer shall be connected to its own suitable silicon rectifier adequately rated for the duty, and provided with surge protection.

3.9. Control, protection and alarm circuitry:

- 3.9.1. Control, protection and alarm systems and circuitry shall be as required by the system or as specified in the main specification but shall be approved by Portnet.
- 3.9.2. Voltage as well as ammeter selector switches shall be provided.

3.10. Auxiliary supplies:

- 3.10.1. Control supplies can be either of the following as required by the main specification:
 - 3.10.1.1. Voltage transformer, 110 V AC;
 - 3.10.1.2. Voltage transformer and rectifier, 110 V DC
 - 3.10.1.3. V DC battery operated.
- 3.10.2. Nickel-Cadmium or Lead Acid batteries of the vented wet cell type complying with NRS 010 is preferred.

Note: Only the same battery type e.g. Lead acid or Nickel-Cadmium as originally installed or which are presently installed in a substation shall be offered.

- 3.10.2.1. The number of cells and capacity of batteries shall be determined from the voltage requirements of the system closing and tripping circuitry. The capacity shall be sufficient to perform the largest requirements of the following (without the aid of the battery charger):-

- 3.10.2.1.1. Five successive tripping and reclosing operations of 20% of the switching devices supplied by the battery, or;
- 3.10.2.1.2. Single tripping and reclosing of all the switching devices supplied by the battery plus supplying all the standing loads on the battery for at least 10 hours.

- 3.10.2.2. The battery set shall be accommodated on a battery stand or in a dedicated battery compartment on shelves suitably arranged to facilitate inspection and maintenance as required. No other

equipment shall be mounted inside such compartments.

3.10.2.2.1. The compartment shall be adequately ventilated to prevent the build up of heat or explosive gasses which may accumulate during the recharging cycle.

3.10.2.2.2. The level of electrolyte shall be clearly visible and sufficient space shall be provided to enable the electrolyte to be topped up when necessary.

3.10.2.2.3. The shelves or trays shall be manufactured from stainless steel and shall be supplied with suitable drain holes and plastic piping to drain spilled liquid to a suitable container.

3.10.3. Battery chargers shall comply with NRS 026.

3.11. Protection Relays and instruments:

3.11.1. Ammeters shall incorporate thermal maximum demand indication.

3.11.2. Accuracy for all indicating instruments shall be at least 3%.

3.11.3. Energy meters shall comply with BS 37 and shall have the following features:-

3.11.3.1. be suitable for 3 phase unbalanced and asymmetrical systems;

3.11.3.2. be of accuracy class 2;

3.11.3.3. must not be of the plug-in type;

3.11.3.4. shall have digital type cyclometer dials.

3.11.3.5. Maximum demand indicators shall:-

3.11.3.5.1. be of the thermal type, unless integrated into digital relays;

3.11.3.5.2. operate over a 15 minute period;

3.11.3.5.3. indicate vKA or kW as required.

3.11.3.6. All energy meters shall be tested and calibrated by a recognised testing authority.

- 3.11.4. Protective relays shall be designed, manufactured and tested in accordance with BS 142 or IEC Publication 255.
 - 3.11.4.1. Protective relays shall have been type tested to verify performance and safety. Proof of these tests in the form of type test certificates shall be included in tender documents.
 - 3.11.4.2. Relays shall have the following minimum ratings:
 - 3.11.4.2.1. Error class rating of 10;
 - 3.11.4.2.2. Operating time class index of 60;
 - 3.11.4.2.3. Rated number of contact operations with electrical duty class index N3;
 - 3.11.4.2.4. Mechanical stability class index S2.
 - 3.11.4.3. Relays shall:
 - 3.11.4.3.1. have three over current elements for each pole;
 - 3.11.4.3.2. be rated in conjunction with its associated current transformer(s), to withstand the over current in the secondary winding of the current transformer/s under fault conditions;
 - 3.11.4.3.3. be continuously rated for any current setting;
 - 3.11.4.3.4. be clearly marked with the current ratio of the current transformer associated there-with;
 - 3.11.4.3.5. be directional;
 - 3.11.4.3.6. have contacts rated to make and carry the current of their associated circuits. The trip coil current shall be interrupted by auxiliary contacts on the circuit breaker;
 - 3.11.4.3.7. have manual reset for short circuit, earth fault and phase failure;
 - 3.11.4.3.8. have an additional set of normally open and normally closed contacts, or auxiliary relays, for remote indication of the relay operation. The contacts shall be capable of handling 50 W in the range of 24 to 110 V DC, and shall be wired to a terminal strip at the back of the panel.

3.11.5. Microprocessor based digital protection relays with the following features or as required by the system or as specified in the main specification shall be supplied:-

3.11.5.1. Definite minimum dependent time lag featuring either an inverse time lag, very inverse time lag or extremely inverse time lag time/current relationship;

3.11.5.2. Instantaneous;

3.11.5.3. Combined time lag and high-set instantaneous;

3.11.5.4. Definite time lag;

3.11.5.5. Differential pilot wire protection if required.

3.11.6. Auto reclosing systems shall consist of instantaneous, time lag, over current and earth fault protection and auto-reclosing relay and shall operate as follows:-

3.11.6.1. Trip no. Tripping by means of Result

Initial condition	Auto reclosing relay reset	
1	Instantaneous O/C or E/F	Reclosing cycle and lockout of instantaneous O/C and E/F relay
2	O/C or E/F timelag	Reclosing cycle
3 etc.		
Final trip	O/F or E/F timelag	Lockout

3.11.6.1.1. If the fault remains, the relay will lockout after a preselected number of trips. If the fault clears before lockout the auto-closing relay shall reset to initial condition. Auto-reclosing shall be inhibited in the event of sensitive earth fault operation.

3.11.6.2. The following functions shall be available:-

- 3.11.6.2.1. selection of the number and sequence of trippings, up to at least four;
 - 3.11.6.2.2. adjustment of the time between the tripping and reclosing in the range of 0 - 30 seconds;
 - 3.11.6.2.3. adjustment of the definite minimum time of the delayed tripping between 0 - 10 seconds;
 - 3.11.6.2.4. cumulative operation counter.
- 3.11.7. Where required in critical supply systems, busbar/frame earth protection shall be provided.
- 3.11.7.1. Individual zone relays shall trip all the switching devices in their respective zones to isolate the fault from all sources of supply.
 - 3.11.7.2. A bus-switching device shall always be a separate zone.
 - 3.11.7.3. Insulating materials between zones and earth shall be high grade non-deteriorating and non-hygroscopic, at least 2 mm thick and shall have a electric strength of not less than 4kV when tested in accordance with BS 2918 for 1 minute, cut to size and ready for installation.
 - 3.11.7.4. The reaction time of the protection system shall be such as to limit the duration of an internal arc fault to the withstand capability of the insulation material.
- 3.11.8. Relays for transformer protection shall have the following features:-
- 3.11.8.1. over current and earth fault protection consisting of at least two extremely inverse definite minimum time lag over current elements, at least two high set instantaneous over current elements with low transient over reach characteristics, at least one extremely inverse definite minimum time lag earth fault element;
 - 3.11.8.2. restricted earth fault protection of star windings, the relay shall be of the instantaneous type and shall be tuned to 50 Hz;
 - 3.11.8.3. biased differential protection with high speed characteristics biased to provide stability during through faults and shall not be operated by normal inrush currents.
 - 3.11.8.4. over temperature, gas detection and overpressure for oil-type transformers and PT 100 thermistors for dry type

transformers;

3.11.8.5. tank earth protection with a current transformer installed between the tank and earth, with an instantaneous type relay.

3.11.9. The relays shall have current settings adjustable in infinite steps.

3.11.9.1. The time delay relays shall have adjustable time lag ranging from 0 to 2 seconds.

3.11.10. Sensitive earth fault relays shall be of the static type and have a current setting of 0.5% to 8% and an operating time adjustable from 1 to 99 seconds.

3.11.11. Digital relays shall incorporate PT100 RTD inputs where required.

3.12. Test Terminal Blocks:

3.12.1. Readily accessible, suitably enclosed test terminal blocks shall be provided on the front panel of the switch unit for the purpose of testing the protective systems.

3.13. General:

3.13.1. Two copies of all type and routine test certificates shall be supplied in accordance with NRS 003 for all equipment in the panels as applicable.

3.13.2. Marking labelling and documentation shall be done according to NRS 003/latest.

3.13.3. Wire numbering shall be done according to Annexure A of NRS 003/latest. Graphic symbols for wiring diagrams shall comply with NRS 002/latest.

4. EARTHING AND BONDING

4.1. All equipment shall be connected to the substation earthing by means of separate insulated copper bars or straps which shall have a minimum cross sectional area as specified below:-

4.1.1. Medium voltage switch boards-

- bonding together of frames of all panels of each zone :- 125mm²
- earthing cable glands of each zone :- 125mm²

- 4.1.2. Low voltage switchboards-
- earthing frame work :- 80mm²
- 4.1.3. Distribution transformers -
- earthing framework :- 125mm²
 - earthing separately of neutral terminal :- 125mm²
- 4.1.4. Batteries and battery charging equipment, other low voltage equipment and other accessory equipment such control relay panels, fire extinguishing equipment, exposed metal work, etc :- 35mm²

5. PROTECTION AGAINST CORROSION

- 5.1. Panels for indoor installation shall be constructed from mild steel frames and mild steel sheeting (at least 2 mm), painted according to specification HE9/2/8.
- 5.2. Panels for outdoor installation shall be constructed from mild steel frames and 3CR12 or similar steel sheeting (at least 2 mm), painted according to specification HE9/2/8.
- 5.3. All bolts, nuts, washers, fixing components, hinges catches, etc. shall be stainless steel.

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END OF SPECIFICATION HE8/2/5 [Version 2]

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