SECTION 6 - SCHEDULE F - TESTS

SCHEDULE F

1 GENERAL

The subsequent section list specific inspections, works and site tests which the Employer requires, but this shall not preclude the Employer's right to require further tests if he considers these necessary.

After the plant has passed the site tests required under this Contract, and has become available for commercial operation, certain additional tests may be carried out in order to investigate the response and recovery of the system during events such as the switching of various items of plant, system faults and load rejection.

2 CIRCUIT BREAKERS

2.1 General

For the purpose of the following tests, the operating pressures for pneumatic and hydraulic operating mechanisms and SF6 gas circuit breakers of all types shall be as follows: -

a. Making and breaking current capacity type test - minimum operating (lock-out) pressures.
b. Inductive current interrupting type test - maximum operating pressures.
c. Capacitive current interrupting type test - minimum operating (lock-out) pressures

2.2 Type tests

2.2.1 Short circuit making and breaking current tests

Each type of circuit breaker being supplied shall be short circuit tested in accordance with the requirements of IEC 62271-100, and shall include the following:

a. The tests shall be made on the maximum number of making or breaking units in series that the output (direct and synthetic) capacity of the test plant will allow.
b. The rate of rise and peak value of the inherent recovery voltage applicable to each test duty shall be the values specified in IEC 62271-100 or in the Schedules.
c. Prior to the commencement of any series of short circuit tests, a complete series of no-load timing tests shall be made on the circuit breaker as specified in IEC 62271-100.
d. Test duty 4 must include at least one 100 per cent symmetrical break (0) test at lock-out operating pressure and longest arc duration.
e. Test evidence shall be provided to show that one set of contacts and nozzles are capable of successfully interrupting the rated short circuit current.at least twenty times.

- ***Breaking and making current capacity under out of phase conditions***

Circuit breakers for operation under out of phase conditions shall be rated and tested in accordance with IEC 62271-100.

- ***Short time current test***

The short time current test shall be carried out in accordance with IEC 62271-100 and 62271-203.

- ***Capacitive current switching tests***

The capacitive current switching duty specified in the Schedules the circuit breaker shall be tested in accordance with IEC 62271-100.

- ***Low inductive current switching tests***

A series of breaking capacity tests shall be made on each type of circuit breaker being supplied in order to demonstrate the performance when switching transformer magnetizing currents or reactor currents, tests shall be made using one or both of the following circuit arrangements: -

a. The high voltage windings of a pair of testing station transformers shall be connected in parallel, and low voltage terminal of one being fed from the test generator, the low voltage terminals of the other being open circuited. The circuit breaker under test shall be connected in the high voltage circuit loops.

b. A series of switching tests shall be made comprising 10 break tests at 18° intervals around the current loop:
   i. under steady state magnetizing current conditions
   ii. under transient (switching in) conditions

c. A series of switching tests shall be made in accordance with IEC 62271-110 (secretariat) 390, comprising 10 break tests at 18° intervals around the current loop at currents of 10, 50, 100 and 600 A (if required).
The choice of test method shall be subject to agreement between the manufacturer and the Employer/Engineer.
Tests shall preferably be made on a complete three phase or single-phase unit, but where this is not possible because of limitations in the testing station capacity, tests shall be made on the maximum possible number of interrupter units with the agreement of the Employer/Engineer.
Tests shall be performed at the rated control voltage, rated Hydraulic or Pneumatic pressures and rated SF6 gas pressure.

- ***Synthetic testing***

The use of synthetic test circuits shall be in accordance with IEC 62271-101.

A single-phase break (0) test shall be carried out with three-poles connected in series at 100 per cent rated fault current and maximum arc duration and lock-out operating pressures. Test duties with failure in the middle of arcing window shall not be acceptable.

- ***Temperature rise test on main circuit***

The temperature rise test shall be made according to paragraph 6.5 of IEC 62271-1. The test shall be performed indoors in an environment substantially free from air currents, except those generated by heat from the switching device being tested.
A measurement of the resistance of the main circuit, according to paragraph 6.4 of IEC 62271-1, shall be made for comparison between the switchgear and control gear type tested for temperature rise and all other switchgear and control gear of the same type subjected to routine tests.

- ***Thermal capacity tests on resistors***

Where applicable the thermal capacity of closing and/or opening resistor unit assemblies shall be proven by subjecting a unit assembly to a short time current equal in duration to that guaranteed in the Schedules and applied voltage being the unit voltage appropriate to the making or breaking capacity and out of phase voltage requirements.

The resistance of each resistor shall be measured before and after the short time current tests and when the resistor has cooled to ambient temperature. There shall have been no significant change of ohmic value when in the cold condition at the conclusion of the test. After the test, resistor blocks shall be free of burning, cracking or other forms of degradation.

- ***Thermal capacity tests on voltage grading capacitors (if any)***

The manufacturer shall demonstrate, by means of a suitable series of tests to be agreed with the Employer/Engineer, that capacitors incorporated in the circuit breaker shall be capable of withstanding the thermal stresses imposed when operating under the short circuit conditions or the dielectric test conditions previously specified.

- ***Short line fault tests***

Each type of circuit breaker shall be proven capable of interrupting faults to IEC 62271-100.

- ***Auto-reclosing tests***

When a circuit breaker is intended for auto-reclosing duties, the following supplementary tests shall be made:

O-t-CO duty cycle	at 10% rating
O-t-CO duty cycle	at 100% rating

The time interval `t' shall be that specified in IEC 62271-100 and the Schedules for delayed or high speed Autor closure.

The TRV shall be as specified in IEC 62271-100. The operating pressure shall be the lockout value appropriate to the above duty cycle.

2.2.2 Dielectric tests

Each type of circuit breaker being provided shall be assembled complete as in service and subjected to the dielectric type tests specified in IEC 62271-100, 60060, 62271-203 and 62271-1 and in the Schedules and there shall be no self-restoring or non-self-restoring disruptive discharges during the fifteen positive and negative impulse test series.

2.2.3 Insulation co-ordination

Insulation coordination tests on circuit breaker shall be performed in accordance with IEC 60071,60691 and 60815.

2.2.4 Radio influence voltage tests

Where applicable, circuit breakers shall be subjected to RIV type tests in accordance with IEC 62271-100 and 62271-1 and the values obtained shall not exceed the value guaranteed in the Schedules.

Test reports covering RIV tests shall give full details of temperature, barometric pressure, humidity and correction factor applied as well as the RIV test values.

2.2.5 Mechanical endurance type tests

Mechanical endurance type tests shall be carried out in accordance with IEC 62271-100.

2.2.6 Low temperature tests

When applicable each type of circuit breaker shall be assembled complete with operating mechanism in a cold chamber to prove that satisfactory operations can be performed at the minimum ambient temperature specified, in accordance with IEC 62271-100.

It shall also be demonstrated that the circuit breaker's operation is not impaired when subjected to coating of ice. To prove this latter condition tests shall be in accordance with ANSI C37.34 Section 7.

Where a complete circuit breaker cannot be tested due to inadequate test facilities unit tests may be performed. The arrangement of the representative unit shall be to the approval of the Employer/Engineer.

Opening and closing tests at normal and minimum operating pressures and voltages shall be performed and the timings and travels of the circuit breaker shall be recorded. There shall be no change in the operating characteristic of the circuit breaker.

2.2.7 Type test certificate

All type test certificates must stand on the test evidence alone and not require interpretations. It shall include relevant calibration, detailed drawings, construction, necessary dimensions and details of material etc. The contractor or sub-contractor shall supply to the Employer/Employer/Engineer two complete sets of the type test certificates.

2.2.8 Circuit breaker tanks

One tank of each type shall be tested to three times the maximum impulse pressure to which the circuit breaker is subjected under short circuit conditions as stated in the schedules.

Measurements shall be made to determine the magnitude of the temporary distortion. There will be no permanent set.

2.3 Routine tests on works assembled circuit breakers

Each circuit breaker shall be assembled completed with its mechanism box, auxiliary switches, etc and subjected to the routine tests in accordance with IEC 62271-100, 62271-203 and 62271-1.

2.3.1 Routine tests on unit assembled circuit breakers

The manufacturer shall demonstrate to the satisfaction of the Employer/Employer/Engineer that the test procedures adopted on each unit assembly are adequate to ensure that the completely erected circuit breaker is capable of operating within the guaranteed limits with respect to opening and closing times etc that all routine tests required by the above standards are covered. Where required by the Employer/Engineer, a complete circuit breaker shall be erected and tested at the manufacturer's works to verify these guarantees.

3 DISCONNECTING AND EARTHING SWITCHES

Each type of disconnecting and earthing switch being provided shall be subjected to the type and routine tests specified in IEC 62271-102 and 62271-203 and shall comply fully with the following supplementary type and routine tests.

3.1 Type tests

In order to demonstrate the insulation co-ordination of the disconnection the critical flashover levels to earth and across the open gap shall be determined in accordance with IEC 60071, 62271-1 and 60815. The `up and down' method described in IEC 60060 shall be used for these tests.

3.2 Routine tests

When the disconnector is not completely assembled in the manufacturer's works, the operational test specified shall be made on each mechanism being provided, the disconnector loading being simulated.

4 CURRENT TRANSFORMERS

4.1 Type tests

Type tests shall be made in accordance with IEC 61869-2 along with the additional tests as detailed below and in the following sequence.

- ***Internal discharge test***

Each current transformer shall be assembled completed as in service and subjected to an internal discharge test at an applied voltage of 0.67 Vph. Measurement of the actual level shall be made when the applied voltage is being reduced from a level 10 per cent in excess of 0.67 VPH. The voltage shall be maintained at a level of 0.67 Vph for at least one minute before making the actual measurements. (Vph = rated system voltage -kV).

The preferred test method is one which enables the apparent magnitude of individual discharges to be determined but the use of alternative test methods (eg NEMA) will be considered by the Employer/Engineers.

The current voltage shall be discharged free at normal working voltage and shall not exhibit discharge greater than 5 per cent at 0.67 Vph. The discharge level of 0.67 Vph using the NEMA method shall not exceed 5 microvolts.

The test procedure and method of calibrating the instrument and test circuit shall be in accordance with IEC 60270 and subject to the approval of the Employer/Engineers. The results obtained on routine tests shall not be significantly different from those obtained during type tests on the same design of transformer.

- ***Dielectric loss angle measurements***

Measurements shall be made of the dielectric loss angle and capacitance of the primary insulation between line terminal and test tapping of each complete current transformer using a Schering bridge or other means approved by the Employer/Engineers.

The loss angle characteristics shall be recorded over a voltage range of up to 1.2 times phase to neutral voltage. The loss angle measured shall not change with voltage and shall not exceed the value guaranteed in this Specification.

- ***Short time current test***

- ***Temperature rise test***

- ***Lightning impulse voltage withstands test.***

This test shall include both full wave and chopped wave lightning impulse voltage withstand tests as specified in IEC 61869-2.

- ***High voltage, wet test***

The external insulation of the current transformer shall be subjected to a high voltage tests to IEC 61869-2 under the rain test conditions specified in IEC 60060.

- ***Radio influence voltage type tests.***

One complete current transformer of each type being supplied shall be assembled as in service and subjected to radio influence voltage tests in accordance with NEMA Publication No 107.

- ***Internal discharge test***

- ***Dielectric loss angle measurements***

- ***Tests for accuracy***

- ***Magnetization and internal burden tests***

The following magnetization characteristic and internal burden test shall be made and the following test results shall be submitted for each core:

a. A magnetization curve shall be made for one ratio preferably the ratio in the schedules for which the output accuracy class and accuracy limit factor, (if applicable) are listed in this

Specification. The exciting current at the secondary voltage specified in this Specification, or of the emf corresponding to the rated accuracy limit factor, shall be particularly noted.

b. Secondary winding resistance corrected for 75°C for each ratio.

- ***Effectiveness of sealing tests***

Each current transformer when filled with oil to at least the normal level and with all sealed fittings in place, but with pressure limiting devices blocked or removed, shall be subjected for a period of 12 hours to a test pressure, measured at the top of the unit not less than twice the maximum operating pressure at ambient air temperature of 40°C or equal to 0.7 bars whichever is the greater. Gaskets below or above oil level shall not leak oil or air respectively.

- ***Mechanical strength on HV terminals***

HV terminals and their associated parts, mounted on the equipment as in service, shall be able to withstand the following tests, which shall be performed on the HV terminals of each type and size of HV terminal arrangement to be supplied on a given order: -

a. Firstly, a pull of 300 kg applied at right angles to the axis of the terminal stem and in a vertical plane and at the tip of the stem without failure of the terminal stem or its associated parts.

b. Thereafter, a pull of 150 kg shall be applied as in a. above concurrently with a test for effectiveness of sealing.

This test shall produce no significant distortion and there shall be no oil or air leaks.

4.2 Routine tests

Routine tests shall be made in accordance with IEC 61869-2 together with the additional tests as detailed below and in the following sequence.

- ***Verification of terminal markings***
- ***Power frequency tests on secondary windings***
- ***Overvoltage inter-turn tests***
- ***Determination of errors***
- ***Internal discharge test***
- ***Dielectric loss angle measurement***
- ***Power frequency dry test on primary windings***
- ***Repeat of Dielectric loss angle measurement***

- ***Repeat of internal discharge test***

- ***Magnetization and internal burden tests***

5 VOLTAGE TRANSFORMERS

5.1 Type and routine tests

Each type of electro-magnetic and capacitor voltage transformer being provided shall be subjected to the tests specified in IEC 61869-3 and 61869-5 together with the additions and modifications stated below, and in accordance with the guarantees submitted in the Schedules. For coupling capacitors IEC 60358 shall apply.

- ***Radio influence voltage tests***

One complete voltage transformer of each type being supplied shall be assembled as in service and subjected to radio influence voltage tests, in accordance with NEMA Publications No 107 and this Specification.

- ***Verification of accuracy over temperature range***

The accuracy of each type of voltage transformer being provided shall be verified. The accuracy shall be within the levels guaranteed and be determined at the maximum and minimum temperature specified and at least two intermediate temperatures.

- ***Measurement of insertion loss***

When the capacitor voltage transformers being supplied are also to be used as HF coupling devices, a test shall be made on one pair of capacitor voltage transformers complete with intermediate transformers and associated line matching units to determine the insertion loss of the complete arrangement under simulated service conditions.

- ***Short-circuit withstand capability type test***

This test shall be performed in accordance with IEC 61869-3 and 61869-5.

6 INSULATING OIL, SULPHUR HEXAFLUORIDE AND COMPOUND

6.1 Insulating oil

Samples of oil from each consignment shall be tested and shall comply with the tests specified in IEC 60296 for insulating oils, before any oil is dispatched.

6.2 Sulphur Hexafluoride

Samples of SF6 from each consignment shall be tested and shall comply with the tests specified in IEC 60376 and 60480, before any SF6 gas is dispatched.

6.3 Compound

Samples of compound selected by the Employer/Engineer from the bulk shall be tested to prove compliance with the requirements of BS 1858 for the appropriate grade of compound.

7 SURGE DIVERTERS

7.1 Tests on Zinc oxide, gapless type surge diverters

Type, routine and standard acceptance tests shall be carried out in accordance with the IEC 60099-4 metal oxide surge arresters.

Type test certificates will be accepted subject to their approval.

7.2 Tests on surge counters

7.2.1 Minimum current operation tests

The rated minimum operating current of the counter shall be passed ten times and the counter shall correctly register these operations.

7.2.2 Maximum current withstand tests

The maximum rated current stated in the schedules with a 8/20 µsec wave shape shall be applied to the counter ten times without any cooling periods and the counter shall register and withstand without distress.

8 BUSBAR CONDUCTOR AND CONNECTIONS

The tests shall be in accordance with IEC 61089.

9 POST INSULATORS

Each type of post insulator being provided shall be type, sample and routine tested in accordance with IEC 60168, 60660 and the following supplementary tests.

9.1 Radio influence voltage type test

Each type of post insulator being provided shall be assembled as in service and subjected to radio influence voltage test in accordance with IEC 60060 and IEC 60437.

10 INSULATOR STRINGS

Type, sample and routine tests on insulators of the string type, porcelain or glass, shall be made in accordance with the requirements of IEC 60383 and 60815 and the supplementary type tests stated below.

10.1 Dielectric tests

The 50 per cent flashover level as well as withstand shall be determined during the impulse and power frequency tests.

10.2 Radio influence voltage test

Each type of string insulator shall be assembled as in service and subjected to radio influence voltage tests in accordance with NEMA 107, IEC 60060, 60437 and this Specification.

11 TENSION AND SUSPENSION CLAMPS AND JOINTS

11.1 Type tests

All joints and clamps shall be submitted for examination before test and all assembly, cutting off of conductor, compound filling (where applicable), and any work whatsoever necessary for the assembly of the clamps and joints in the field shall be carried out in the presence of the Employer/Engineer with the erection methods and tools proposed for field use. Approval of such methods and tools will be subject to inspection at the time of the tests. The Contractor shall ensure that a reasonable number of his supervising staff shall be present at the type tests.

- ***Mechanical type test***

The following tests shall be carried out on the conductor clamps and joints:

a. Two tension clamps shall be fitted to the end of a length of conductor not less than 6 meters long.

b. A tension joint shall be fitted in the center of a 6 meter length of conductor, each end of which shall be held in a half joint.

For both tests (a) and (b) a tensile load of about 50 per cent of the breaking load of the conductor shall be applied and the conductor shall be marked in such a way that movement relative to the fitting can easily be detected. Without any subsequent adjustment of the fitting, the load shall be steadily increased to 95 per cent of the breaking load and then reduced to 90 per cent of the breaking load and maintained for one minute. There shall be no movement of the conductor relative to the fitting due to slip during this one minute periods and no failure of the fitting.

A slip test shall be carried out on suspension clamps to demonstrate compliance with this Specification and to establish the torque to be applied to the clamp bolt nuts.

Non-tension joints and clamps, and non-tension parts of tension clamps shall be similarly tested to show compliance with this Specification.

- ***Electrical type tests***

The following test shall be carried out on a sample each of tension joints, tension clamps in which the conductor has necessarily to be cut, and non-tension joints. The test shall be carried out on an assembly consisting, where applicable, of a tension clamp, tension joint and non-tension joint, together with a length of the line conductors, the whole being connected in series. The lengths of intermediate conductor shall be cut so that the distance between the mouths of the test fittings shall not be less than 1 meter. The assumed maximum full load current specified at 50 Hz shall be passed continuously through the assembly for a period of 8 hours, followed by approximately 16 hours shutdown, followed by a further 8 hours heat run. At approved intervals throughout this period measurements of temperature rise shall be recorded on the fittings and on the intermediate conductors. Immediately at the ends of the heat-runs accurate voltage drop measurements shall be made on standard lengths, including fittings and conductor. If possible a.c. voltage

drop measurements shall also be made during the heat runs. The temperature rise and resistance per unit length of any fitting shall at no time exceed those of the conductors. Temperature measurements on fittings and conductors shall be made in an approved manner. No tightening up or adjustment of fittings in any way shall be permissible during the progress of the test.

At the conclusion of the test all fittings shall be completely dismantled and there shall be no signs of local heating, burning or fusing on any part of the fittings or on the conductor itself.

All conductor fittings shall be shown to comply with the visible corona and RIV levels specified.

11.2 Sample tests

Sample clamps and joints shall be submitted to such tests as the Employer/Engineer may require in order to demonstrate compliance with this Specification.

12 STRUCTURES

A representative sample of each type of support structure being provided shall be assembled prior to dispatch to site, and loads applied which simulate the specified design parameters.

Such loads shall be withstood without deformation of any structure member.

13 MATERIAL

13.1 Type tests

Samples selected by the Employer/Engineer from metals used in the Contract Works shall be tested to prove compliance with the Specification including the guarantees stated.

14 GALVANISING

14.1 Routine tests

Samples selected by the Employer/Engineer of all galvanized material shall be subjected to the galvanizing tests set out in BS EN 10244-2 (Testing of Zinc Coating on Galvanized Wires) or BS EN 1461 (Testing of Zinc Coating on Galvanized Articles other than Wire) whichever is applicable.

15 AUXILIARY MULTICORE CABLES

15.1 Routine tests at Manufacturers' Works

- ***Conductor resistance***

The dc resistance of the conductors shall be measured by an approved method and shall not be greater than the figure stated in the Schedules when adjusted for temperature.

- ***Voltage test***

The voltage test shall be made with alternating current of approximately sine wave form at any frequency between 40-62 Hz inclusive. The voltage shall be increased gradually and maintained continuously for one minute at 5 kV ac rms between each conductor and the remaining conductors connected to the armour and earthed. No breakdown of the insulation shall occur.

- ***Insulation resistance***

The insulation resistance shall be measured between each conductor and the other conductors connected to the armour. After the application of 500 V dc for one minute, the measured value shall not be less than the figure stated in the Schedules when adjusted for temperature.

- ***Electrical tests on extruded PVC over sheath***

Extruded PVC over sheaths shall be spark tested.

- ***Mutual capacitance***

The mutual capacitance of multipair cable shall be measured between the two conductors of each pair with the other conductors and armour earthed. The measurements shall be made using alternating current and a suitable bridge and the mean value obtained shall be recorded.

- ***Bending test***

A sample of each completed cable shall be subjected to a bending test , the test cylinder diameter being not less than eight times the overall diameter of the cable. After test a 300 mm length cut from the middle of the sample shall be stripped and examined.

16 CONTROL AND INDICATING PANELS, INSTRUMENTS AND SECONDARY WIRING

16.1 Type tests

- ***Mimic diagram panel operation tests***

One typical indicating panel shall be erected as in service and the indicating devices operated to the satisfaction of the Employer/Engineer.

16.2 Routine tests

All panels and instruments shall comply with the tests specified in the appropriate standard Specifications.

The wiring on each panel, cubicle, rack and each removable panel or plate of apparatus shall be subjected for one minute to an alternating voltage equal to the test voltage specified for the apparatus to which it is connected. This test shall take place after the complete assembly of the apparatus and wiring on or in the panels, cubicles and racks.

All wiring and apparatus which is, or may become, connected to voltage sources other than the supply for the very low voltage (50 volts and below) apparatus shall be subjected for one minute to an alternating test voltage of 2 000 volts rms to the frame of the panels on which they are accommodated, immediately after

which the insulation measured at 500 volts dc shall not be less than 20 Megaohm. Included in these requirements is apparatus and wiring which become connected to voltage or current transformers.

The windings and electrical connections of indicating and recording meters shall be subjected for one minute to a test voltage of 2 000 volts rms to the case or any other metal which is not intended to be insulated from the case when the instrument or meter is in use.

17 PROTECTION EQUIPMENT

17.1 Routine tests

All relays shall be subjected to routine tests at the manufacturers works to confirm that they comply with the claimed performance and design limits.

For measuring relays (ie relays which have a defined setting of the input and/or characteristic quantity subjected to accuracy requirements, eg current, time, etc) these routine tests shall include as a minimum the following:

a. Measurement of the assigned error(s) under reference conditions, ie measuring accuracy and operating time characteristics.
b. Measurement of the resetting ratios.
c. Dielectric tests as specified in Clause 6 of IEC Publication 60255-27, the test voltage being 2 kV rms. All normally open output contacts of all relays shall withstand a test voltage of 1 kV rms.

For all-or-nothing relays, the routine tests shall include a check of relay operation and resetting, together with the dielectric tests described above.

Unless otherwise agreed with the Employer/Engineer, all unit protection schemes using either biased differential, current balance or voltage balance principles shall be subjected to heavy current conjunctive tests using the actual current transformer windings which will be used in service. Tests shall be made to prove operating sensitivity, time of operation and to demonstrate stability of the protection under the worst transient external fault conditions. Tests will only be waived if the manufacturer is able to produce type test results for an identical scheme. In this case it will be sufficient to prove that individual component characteristics are identical, eg current transformers are of the same design, have the same magnetization characteristics, knee-point voltage and secondary resistance.

For protection schemes including distance protection, phase comparison protection, auto reclosing and automatic switching sequence schemes, etc routine tests shall be performed on each complete scheme to ensure that all possible operational sequences and features are fully functional. Where necessary, this shall be done using simulation of any ancillary equipment normally used in conjunction with the scheme, e.g. circuit breakers. These routine tests will be performed in addition to the tests normally applied to individual elements of the scheme and details of the proposed test program shall be submitted to the Employer/Engineer for approval not less than one month before they are to be performed.

If such routine tests are not practicable due to the complexity of the scheme, a scheme type test will be accepted on representative production equipment. The test shall be performed so as to simulate, as nearly as possible, the conditions which will be experienced in service and details of the proposed test program shall be submitted to the Employer/Engineer for approval not less than one month before they are performed. In those cases where correct operation of the scheme is dependent on measured quantities associated with primary system plant (eg circuit breaker gas pressure), such quantities shall be measured directly during the tests.

Each circulating current protection scheme must fulfil the following routine testing requirements:

a. Each current transformer, which must be of the low reactance type, shall be individually tested for turns ratio, secondary winding resistance and excitation characteristic up to a secondary voltage equal to 120 per cent of the "knee-point" voltage.
b. The VA consumption at operation of current operated relays shall be measured and shall not exceed the maximum value declared by the manufacturer.
c. The operating current of voltage relays shall be measured and shall not exceed the maximum value declared by the manufacturer.

17.2 Type tests

Approved type tests shall be carried out in the manufacturers works on each type of protection system. During the tests, ancillary equipment shall be erected and connected so as to reproduce service conditions as closely as possible. The main purpose of these tests shall be to determine the performance of the protection for the range of system conditions which will be encountered by the protection in practice, and to determine all the appropriate application parameters. The test condition shall be as agreed by the Employer/Engineer.

Where type tests have been carried out under previous contracts on protective equipment similar in all essential respects to the equipment included in the Contract, the Employer/Engineer may waive the type tests on production of complete test records which he approves, relating to the equipment concerned. Each set of test records shall include a full statement of the performance claims, eg performance under reference conditions, effect of influencing the quantities, steady state and dynamic stability for unit protection schemes, current and voltage transformer requirements, etc and full details of tests performed on representative samples of production equipment to demonstrate that the performance claims have been met.

For circulating current protective schemes using high impedance relays, calculation of the predicted performance will be accepted in lieu of type testing of each individual scheme. Type test results must, however, be available for inspection by the Employer/Engineer to show that heavy current conjunctive tests have been performed on a representative scheme to prove the stability and operating time performance.

18 TELECOMMUNICATION EQUIPMENT

The type tests, FAT tests and site tests of telecommunication system equipment shall be according to the relevant clauses included in the Technical Specification Part A.

19 BATTERIES AND ASSOCIATED EQUIPMENT

19.1 Battery

A full charge and discharge cycle shall be performed on one element to verify the suitability of the chosen battery to suit the required performances.

19.2 Battery charger

19.2.1 Constant voltage chargers.

Tests shall be carried out to show that the output voltage remains constant with any combination of the stated input voltage, frequency and load variations and the output voltage on each voltage tap shall be measured at rated load and frequency.

The efficiency shall be measured at normal output voltage and current and normal input voltage and frequency.

Tests shall be made to prove that the insulation resistance of the transformer complies with this Specification.

The output terminals of the charger shall be short circuited and the output current measured. This shall not be greater than the value given in the Schedules.

In the case of 50 volt battery chargers only, tests shall be made to show that the psophometric noise level specified is not exceeded and for this purpose the following notes shall be observed.

19.2.2 Boost chargers

Tests shall be carried out to prove compliance with the particulars given in the Schedules.

Tests shall be made to prove that the insulation resistance of the transformer complies with this Specification.

20 LOW VOLTAGE SWITCHBOARDS (BOTH AC AND DC)

Type and routine tests shall be performed in accordance with IEC 61439. All individual components contained in the switchboard shall be tested in accordance with the relevant part of this Specification.

21 AUXILIARY AND EARTHING TRANSFORMER

Routine, type and special tests shall be carried out in accordance with IEC 60076.

22 DIESEL GENERATOR SET

The diesel motor, the electric generator and auxiliary equipment shall be mounted on their basement to verify that all parts match one-each-other.
In addition to standard tests, the following shall be done:

a. Measurement of the vibrations of the complete set
b. Measurement of the noise without and with shelter
c. Measurement of fuel consumption at rated load

23 FIRE PROTECTION EQUIPMENT

All parts of the fire alarm system, fire extinguishers and transformer fire protection system shall be tested in accordance with the appropriate IEC or other standards to the approval of the Employer/Engineer.

24 TESTS AT SITE

After the plant and ancillary equipment have been erected and connected up on site, the Contractor shall carry out to the satisfaction of the Employer/Employer/Engineer such tests as may be required to prove compliance with the specification, independently of any tests carried out at the manufacturer's works.

Not less than thirteen weeks before any section of the plant is required to enter commercial service, the Contractor shall submit for the approval of the Employer/Engineer his detailed site test proposals for that section of the plant, together with details of the test equipment and methods that he proposes to use. Subject to approval of the tests, these will be written by the Employer/Engineer into an overall program of tests, which will be issued to all directly concerned prior to the starting date for the tests.

The Employer/Engineer shall have the right to witness all tests, and the results must be available to him as the tests proceed. He may recommend waiving of some tests, or may add further tests if considered necessary to prove compliance with the Specification.

Clear records of all tests necessary before the plant can be regarded as ready to be first connected to the Employer's system shall be maintained by the Contractor and submitted to the Employer/Engineer.

Initial energizing and all subsequent 'live' tests will be directed by the Employer/Engineer, and carried out jointly by the Employer, Contractor and Employer/Engineer. They will be subject to the Employer's standard safety procedures, and all operational switching will be carried out by the Employer according to a detailed program which the Employer/Engineer will prepare and which will be agreed in advance between all three parties.

During these 'live' tests the Contractor shall remain responsible for the performance of his plant.

A record of the results of the tests in this category will be made available to the Contractor by the Employer/Engineer.

The Contractor shall submit to the Employer/Engineer for approval a list of recommended settings for all protection and other types of automatic equipment, not less than thirteen weeks before such equipment is required in commercial service. Where the settings involve discrimination with settings of an existing network or plant supplied under a separate contract, the relevant information will be supplied to the Contractor.

The program for system tests will be issued by the Employer/Engineer, who will be responsible for their overall direction.