INSPECTION STANDARD

FOR

PRECOMMISSIONING ELECTRICAL TESTS

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APPENDICES: CHECK LISTS AND / OR TEST SHEETS

ATTACHMENTS:

1. SCOPE

1.1 This precommissioning instructions cover the preacceptance test carried out by the contractor before any equipment is handed over for commissioning. These inspections and tests are additional to the full inspections and tests carried out already at manufacturer's work.

Equipment may consist of:

a) Switchgear, load centers, motor control centers and individual motor starters;
b) rotating electrical machines such a motor and generators;
c) transformers and transformer rectifiers;
d) batteries, inventers and UPS;
e) power factor improvement equipment;
f) cabling, wiring and earthing;
g) protective devices and meters;
h) overhead distribution and transmission power lines;
i) distribution boards, isolators and fuse switches.

1.2 The results of the tests shall be recorded on the test record sheets typical copies of which form part of this Standard, and the master copy of these sheets will be held by Company. After completion of the work test sheets shall be returned to the client for filing.

1.3 Visual inspection of all equipment and materials shall be made before and during installation and testing to ensure that they are correct to the design criteria, and functions correctly, that they are not damaged and have not been deteriorated due to storage or other causes.

1.4 The tests shall be to the satisfaction of and witnessed by the Engineer or his representative who will signify acceptance by signing the appropriate section of the test sheet.

2. REFERENCES

In implementation of this Standard the latest edition of the following standards shall be applied.

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 55	"Paper Insulated Metal Sheated Cables"
IEC 56	"High Voltage Alternating Circuit Breakers"
IEC 76	"Power Transformers"
IEC 156	"Method for the Determination of the Electric Strength of Insulating Oil"
IEC 157	"Low Voltage Switchgear and Controlgear"
IEC 296	"Specification for Unused Mineral Insulating Oils for Transformers and Switchgear"
IEC 422	"Maintenance and Supervision Guide for Insulating Oil in Service"
IEC 439	"Low Voltage Switchgear and Controlgear Assembly"
IEC 694	"Common Clauses for High Voltage Switchgear and Controlgear Standards"

BSI (BRITISH STANDARD INSTITUTE)

BS 142	"Electrical Protection Relays"
BS 4999 Part 140	"Specification for Voltage Regulation and Parallel Operation of Synchronous Generations"
BS 5000 Part 99	"Machines for Miscellaneous Application"
BS 6651	"Code of Practice for Protection of Structures Against Lightning"

3. SAFETY

It is a must that inspection and testing personnel should be fully familiar with the operation of the various equipment that they are called upon to handle.

Electrical equipment are regarded to be capable of giving rise to danger. Access to part which may be live should therefore be prevented preferably by physical means such as locked enclosure, when access for work on or about such equipment is necessary it should be restricted to qualified persons having sufficient technical knowledge to avoid danger. No person should carry out any testing on any part of apparatus which are normally live unless the following steps are taken:

1) The part to be tested to be made dead.

2) Isolated and all practicable steps taken to lock-off from live conductors.

3) Checked where practicable with voltage indicator.

4) In the case of high and medium voltage apparatus, efficiently connected to earth at all points of disconnection of supply to such apparatus.

5) Adjacent equipment screened where necessary to prevent danger, and "CAUTION" and "DANGER" notices affixed.

6) Released for work by the issue of "Permit to Work" where appropriate.

It is the duty of the person issuing the "Permit to Work" to ensure that the foregoing provisions are complied with and that the person carrying out the work is fully conversant with the nature and extent of the work to be done and with the location of equipment which will remain alive.

Before returning the electrical equipment to service, a final check should be made of the complete apparatus to ensure that all parts are in working order.

Tools or appliances that have been employed during the inspection and test should be checked to ensure that none has accidentally been left inside the apparatus, and that all temporary earth conductors and devices have been removed. Omission of this precaution has been known to cause serious accidents.

Smoking or the exposure of naked flame such as blow lamp is not allowed where there is the risk of gas explosion or fire hazard.

4. FIRST AID

A placard of instructions for the treatment of persons suffering from electric shock should be affixed in a prominent position. It is desirable that all inspection personnel be trained in the application of the artificial respiration.

First aid equipment should be made available for treatment of burns, cuts and abrasions, the address and telephone No. of the nearest Dr., first aid center, or hospital should be prominently displayed on the premises.

5. PERMIT TO WORK

A permit to work is a written authorization to carry out work on or about electrical apparatus, signed by or on behalf of the person or whom the Owner's responsibility for safety of supervision rests. It should, as a minimum, set out clearly and concisely the apparatus on which the work is to be done, the extent of the work and the precautions which are to be taken to ensure that the apparatus designed is safe to work on.

Permits to work should only be issued by persons specially authorized in writing by the client to do so. The permits should be numbered serially for reference and should be in duplicate. One copy should be retained by the issuer and one

copy handed to and signed as an acknowledgment of its terms by the person carrying out or incharge of the work; he should retain it until the work is completed or stopped.

When the work is completed or stopped, the appropriate section of the permit should be signed by the person to whom it was issued and the permit returned to the issuer for cancellation. In those cases where the permit is returned prior to the completion of the work a note to that effect should appear on the permit, and work should not be recommended until a fresh permit is issued.

The apparatus designated in the permit or permits as "dead" must not again be made alive until every permity covering that apparatus has been cleared by the person to whom it was issued and returned to and canceled by the issuer.

When a person authorized to issue permits to work on the apparatus himself, he should complete a permit to work form, to ensure that he is taking the same precautions as he would, when authorizing work by others.

Before carrying test, visual inspection shall be carried out to confirm that the installation and material are according to the drawing.

6. a.c. MOTORS TESTS

6.1 Insulation Tests

The earthing of the frame pedestals and any contactor cubicle or switchbox shall be checked with appropriate ohm meter. An insulation resistance test shall always be made before connecting to the supply, preferably a few days before the motor is required for service to allow time for drying-out necessary.

A final insulation resistance test, including associated if switchgear and cables, shall be made immediately prior to the first switching on. A value of at least 10 Meg.ohms for LV motors and approximately 50 Meg.ohms for motors cod at 3.3 kV and above is usual for machines which have not been exposed to damp.

If values lower than 2 and 5 Meg.ohms for LV and MV motors respectively are obtained, the motor shall be dried out.

6.2 Drying Out

In general, motors wound for medium voltages are more likely to need drying out than those with LV windings, due to the greater insulation thickness. Also the dry-out period is likely to be longer. The value of insulation resistance to earth measured cold, is not an entirely reliable basis for deciding whether drying-out is essential before energizing. Even if the majority of the insulation is wet, a very slight drying influence will remove the moisture from the other layers and a good value of resistance will be measured.

Once the conductors are warmed by current the moisture will distribute itself through the insulation and the resistance will fall. A phase to phase insulation check often gives the gaps which should be measured with feelers extending the whole length of the motor core, and a second set of readings taken with the rotor turned through 90°, where plain journal bearings are fitted and no provision is made to take thrust load, rotor position shall be checked to ensure that excessive rubbing does not occur.

To avoid eccentric positioning of the rotor in the stator bore, the following procedure for air gap check shall be followed:

a) The air gap space shall be inspected, by torch light for stator winding wedges condition.

b) The air gap checking as explained above shall be carried out at 12 O'clock, 3 O'clock, 6 O'clock and 9, O'clock positions.

c) The rotor shall be turned by 90° and the air gaps checked as stated in (b) above once again.

6.3 Air Gap and Alignment

Where large motors with pedestal bearings have to be erected on site the air gap shall be checked in all sectors. The gap should be as stated on the test certificate, with a discrepancy of not more than ±5% in the four sectors. If possible run for checking correct direction of rotation. Some drives use a nut threaded to tighten under the normal direction of torque and a impulse applied in the reverse direction can have serious consequences. In the event of the rotation of an a.c motor being incorrect. It is normally only necessary to reverse any two phase connections at the most convenient, point, however, in the case of motors with special method of speed control, instruction of the manufacturer shall be accurately followed.

In any case the motor shall be run and checked for correct direction of rotation. Whatever the method of starting is designed.

6.4 Final Checks and Direction of Rotation

In the case of large motors the pedestals insulating joints, dowel pins and earthing connections shall be checked in accordance with the manufacturers recommendation. To avoid circulating current resulted from induced voltage from stator core, one side of the pedestal earth connection shall be opened. The transportation break pads, inside the sleeve bearing shall be removed. Before an initial run is taken as a precaution the overload setting shall be reduced and the time lags removed to ensure rapid tripping. This change of setting shall be carried out in such a way that motor will not trip during start up period.

6.4.1 A complete check of lubricating system shall be carried out for ascertaining:

a) Proper functioning of lub-oil pressure and associated safety devices.

b) Proper fitting of insulating flanges, gaskets and other bypass-oil pipe line fittings, to ensure that the lub-oil supply lines do not bypass the bearing insulation.

Before energizing the motor the terminal nuts and earth connection nuts shall be checked for tightness, also that the terminal box and bushings are free from moisture and dirt. For motors wound for 3.3 kV and above the above checks are most important. In addition the cable box shall be checked for compound level. Starting the motor before filling insulating compound inside the cable box shall be avoided. The motor bearings shall be checked to ensure that they have been supplied with the appropriate lubricant, as specified by the manufacturer. The motor shall be uncoupled from the driven unit and more reliable indication of the wetness of the windings. A combination of heating and ventilation is necessary for drying-out. This may be achieved in one of the following ways:

a) A combined electrical heater and fan blowing hot air through the windings.

b) Small heaters may be placed within the frame; some large machines have built in heaters.

c) The motor, with locked rotor, may be connected to a separate low-voltage a.c. supply. If necessary with a resistor in series, to circulate not more than 80% full load current through the windings.

d) If no suitable a.c is available, all windings should be connected in series and supplied from a variable voltage d.c source such as a motor-generator or battery charger. Care should be taken to ensure that the heating is not equivalent to more than 80% full load.

In each of the above cases the frame shall be suitably covered to reduce heat losses and permit the insulation to reach a higher temperature. End covers or inspection plates must be removed to permit water vapor to escape, otherwise the moisture will merely be transferred to the cooler parts of the frame.

Where direct heating is employed, (c) and (d), the current shall be continuously measured. In all cases, values of insulation resistance shall be taken every hour until it becomes constant for a number of hours.

With slip ring machines the rotor shall be short circuited during the dry-out, in order to dry the rotor winding at the same time.

Methods (a) and (b) are the safest although they will probably take longer. Methods (c) and (d) must not be used if the windings are very damp.

Methods (a) and (b) are the safest although they will probably take longer. Methods (c) and (d) must not be used if the windings are very damp.

Method (d) is especially dangerous in this connection, as partial impregnation of the insulation by copper salts formed by electrolytic action is possible.

In general it is far better to ensure that all motors are stored in dry, warm conditions from the moment they are received and if this is not possible, heaters, of quite low rating, placed within the windings together with tarpaulins covering the stator are adequate to preserve the insulation until the motor is needed. Quick high temperature dryouts are not permitted.

6.4.2 If the direction of rotation is correct then the motor shall be run for several hours and tests be made for the followings:

a) Proper lubrication of bearings and operation of lubrication, safety pressure switches, if applicable.
b) Free from leakage of lubrication oil from the pedestals and ingress of lub-oil into the stator.
c) Bearing noise or heating.
d) Local heating of windings.
e) Excessive noise or vibration whilst the motor is running.
f) Recording no load current and comparing with manufacturer's test certificates.
g) Speed.

6.4.3 The motor shall be coupled to the driven unit and the, coupling shrouds fitted for personnel protection; it is most important that the unit does not turn without these. The driven unit bearings are to be adequately lubricated and if applicable, bearing cooling water checked for, flow. The motor shall be run on full load and the speed, temperature, vibration of bearings, full load current and the balance of current in the three phases shall be checked. If motor protection relays are used they shall be checked visually for stability indication.

7. MOTOR PROTECTION

Motor protection is usually provided by either thermal or magnetic overloads, undervoltage relays, stall relays and differential protection relays with fuses as back-up. Before commissioning the following tests are required:

7.1 Operation Tests

7.1.1 Overload protection

A current of minimum operation value shall be injected into the motor starter and the time taken for the relay to trip compared with the manufacturer's curve. A check shall be made at other values of current in excess of 110% and the time again compared with the curve.

7.1.2 Undervoltage protection

The supply voltage shall be reduced to 85% of rated voltage, at which value the relay should not trip. Reduce the voltage still further and note that the relay operates.

7.1.3 Differential protection

The polarity of currant transformers located inside the circuit breakers shall be checked to be in line with the motor supplier current transformers drawings located inside the motor. To compare current values at both sides of the motor phase windings and ensure proper operation of the relay upon incept of earth/phase to phase fault, all six CTS shall be short circuited one by one and the relay shall operate and trip the motor starter on its respective phase.

7.1.4 Stall protection

The relays trip contacts operation time and the magnitude of the injected current for trip operation shall be in line with the stall protective relays manufacturers supplied curves and the actual motor acceleration time from stand still to synchronous speed at applied load.

7.1.5 Field application relays

The automatic/manual operation of synchronous motors field supply contacts shall be checked and ensured that the circuit breaker operates at full rated torque.

7.2 Stability Tests

Start the motor several times and note that the relays & trips do not operate. For large motors the number of starts/hour shall be in compliance with manufacturers recommendations.

8. TRANSFORMERS

8.1 Insulation Tests

Using a 1000 V or 5000 V (as appropriate) insulation resistance test set to make the following tests:

a) Check earthing of tank and the secondary wiring system.

b) MV to LV winding.

c) MV winding to earth.

d) LV minding to earth.

These values shall approach infinity.

e) Check core to tank insulation with 500 V insulation resistance Test Set having first opened the appropriate link or connection. Verify subsequently the integrity of this connection if applicable.

The condition of the oil shall be examined as follows:

a) Crackle test for moisture in oil.
b) Pressure test for breakdown strength.
c) A detailed oil test procedure is given in Clause 14 of this specification. A sample may be requested for an acidity test. The standards covering transformer and switchgear oils are given in: IEC 296 (1982) and IEC 156 (1963).

8.2 Drying Out

A dry out will be necessary, at the discretion of the Engineer, in any of the following circumstances.

8.2.1 If the winding insulation resistance readings are below 200 Meg.ohms.

8.2.2 If the oil has a low breakdown strength.

8.2.3 If the winding has been removed from the tank.

8.2.4 Transformers shipped in dry air or nitrogen should have pressure in them when opened. If there is no pressure left, the winding shall be dried out.

8.2.5 In any event the manufacturer shall be contacted for special instruction before a dry out is carried out.

8.2.6 Drying out may be carried out using a centrifugal purifier, in which a heater unit forms part of the equipment. The warmed oil shall be returned to the bottom of the transformer tank to assist in driving off moisture from the windings and returned to the centrifuge from the top of the transformer tank.

In transformers equipped with inlet and outlet pipe for dry out the centrifugal purifier shall be connected according to instruction.

The transformer can be considered "dried out" when the insulation resistance, having dropped initially, rises and reaches a steady value with a constant temperature being maintained.

8.3 Tap Changer Equipment

If off-load manually-operated equipment is installed, this shall be operated several times to ensure freedom of movement, and the voltage ratio checked at each tap. An estimate of the most suitable tap shall be made and the transformer left and locked at this ratio.

If the transformer is provided with on-load remote operated tap changer equipment all the secondary wiring shall be insulation resistance tested and earthing of cubicles and bonding verified. The voltage ratio on each tap shall be checked and several runs over the complete tap range made in quick succession.

8.4 Cooling Equipment

If provided, the oil circulation and cooling pumps and fans shall be tested, especially any automatic start arrangements.

8.5 Measurement of Voltage Ratio and Check of Voltage Vector Relationship

According to Sub-clause 8.3 of IEC 76-1, the voltage ratio shall be measured on each tapping. The polarity of single phase transformers and the connection symbol of three phase transformers shall be also checked.

8.6 Measurement of No Load Loss and Current

For measurement of no load loss and current carry on test according to Sub-clause 8.5 of IEC 76-1 (1976).

9. TRANSFORMER PROTECTION

Some or all of the following protection systems are usually provided for transformers:

- Differential
- Restricted Earth Leakage.
- Overload and Earth Fault As Back-up.
- Buchholz.
- Temperature.

Before commissioning, the following tests are required at the discretion of the Engineer.

9.1 Operation Tests

9.1.1 Differential protection

According to relay manufacturers publication the polarity of the current transformers should be checked and a.c. current shall be injected through any one current transformer and the tripping of the differential protection relay is to be noted.

9.1.2 Restricted earth fault

After polarity check as above, a.c current shall be injected into the neutral current transformer and the tripping of the restricted earth fault relay noted.

9.1.3 Overload and earth leakage

a.c current shall be injected into one CT and a short circuit placed on the earth leakage coil. For various values of primary current note the times required for the overload relay to operate. Remove the short circuit from the earth leakage coil and short the overload coils. For various values of primary current note the times required for the earth leakage relay to operate. The setting of time multipliers shall be done according to manufacturer instruction.

9.1.4 Temperature detector device

The temperature detector device shall be checked according to manufacture instruction and test procedure.

9.2 Stability Tests

9.2.1 Differential

A short circuit shall be placed on the three phases outside the protected zone. The current shall be built up to full load, at which value the relay should not operate and the low impedance milliammeters placed in circuit should not read more than 10 mA out of balance.

9.2.2 Restricted earth fault

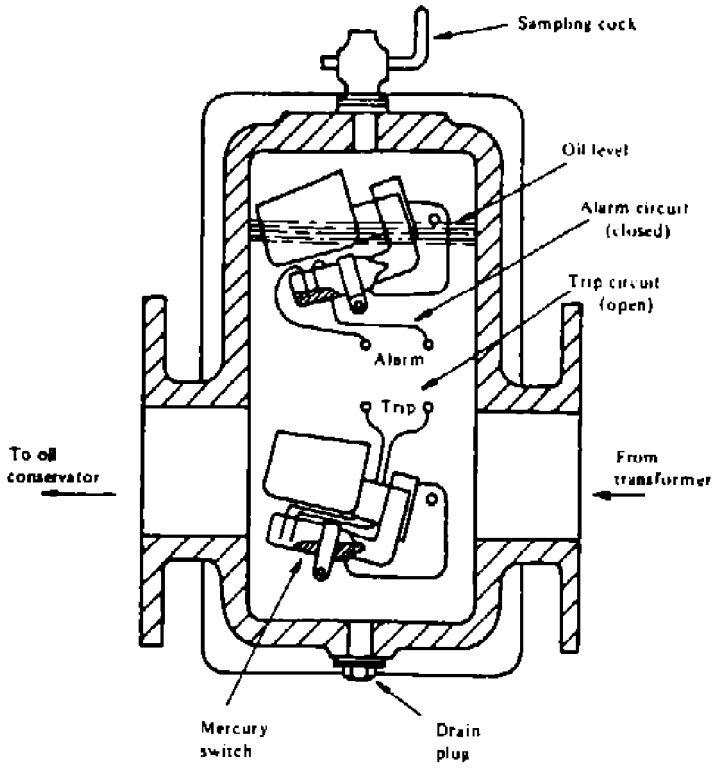
Inject current through a phase CT and the neutral CT and check that no spillover occurs in the earth leakage element. Repeat for each phase.

9.2.3 Overload and earth leakage

Set the overcurrent relays plug at 50%; 75% and 100% repeat 9.2.1, bring up the current, note the tripping of the overcurrent relays and also that the time for operation is appropriate and in compliance with the manufacturer recommendation.

9.3 Buchholz Relay

Tests to be carried out in accordance with Sheet 1 of 3. For power transformer physical check and tests an illustration of buchholz follows:



BUCHHOLZ
Fig. 1

10. ALTERNATORS

10.1 Inspection

A visual inspection shall be made to verify the correct air gap, that bearings are free and that the lubricating system is free of dirt and foreign matter.

10.2 Drying Out

10.2.1 Where necessary dry out shall be accomplished before a new alternator is run up and excited to full voltage. Even if a cold insulation resistance test shows a high value of insulation resistance, there may be moisture trapped which will be released during the initial heating of the coils.

10.2.2 The makers instructions for drying out must always be followed. The normal method is to run the alternator on short circuit at full rated current and reduced speed when applicable so heating both stator and rotor windings.

10.2.3 Where a very low exciter current is required a close watch should be made to ensure that the excitation and short circuit currents do not rise due to exciter instability.

10.2.4 Generally

For medium voltage alternators (11 kV upward) the following insulation resistance figures are experienced, exciter field not less than 100 Meg.ohms alternator stator not less than 200 Meg.ohms, and alternator rotor not less than 50 Meg.ohms. For measuring the stator and rotor insulation resistance a 2500 Volt and 500 Volt insulation resistance test sets may be used respectively.

10.2.5 For 3.3 kV and 6.6 kV alternators use 1000 Volt and 500 Volt insulation resistance test sets for stator and rotor respectively.

10.2.6 During drying out, the correct function of thermocouples and alarm systems, if provided shall be noted.

10.3 Short Circuit Curve

If requested by the Engineer and since the necessary connections are already made, the dry out is to be followed by a test to ascertain the short-circuit characteristic of the alternator. The relationship between the stator current in all three phases and the field current shall be plotted for a series of values. This should normally be carried out at full speed, although small speed variations will be insignificant. The values of stator current for each phase must be closely comparable.

10.4 Stator High Voltage Tests

BS 4999/5000 covers this test.

Care shall be taken that all ancillary equipment e.g. V.T.'s, unit transformers, cables etc. are disconnected. Immediately before applying the test voltage a megger check shall be made. The stator test voltage, from an a.c source, is (twice the rated voltage + 1 kV) × 0.85, applied for 1 minute.

If no a.c source is available the test may be made using a.d.c supply and in this case; the test voltage is 1.2 × the equivalent a.c test value, applied for 1 minute.

10.5 Phase Sequence

Before phasing in, it is essential to ensure that the phase sequence of the incoming alternator and the bus bars are the same by either:

a) Phase sequence indicator
b) Synchroscope
c) Lamps

11. ALTERNATOR PROTECTION

Some or all of the following protection systems are usually provided for alternators:

- Differential protection
- Negative phase sequence (NPS)
- Field failure protection
- Overcurrent and earth leakage as back up
- Interturn protection to machines with windings
- Revers power
- Protection against field earth fault
- Over temperature
- Overvoltage and undervoltage protection.

Before commissioning an alternator, the following tests are required, at the discretion of the Engineer.

11.1 Primary Injection Tests

a.c current shall be injected through each terminal so that it energises one current transformer only and the tripping of the corresponding differential protection relay shall be noted.

11.2 Trip Tests

Close field switch, main alternator and earthing circuit breakers with jumpers plugged in, and carry on as follows.

11.2.1 Push the emergency stop button, if provided, and all three above mentioned switches should trip.

11.2.2 Operate the differential protection and NPS (negative phase sequence) relays manually, all switches should again trip. Operation of the differential protection relay should also usually trip the circulating air fan and steam emergency stop valve if provided.

11.2.3 Operate overcurrent relays manually. The main alternator circuit breaker should trip.

Note:

The overcurrent relays may be designed as backup to differential protection in which case they should trip the same circuits as the differential protection.

11.2.4 Operate the auto fire fighting relay (if provided) all switch gears and drive control system should trip.

11.3 Fault Tests

11.3.1 Phase fault tests

A short circuit shall be made between two phases within the protected zone. (In the case of alternator transformer until the protected zone is extended to include the primary and secondary windings of the main transformer.) Current shall be increased by the exciter rheostat until the corresponding differential protection relays operate.

11.3.2 Earth fault tests

One phase in the protection zone shall be connected to earth and the excitation shall be gradually increased until the corresponding differential protection relay operates. The value of the fault current to produce relay operation should be in accordance with the manufacturer's specification, generally this is about 15% FLC.

11.3.3 Field fault

The main field terminal shall be disconnected or earthed and, if provided with an alarm, the appropriate signal noted.

11.4 Stability Tests

11.4.1 A short circuit shall be placed on the three phases outside the protected zone. The current shall be increased to full load, at which value, the NPS (negative phase sequence) and differential protection relays should not operate, and the low impedance milliammeters in the differential protection circuits not read more than 10 mA out of balance.

11.4.2 Set the overcurrent relays plug at 50%, 75%, and 100%, repeat 11.4.1, increase the alternator current, note the tripping of the over current relays and also that the time for operation is appropriate to these settings. The setting of the overcurrent relays shall be high enough to act as back-up to the differential protection relays and not operate on normal overload conditions.

11.4.3 Connect any two phases together or any one phase to earth, outside the protected zone. Increase the current to more than the NPS (negative phase sequence) setting and note that the NPS relay trips.

Note:

When carrying out fault tests and stability tests on a turbo-alternator, run the machine with reduced r.pm to prevent over-heating of the turbine exhaust hood where applicable.

12. CIRCUIT BREAKERS

12.1 Cleaning and Oil Filling

The circuit breaker tanks shall be cleaned by using chamois leathers soaked in clean oil, not cotton or rag cloths since fibrous particles will be left behind.

The tanks shall be filled with insulation oil to IEC 296 (latest edition). A sample of oil should be taken either from the bottom of the tank or, by dipping in a tube and extracting a representative sample. This shall be tested for moisture and breakdown as described in Clause 7.1, of this standard check the acidity of the oil, if there are definite suspicions then treatment and handling of oil shall be carried out in accordance with BS 5730 # IEC 422. In the case of sealed chambers a space of approximately 5% of the total volume shall be left unfilled to allow for expansion.

12.2 Electrical Inspection

Check all main conductors for proper clearance, clean and polish all porcelain insulators for hairline cracks, since these will absorb moisture and may lead to electrical failure. Insulation resistance test all control and secondary wiring with a 500 Volt set to ensure the insulation resistance is not below 10 Meg.ohms. Insulation resistance test the main conductors with V.T.'s removed using a 1000 Volt insulation resistance test and check the insulation resistance approaches infinity.

12.3 Electro-Mechanical Inspection

Clean off all protective greases and dust from the mechanism and contacts. Very slight lubrication should be applied to fulcrums and joints. Excessive lubrication must be avoided as this will lead to dust traps and the lubricant may become plastic at low temperatures. In all cases it is advisable to refer to the manufacturer's instructions before lubrication. Visually inspect tank linings, cross-bars, contacts and lifting bars. Check the circuit breaker operation by slow closing and opening.

The alignment of the contacts shall be checked with "two AVO" meters simultaneously. Ensure that contact is made by the fingers and examine the contacts for marks of point or no contact. Visually inspect the isolator male and female contacts and ensure that the isolator locking device indicator corresponds with the isolator contacts full engagement. Close the circuit breaker a number of times by the solenoid and check that:

a) Fierce closing and bouncing does not occur.

b) Feeble closing does not occur at the end of the stroke as the contacts meet.

If these defects are noted, dashpots (if provided) shall be adjusted so that the closing stroke takes place smoothly.

c) Check the busbar joints nuts and bolts once again according to manufacturers specification before insulating material such as polyurethane foam, exposy resin and PVC encapsulation is applied.

d) The breaker should close with 80% normal closing voltage and trip with 50% normal voltage. Tap the batter-ies to check operation at these reduced values.

12.4 General Examinations

Examine all auxiliary switches and contacts for adequate pressure, and robust construction and fitting. Check nuts for tightness, and cable lugs for efficient fitting. An approved method of fixing a cable lug to a terminal is to lock the lug between two nuts onto a stud in the terminal bar. In this way the expansion and contraction of the bar will not slacken the nuts. Operate all circuit breakers, isolators and other switches to ensure that the indicating devices show their correct position. Examine all switchgear earthing. See Clause 19 of this specification.

13. HIGH VOLTAGE TESTING

13.1 Circuit Breaker

The a.c test voltage shall be carried out on circuit breaker according to table indicated below if the cables are not connected, the switchgear, busbars and CT chambers may be tested together. If the cables are connected, then the switches must be isolated and tested separately. The CT chambers and spouts shall be tested as part of the cable, subject to approval of the switchgear manufacturer. Tests shall be made as follows:

a) Each phase to earth with the other two phases earthed.
b) Across the circuit breaker contacts. All the phases shall be joined together on each side of the contacts and the voltage applied between the busbars side and the cable box side.

The circuit breaker frames must be earthed during all the tests. The secondary windings of the C.T.'s shall be short circuited. If the CT chamber and cable box are included for test with the cable a.d.c source will be used. This shall be applied for 15 minutes and should be in accordance with the reduced voltages for cables given in the BS 6480 or IEC 55 as reproduced in this standard in Sub-clause 12.2. (The switchgear manufacturer must give approval before making this test.) After HV testing all parts must be discharged to earth before handling, and finally insulation resistance test, described in section 12.2 shall be carried out. Pressure tests at power frequency shall be carried out on high voltage circuit breaker and fuse switches at set out in BS 5311/IEC 56.

Test Voltage (new equipment only)	Test Voltage old equipment only	Voltage of Equipment kV (rums.)
28,000	18000	12
20,000	11400	7.2
10,000	6400	3.6

13.2 Cables

Before testing, all cable boxes shall be visually inspected to ensure that they are free from moisture and dirt, and that any filling compound is at the correct level. It should be noted however that when selecting a conductor size for use in a motor circuit it should be chosen so that the voltage at the terminal of the motor-when running under full load is in compliance with regulation 522-08 of the IEE wiring regulation sixteenth Edition (1991).

Additionally it is a must that the cables specified in this standard shall be installed only when both cable and ambient temperatures are above a temperature of 0°C and have been so kept for the last 24 hrs. or when special precautions have been taken to maintain the cable above this temperature to avoid risk of damage during handling. Also none of the cables specified in this standard shall be bent during installation, to a radius smaller than the following values: agreeing with BS 6480 (1988).

Voltage		Minimum Bending Radius During Installation	
		Twin and multi core	Single-core
Up to and including	6350/11000	12 D	15 D
	12700/22000	15 D	18 D
	19000/33000	18 D	21 D

Where D is the overall diameter of the cable.

13.2.1 For cables of 3.3. kV and below by use of 500 V. megger, a MV insulation resistance test should always be made lasting two minutes but in any event until a stable value is indicated. If the insulation resistance is low the leakage current will be large compared, with the capacitive current and the final reading will be reached immediately. If the leakage current is small, and since the capacitive current takes some time to reach its final value, the instrument will not give an accurate reading until a sufficient time interval has passed. The value of insulation resistance should approach infinity.

13.2.2 Above 3.3 kV the cable shall first be insulation resistance tested and then pressure tested in accordance with the following figures.

EXTRACT FROM BS 6480 (1988) /IEC 55
TEST VOLTAGE AFTER INSTALLATION

1	2	3	4
VOLTAGE DESIGNATION	TEST VOLTAGE (d.c) BELTED CABLES		SINGLE-CORE AND SCREENED CABLES
	Between conductors	Between any conductor and lead or lead alloy sheath	Between any conductor and lead or lead alloy sheath
	Volts	Volts	Volts
600/1000	3500	3500	3500
1900/3300	10000	5800	6000
3800/6600	17000	9800	10000
6350/11000	25000	14400	15000
12700/22000	—	—	30000
19000/33000	—	—	45000

Note:

The voltage applied shall be equal to SKV per millimeter of specified thickness of oversheath subject to a maximum of 25 kV.

13.2.3 Voltage tests on cables with higher ratings than these tabulated are generally made using a.d.c voltage is given by (2X system line voltage). The voltage in all cases must be applied gradually and maintained for 15 minutes. After a.d.c test the cable must be earthed for at least five minutes before it is handled, otherwise a high voltage can appear at the conductor due to the energy stored in the dielectric during testing.

13.2.4 Multicore cable sheaths shall be bonded to earth in all cases for testing.

13.2.5 Fill sumps and unfilled trenches with pebbles to permit oil drainage in case of oil leakage or fire.

13.2.6 Seal off all cable holes where feasible, to prevent passage of vermin and burning oil or compound in case of fire.

13.3 Termination and Joints

The a.c voltage withstand test (between earth & conductor for terminations and joints for power cables for 3.6 kV to 72 kV shall be as follows:

13.3.1 Plastic cable

					15 min at:
6.5	kV	for	3.6	kV	joints
11	kV	for	7.2	kV	joints
15	kV	for	12	kV	joints
22	kV	for	17.5	kV	joints
30	kV	for	24	kV	joints
45	kV	for	36	kV	joints

13.3.2 Screened paper cables

					15 min at:
14.4	kV	for	12	kV	joints
21.7	kV	for	17.5	kV	joints
28.9	kV	for	24	kV	joints
43.3	kV	for	36	kV	joints
6.5	kV	for	52	kV	joints

13.3.3 Belted paper cables

					15 min at:
20	kV	for	12	kV	joints
29.6	kV	for	17.5	kV	joints
40	kV	for	24	kV	joints
60	kV	for	36	kV	joints

13.4 Busbars and Busbar Connections

Busbars and busbar connections shall be tested for one minute with alternating current of any available frequency between 25 C/sec. to 100 C/sec. and approximately of sine wave form. This power frequency voltage shall be applied to all connections and joints as in service. The rms test voltages shall be as given in table below:

As an alternative to the power frequency voltage, a test with a.c. at a voltage not in excess of values given below and test duration of 15 minutes shall be carried out.

BUSBARS AND BUSBAR CONNECTIONS TEST VOLTAGE AFTER ERRECTION ON SITE

Rated Voltage kV	Test Voltage a.c kV	Test Voltage d.c kV
Up to and including 0.6	2.0	3
3.3	8.6	5
6.6	15.2	10.5
11.0	24.0	18.0
15.0	32.0	25.0
22.0	46.0	37.5
33.0	68.0	60.0

14. INSTRUMENT TRANSFORMERS

14.1 Current Transformers

The ratio & polarity shall be checked. Never open-circuit a current transformer when on load, since the primary current does not fall in value but continues to flow and is in effect all magnetizing current. This causes excessive flux densities which give rise to a high secondary voltage, especially when the CT ratio is high, which can be fatal to life. In addition the increased flux can cause overheating, permanent magnetization and failure of the CT insulation. Therefore a check should always be made that the secondary circuit is complete or short circuited before energizing the primary. If a number of CT's are balanced to operate a residual circuit and the other CT's are not subjected to such a heavy burden, they will deliver their correct current and a false residual current will flow through the earth fault coil so causing operation.

14.2 Voltage Transformers

The ratio and polarity shall be checked. If VT's are supplied in oil, drying out will not be necessary unless moisture has penetrated the tank. If VT's are supplied for air insulation a megger test shall be taken and if below 100 megohms on the MV winding, drying out is necessary. MV and LV fuses shall be checked for continuity. Check that there are no parallel circuits on the LV side which can feed back when the VT is out of commission, so making the MV connections live. This situation can arise from synchronising frequently. Always open the VT isolator as well as the main isolator when rendering any apparatus dead.

15. TESTS FOR TRANSFORMER AND CABLE OIL

Refer to BS 148/IEC 296 and IEC 156.

15.1 Crackle Test for Moisture

On site, new insulating oil shall be tested for moisture. To accomplish this test pour enough oil into a clean, dry test tube about 125 mm long and 12.5 mm in diameter to fill it to one-quarter of its depth the temperature of the oil shall be 15-25°C. The tube is then heated rapidly in a silent flame until the oil begins to boil; if any audible cracking occurs then water is present. For general procedure for handling, reconditioning, replacing and disposing of insulating oil refer to BS 5730 or IEC 422. Further more, it shall be noted that.

The use of non-flammable liquids which contain PCB shall be avoided.

15.2 Electrical Tests

15.2.1 Out line of method

The oil is subjected to an a.c. electric field with continuously increasing voltage, until the oil breaks down.

15.2.2 Test cell

The cell, made of glass or plastic shall be transparent with an effective volume of between 300 ml. and 500 ml. and preferably fitted with a suitable lid.

15.2.3 Electrode

The copper, brass, bronze or stainless steel polished electrode shall be spherical (12.5 mm-13.00 mm diameter) the electrodes are to be mounted at horizontal axis and are 2.5 mm apart.

16. EQUIPMENT FOR USE IN HAZARDOUS AREAS

All equipment to be installed in hazardous areas shall be inspected to ensure:

a) Selection of equipment in compliance with the design IP codes or IEC standard.
b) That the flame proof and explosion proof covers fully bolted and secure.
c) That cable gland's ingress protection are fully achieved and IP 65 and IP 54 adhered to.

It is to be noted that since many types of cable glands can be made available at site, care shall be exercised to use suitable glands to meet the proper material, finish and entry threads. Additionally, it is the construction Engineer responsibility to ascertain that the application of cable glands within hazardous area will not cause danger, and ultimately in line with the area classification rules and established regulations, proper workmanship is implemented.

Note:

For precommissioning test of electrical apparatus in potentially explosive atmosphere see also IPS-I-EL-215.

17. BATTERIES

All batteries shall be properly prepared and charged by strictly following the manufacturers step by step recommendations. The following important points shall be taken care during installation and charging process:

17.1 Lead Acid Batteries

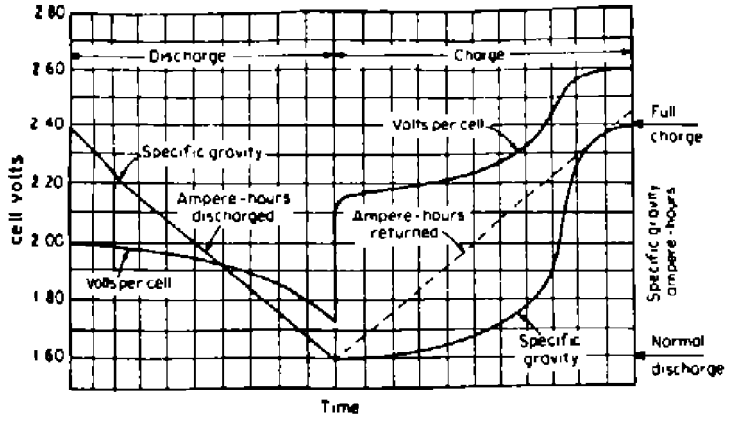
17.1.1 For preparation of dilute sulfuric acid (H_2SO_4), add the concentrated sulfuric acid to distilled water according to instruction of manufacturer.

Caution:

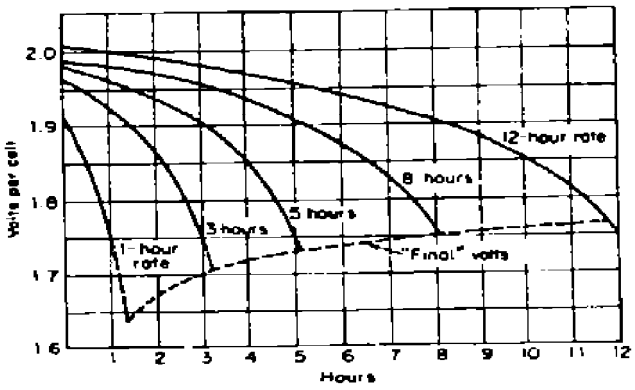
Never add distilled water to concentrated sulfuric acid because considerable heat will be generated from this operation which can be dangerous to the surrounding.

The charge and discharge typical curves showing the electrolyte specific gravity and voltage characteristics in the process as well as the chemical formula of lead acid batteries are shown in Figs. 2 and 3.

$$PbO_2 + Pb + 2H_2SO_4 \underset{\text{CHARGE}}{\overset{\text{DISCHARGE}}{\rightleftharpoons}} 2PbSO_4 + 2H_2O$$



PERFORMANCE CHARACTERISTICS OF LEAD-ACID BATTERIES
Fig. 2



DISCHARGE CURVES OF LEAD-ACID BATTERIES AT DIFFERENT HOUR RATES
Fig. 3

17.1.2 The following ranges of specific gravity shall be used for the applications specified below:

1.275 For heavily worked or "cycled" batteries such as electric industrial trucks.
1.260 Automotive service.
1.245 Large engine starting batteries etc.
1.210 Batteries in stationery stand-by or emergency service.

Further more the open circuit voltage of each cell shall be in accordance with the following formula: volts/cell = specific gravity + 0.84 thus the open circuit voltage of a cell with a specific gravity of 1.210 will be 2.05 Volt; one with a gravity of 1.280 will be 2.12 Volt. Therefore during charging process those cells which do not follow the above voltage build up formula, shall be considered as defective.

17.1.3 Where batteries are used for switchgear operation, the discharge capacity shall be checked to see that the circuit breaker may be operated within the limits shown in the typical curve in 17.1.1 above or specified in BS 5311/IEC 56 without over discharging.

17.2 Alkaline Batteries

The preparation procedure published by the battery manufacturer shall be followed strictly.

The electrolyte used in Nickel/Cadmium batteries shall be a solution of potassium hydroxide with a density of 1.18 to 1.23 g/ml. This solution may also contain lithium hydroxide in amounts varying from 15-50 g/l. This addition will improve the cycle life of the positive plates, especially at elevated temperatures.

The electrolyte used in Nickel/Iron batteries shall be a mixture of potassium hydroxide and lithium hydroxide solutions. The lithium addition is mainly made because of its stabilising effect on the capacity of the nickel electrode during cycling. Typically the composition of the electrolyte is 240 g/l of potassium hydroxide and 50 g/l of lithium hydroxide, corresponding to an electrolyte density of 1.23 g/ml.

17.2.1 Charge characteristics

The charge efficiency can be defined as the ratio of the output of a battery to the input required to restore the Capacity.

The charging system of nickel cadmium batteries can be defined as under:

a) Constant current charging.
b) Constant potential charging.
c) Modified constant potential charging with current limitation.

When instructed by the manufacturers of batteries (a) and (b) above can be used in conjunction with the supplied curves, but as an established standard, method (c) shall be used. By this method, the current is often limited to 0.4 × CA or less and the constant potential range used is 1.50-1.65 V.

18. RECTIFIERS AND INVERTERS

18.1 Before energizing the static inverter, all connection and components shall be checked for good and sound termination and secure fixing, the electrolyte type capacitors shall be checked for polished and clean surface with free from electrolyte leakage.

18.2 Check for cleanliness and tightness of all terminals and wiring. In relay and control panels in addition to the manufacturer'sinstructions.

18.3 Check that fuses and links inserted, are properly rated and in sound condition.

18.4 Ensure that panels are free from vibration, and that no objects or local heat source obstructs adequate ventilation. Check contact pressure in regard to all auxiliary switches.

18.5 Rectifier units must be checked for polarity by a direct current battery and a galvanometer set. Insulation resistance test sets shall not be used as the high voltage will be detrimental.

18.6 Rectifiers can be tested with a resistance meter, provided that the battery voltage exceeds 3 Volts. Selenium rectifiers shall show a high resistance in one direction, low resistance in the other. Silicon controlled rectifiers shall show a high resistance for anode to cathode in both directions.

18.7 Check all supply polarities as a reversal can cause damage on inverters.

19. EARTHING

19.1 Check continuity of earth conductors.

19.2 The resistance measured between the earth terminal and all parts of equipment liable to be made live due to an insulation fault must not exceed 0.1 ohm.

19.3 Measure the earth electrode resistance by an earth tester. The value shall not exceed that specified on the drawings. When no values are specified, the recommendations of the IEE regulations shall apply.

19.4 Earthing of Apparatus In Power Stations

All metallic parts in proximity to live metal must be efficiently earthed. In areas where flameproof equipment is required all metalwork must be earthed including metal window-frames and doors. The resistance measured between the point of connection of the earth continuity conductor to earth and any other point must not exceed 1 ohm.

19.5 Lightning Conductors

When a lightning conductor is first erected, and scaffolding is available, its resistance shall be measured by an insulation resistance earth test set.

According to the BS 6651 protection of structures against lightning, the maximum resistance of the earth connection, one or more electrodes in parallel, is 10 ohms.

20. SMALL WIRING FOR LIGHTING AND POWER

a) Check that all earth sockets in 3-pin outlets are connected to earth.
b) Check that all s.p phases in single pole switches are connected in the phase.
c) Check the insulation resistance of the completed installation:

1) Between phase and neutral with all apparatus disconnected;
2) between phase and neutral to earth with all apparatus connected.

The value in each case shall not be less than 50 divided by the number of outlets, in Meg.ohms but it need not exceed 1 Mega.ohm, for the whole installation (see IEE regulation).

21. OVERHEAD TRANSMISSION AND DISTRIBUTION LINES

21.1 Inspection of Lines (Check List)

Check the following: for compliance with construction drawing proper installation and correct functioning.

DESCRIPTIONS	CONDITION	REMARKS
21.1.1 Phasing and phase marking 21.1.2 Continuity of line conductors 21.1.3 arrangement of transpositions (if any) 21.1.4 Continuity of shield wire/cable 21.1.5 Straightness of towers and/or poles 21.1.6 Sign of cracks in insulators 21.1.7 Sign of cracks in arresters 21.1.8 Arc horns 21.1.9 Anti vibration dampers 21.1.10 Guy wires 21.1.11 Anchores 21.1.12 Sign of over-tensioning 21.1.13 Cross arms 21.1.14 Ganged operated switch fuses 21.1.16 Earthing switches 21.1.17 Sectionalizing switches (if any) 21.1.18 Anticlimbing devices 21.1.19 Danger signs 21.1.20 Danger marking balls in road crossing (if any) 21.1.21 Any indication of unexpected hazard 21.1.22 Tower or poles numbering plates 21.1.23 Earthing of lightning shield and wiring 21.1.24 Any sign of washout in foundations 21.1.25 Sign of insulators swing 21.1.26 Any sign of uplift 21.1.27 Any sign of corrosion on towers or poles 21.1.28 Any deviation from route profile 21.1.29 Gantries arrangement and safety 21.1.30 Adequacy of lighting installations and safety of lamp changing in terminal stations 21.1.31 Adequacy and safety of access road		

Signature	Date	Signature client	Date

21.2 Measurements

The following measurements shall be made during inspection:

21.2.1 Clearance from crossings.

21.2.2 Clearance from buildings.

21.2.3 Clearance from power lines.

21.2.4 Clearance from gas lines.

21.2.5 Clearance from oil lines.

21.2.6 Clearance from water lines.

21.2.7 Clearance from rivers.

21.2.8 Clearance from bridges.

21.2.9 Measurement of sag

At every one kilometer the depth of sags shall be measured (using stop watch or any other approved methods). Depth of sag shall be compared, with sag in "SAG-TENSION" data sheet for the span under test, and temperature of time of measurement.

21.3 Tests

21.3.1 Continuity of all dropper lightning earth bars or wires.

21.3.2 Earth resistance at foundation of towers.

21.3.3 Pressure test on transmission and distribution lines shall be in accordance with Tavanir current procedure.

21.4 Precautions During Test

21.4.1 Isolate lines on both ends while electrical tests are carried out.

21.4.2 Discharge lines to earth before and after test (this is very important from safety point of view).

21.4.3 No work shall be carried out on transmission and/or distribution lines when there are signs of storm and or lightning.

21.4.4 Only sound ladders to be used while inspection is carried out and the ladder shall be tightened to tower by appropriate rope.

21.4.5 Safety belts, electrical safety helmets, safety shoes and safety gloves shall be used wherever required.

22. GUIDANCE FOR PROTECTION

22.1 Testing of Relays and Protection Schemes

The high standard of performance of modern protection arises from the comprehensive testing of equipment which has led to understanding of many of the complex processes which occur when the system is disturbed. It is not always understood that testing is of several distinct categories, each having distinct functions and requirements.

22.2 Test at Manufacturing Works (Informational)

a) Type testing

A new design of relay or scheme is subjected to stringent testing before it is put into production. The object is to prove the design in all respects and to determine all relevant characteristics. To this end, the relay is assembled

with all ancillary components including measuring transformers, leads simulated by resistors, pilots where relevant, simulated by a network of resistors, reactors and capacitor of sufficient complexity to reproduce typical line characteristics, and any other special items that may apply to a particular case.

The equipment is connected together to form the complete scheme and is then tested by the application of current which is of magnitude to cover the range of application taking into account the current transformer ratio, and which also has transient characteristics similar to those experienced in service.

Performance is examined with respect to sensitivity, operating speed and stability (where relevant). Burdens, self-heating, contact performance durability and insulation are examined. The equipment is also tested critically with regard to such environmental conditions as the permissible ambient temperature range, the effect of frequency deviation and the resistance to mechanical shock and vibration. Part of such testing is the assessment of the range of errors and the tolerancing of components. Such testing is very expensive; it may occupy several weeks or even months and requires extensive, specialized and high power plant. It is intended to be performed only once for each scheme. The results of the tests are recorded as a permanent reference.

b) Calibration

Each relay manufactured is tested. This is a process not of design proving, but of adjustment, and is therefore to be ranked as a manufacturing process. Hence the tests applied may not have any direct relation to the normal service of the item in question; they are satisfactory provided they enable the equipment to be brought into a standard condition, the tests being chosen for their suitability and convenience in achieving this object.

22.3 Testing at Site

Commissioning:

Unlike a self-contained piece of apparatus which may be expected to function correctly as received, a protection system may require many interconnections with remote parts of the station or even beyond. The complete protection system may comprise the relays and ancillary equipment mounted on the relay board, current and voltage transformers, auxiliary switches in the primary switchgear, d.c. power supplies and tripping connections, with interconnections to other stations to complete a 'unit' system or for intertripping or indication purposes.

Clearly, such a complex system of equipment and connections which must be completed on site, should be proved to be correct before the equipment can be considered fit for service. It is necessary, therefore, to carry out such examination and testing as are needed to prove that:

a) All times of equipment are undamaged by transport and handling;
b) the correct items are connected together, e.g. the correct set of c.t.s are connected to a given set of relays;
c) all connections, including leads and pilots to remote equipment and panel wiring are correct;
d) the correct settings and/or other adjustments are applied according to the design of the protection scheme and the requirements of the primary system.

It will be clear from the above that any degree of type testing has no place in normal site work. Setting aside special site tests which are occasionally planned to investigate conjunctive operation with power plant on a scale which is not readily feasible in a laboratory, attempts to measure detailed relay characteristics on site are likely only to produce misleading results and may result in damage to the equipment. In general, the test equipment for site use, which essentially has to be portable, is unsuitable for detailed investigations, whilst all too often limitation of the facility of operation leads to high current values being sustained for excessive periods. It must always be remembered that relays may be continuously rated only at the maximum continuous current of the circuit and with currents of magnitude corresponding to system faults they may be very short rated.

After visual examination to check that all appears to be in order, a relay should be checked by injection testing to show that it is undamaged. For example, an i.d.m.t.l. overcurrent relay may be injected on one tap to observe:

a) No operation at setting current;
b) complete operation at 1.3 times setting current;
c) operation at between 2 and 4 times setting current with reasonable accuracy (see BS 142: 1966 for permitted tolerances).

The test set must have a good waveform when used with the relay at this level of current, otherwise a further tolerance may be needed for this, and also it must be borne in mind that loose test instruments which have been taken to many sites may not retain their original accuracy. If the injection is made with c.t.s still connected but the primary circuit disconnected, the c.t. will draw an exciting current which will cause a further disdcrepancy.

Several sets of current-transformers are often mounted in one circuit-breaker; they may very likely have similar ratios but may differ very considerably in output.

To establish that the correct set has been connected to a given burden it is usual to check the excitation characteristic, injecting from the relay panel terminals. Only a single point on the excitation curve need be measured, which may be the knee point or, if this is inconveniently high, as high a value as can be provided by the testing supply. The results compared with the estimated characteristics will usually suffice for identification purposes and nothing is then to be gained by measuring and plotting the entire excitation characteristic. The above two examples are given to illustrate the nature of this work. More details of commissioning procedure are given in Chapter 18. Detailed instructions for testing every scheme are impracticable in the available space, and these schemes are continually being extended or modified. In general detailed commissioning data is available from the manufacturers for all proprietary schemes; much of the procedure for these is obvious provided the working of the system is understood.

22.4 Future Trends in Relay Design (Informational)

Although the majority of relays in service at the present are of electromagnetic construction, development work is principally directed to electronic designs. It is not yet practicable to replace the multicontact hinged armature unit by an electronic equivalent on economic grounds; in fact most electronic relays have a hinged armature unit as a final output device. There is little sign also of the i.d.m.t.l. induction relay being extensively displaced by its electronic equivalent. Elsewhere, the electronic technique offers greater flexibility in design to meet given protection functions.

In the future, solid-state relays will produce new characteristics and concepts for protection schemes. The exploitation of integrated circuits will increase as the cost of these components falls, particularly in the case of custom-built circuits.

The fundamental measurement and logic functions of a protective relay can be accommodated on a single silicon slice or ’chip’ with a great reduction in size over earlier techniques. Redundancy techniques such as ’two out of three’ schemes thereby become economically feasible, providing even more reliable protection.

Note:

Bibliography

Books

Automatic protection of a.c. circuits by GW Stubbings (Chapman & Hall) Relay systems by I T Monseth and P H Robinson (McGraw Hill Book Co.Inc.).

APPENDICES
CHECK LISTS AND / OR TEST SHEETS

APPENDIX A
INDUCTION MOROTS TESTS AND PHYSICAL CHECKS

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS			

INDUCTION MOTORS
TESTS AND PHYSICAL CHECKS

LOCATION ON SITE:

(SHEET 1 OF 1)

MOTOR REF. NO.	MOTOR SERIAL NO.	HP.	FLC	TESTS				CHECKS		SIGNATURE	DATE	SIGNATURE	DATE
				INSUL. Meg Ω	LIGHT RUN (HRS)	BEARINGS		CABLE TERM.	ROTATION				
						DE	NDE						

SIGNATURE:	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX B
MOTOR CONTROL CENTER

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

MOTOR CONTROL CENTER (SHEET 1 OF 2)
PHYSICAL CHECKS AND INSULATION RESISTANCE TEST SHEET

MOTOR CONTROL		MANUFACTURER	
SERVICE VOLTS		LOCATION ON PLANT	

THESE CHECKS TO INCLUDE MOTOR CONTROL CENTER AND REMOTE CONTROL UNIT		SIGNATURE	DATE	SIGNATURE CLIENT	DATE
BUSBARS SECURED					

TERMINAL SECURED		PRESSURE TEST		
NUTS & BOLTS SECURED		EQUIPMENT	VOLTAGE	TEST VOLTAGE
OPERATION OF ISOLATORS				
OPERATION OF CIRCUIT BREAKERS				
OPERATION OF CONTACTORS				
OPERATION OF SWITCHFUSES				
OPERATION OF AUXILIARY CONTACTS				
OPERATION OF ASSOCIATED RELAYS				
OPERATION OF LOCAL PUSHBUTTION & RESETS				
OPERATION OF INDICATOR LIGHTS				
OPERATION OF METERS		EQUIPMENT	INSULATION RESISTANCE MEG. OHMS	
MAIN CABLE TERMINATION & MARKING				

			R-E	Y-E	B-E	R-B	R-Y	Y-B
CONTROL CABLE TERMINATION & MARKING								
DESIGNATION LABELS CORRECT		PHASE BARS & WIRING						
REMOTE ALARMS OR INDICATIONS		AUX. WIRING						
REMOTE CONTROL UNIT SECURED& WEATHER-PROOFED		MOTOR CABLE						
OPERATION OF REMOTE CONTROL DEVICES		CONTROL CABLE						
OPERATION OF REMOTE AMMETERS								
EARTHING CONNECTION AND CONTINUITY								

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

(to be continued)

APPENDIX B (continued)

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

MOTOR CONTROL CENTRE
PRIMARY INJECTION TEST SHEETS (SHEET 2 OF 2)

SWITCHGEAR REF.		MANUFACTURER	
SERVICE VOLTS		LOCATION IN PLANT	

CONTACTOR DUTY	MOTOR HP	MOTOR FLC	HRC FUSE	AMM. C/T RATIO	O/L C/T RATIO	105% TEST AMPS	SET TRIP TIME	115% TEST AMPS	SET TRIP TIME	REMARKS

SWITCHFUSE DUTY	SWICTH RATING	SPN/TPN	FUSE RATING				
				SIGNATURE	DATE	SIGNA-TURE CLIENT	DATE

APPENDIX C
RELAY TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

RELAY TEST SHEET — LOCATION ON SITE. — (SHEET 1 OF 1)

RELAY SERIAL NO.			MOTOR NO.	
RELAY SETTING	%LOAD TO TRIP	%	MOTOR HORSEPOWER	
	PLUG SETTING	%	MOTOR VOLTAGE	
	INSTANTANEOUS TRIP	TIME	MOTOR FULL LOAD AMPS	
CURRENT TRANSFORMERS RATIO			MOTOR STARTING AMPS	

TEST		CURRENT (AMPS)	TIME (SECS)	SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE
START CURVE							
RUNNING CURVE				NOTE: INSTRUCTIONS OF MANUFACTURER SHALL BE FULLLY ADHERED TO DURING TEST			
SINGLE PHASING	R & Y						
	B						
	R & B						
	Y						
	Y & B						
	R						
EARTH FAULT							
INSTANTANEOUS TRIPS							

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX D
THERMAL OVERLOAD TEST SHEET * FOR MOTOR STARTERS

Ref. Drawings No.	Date	Revision	By	Ck	Approvals

(Sheet 1 of 1)

Location on Site .....

Motor:

Make ..... RPM..... F.L.C.....Ampere

Type ..... Frame.....Voltage.....

Starter

Make ..... Type Rating .....

Overcurrent Test:

Heaters Direct or C.T. Operated	Heaters Current Rating Ampere	Test Current Rating Ampere	Trip Time from Curve in Second(s)	Trip Time Actual in Second(s)
Cold/.....	.....	.....	.....	.....
Hot/.....	.....	.....	.....	.....

Setting Left on Heaters at.....%

Earth Fault Test: (where applicable)

Injected Current.....Amps

Tripping.....Time.... .....Second(s)

Ammeter Test:

C.T. Ratio..... Injected Current..... Ammeter Reading .....

Signature	Date	Signature (Client)	Date

*** Attention:**

Before attempting any test on protection relays read carefully Clause 22 of this Standard.

APPENDIX E
OVERCURRENT AND EARTH FAULT RELAYS TEST SHEET *

Ref. Drawings No.	Date	Revision	By	Ck	Approvals

(Sheet 1 of 3)

Location on Site.....

1. Overcurrent Relay:

Make & Type.....Serial No. ..... 100% Rating.....

1.1 Minimum Operating Current:

	Current Setting %						
	50	75	100	125	150	175	200
Red Phase							
Yellow "							
Blue "							

2. Earth Fault Relay:

Make & Type..... Serial No. ..... 100% Rating.....

2.1 Minimum Operating Current:

Setting % .....
Operating.....

Signature	Date	Signature (Client)	Date

* Attention:

Before attempting any test on protection relays read carefully Clause 22 of this Standard.

(to be continued)

APPENDIX E (continued)

Ref. Drawings No.	Date	Revision	By	Ck	Approvals

(Sheet 2 of 3)

Location on Site.....

3. Timing Tests:

Overcurrent Relay at 2x.....%
Earth Fault Relay at 2x.....%

	From Curve		Actual		Reset Time from
	Max. Time	0.5 Max. Time	Max. Time	0.5 Max. Time	Max. Time
Red Phase	.....	.....	.....	.....	.....
Yellow "	.....	.....	.....	.....	.....
Blue "	.....	.....	.....	.....	.....
E/F "	.....	.....	.....	.....	.....

4. Indicating Ammeters:

CT. Ratio.....
Injected Current (Amp.): R..... Y..... B.....
Indicated Amps. R..... Y..... B.....

5. On Load Current Measurement:

Load Amps.:	O.C. Relay			Normal E/F	Standby E/F	Restricted E/F
	R.....	Y.....	B.....	.....	.....	.....

6. Restricted Earth Fault Relay:

Make & Type..... Serial No..... 100% Rating .....

6.1 Minimum Operating Current:

Setting %.....
Operating Amps.....

Signature	Date	Signature (Client)	Date

(to be continued)

APPENDIX E (continued)

Ref. Drawings No.	Date	Revision	By	Ck	Approvals

(Sheet 3 of 3)

Location on Site.....

7. Standby Earth Fault Relay

Make & Type.....Serial No.....100% Rating.....

7.1 Minimum Operating Current:

Setting %.....
Operating Amps.....

7.2 Timing Tests

Test Made at 2 × Current Setting.

Max. Time from Curve in Seconds	0.5 Max. Time from Curve in Seconds	Max. Time Actual in Seconds	0.5 Max. Time Actual in Seconds	Reset Time from Max. Time in Seconds
.....	.....	.....	.....	.....

8. Timing Relay:

Make & Type.....Serial No.....

Setting in Second(s).....
Operating in Second(s).....

Insulation Resistance:	Settings Left On:
O.C. Circuit.....	O.C. Relay.....
Standby. E/F Circuit †.....	E/F Relay.....
Restricted E/F Circuit.....	Restricted E/F Relay.....
	Timing Relay.....

Remarks:

Signature	Date	Signature (Client)	Date

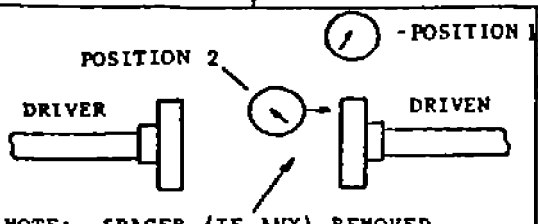
Note:

y Denotes where applicable.

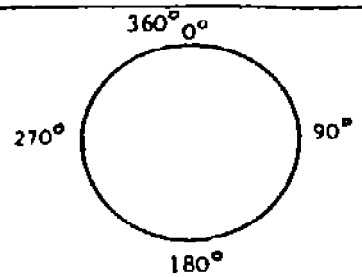
APPENDIX F
COUPLING ALIGNMENT TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

COUPLING ALIGNMENT TEST SHEET	LOCATION : (SHEET 1 OF 1)
EQUIPMENT TITLE	
EQUIPMENT No.	
TYPE OF COUPLING	SPACER / NON SPACER, FLEXIBLE / NON FLEXIBLE
	RUBBER / METALLIC



NOTE: SPACER (IF ANY) REMOVED
POSITION 1 FOR PERIPHERAL ALIGNMENT
POSITION 2 FOR GAP ALIGNMENT



		0°	90°	180°	270°	360°
A:	CLAMP ON DRIVER COUPLING CLOCK ON DRIVEN COUPLING PERIPHERY (POS 1)					
(I)	BOTH COUPLINGS MUTUALLY ROTATED	0				
(II)	DRIVEN COUPLING STATIONARY DRIVER COUPLING ROTATED	0				
B:	CLAMP ON DRIVER COUPLING CLOCK ON DRIVEN COUPLING FACE (POS 2)					
(I)	BOTH COUPLINGS MUTUALLY ROTATED	0				
(II)	DRIVEN COUPLING STATIONARY DRIVER COUPLING ROTATED	0				
C:	CLAMP ON DRIVEN COUPLING CLOCK ON DRIVER COUPLING PERIPHERY (POS 1)					
(I)	BOTH COUPLINGS MUTUALLY ROTATED	0				
(II)	DRIVEN COUPLING STATIONARY DRIVER COUPLING ROTATED	0				
D:	CLAMP ON DRIVEN COUPLING CLOCK ON DRIVER COUPLING FACE (POS 2)					
(I)	BOTH COUPLINGS MUTUALLY ROTATED	0				
(II)	DRIVEN COUPLING STATIONARY DRIVER COUPLING ROTATED	0				

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX G
POWER TRANSFORMERS PHYSICAL CHECKS AND TESTS

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

POWER TRANSFORMERS
PHYSICAL CHEEKS AND TESTS (SHEET 1 OF 3)

TRANSFORMER REFERENCE			MANUFACTURER	
SERVICE VOLTS	PRIMARY	SECONDARY	SERIAL NO.	
SET AT TAPPING			RATING K.V.A. VECTOR GROUP % IMPEDANCE	

CHECK PHASING					
CHECK BREATHER (COLOUR TO BE BLUE)					
OPERATION OF BUCHHOLZ (MECHANICAL)					
OPERATION OF BUCHHOLZ (ELECTRICAL)					
BUCHHOLZ TRIP AND ALARMS					
OIL TEMPERATURE TRIP AND ALARMS		H.V. TEST TO EARTH	TEST VOLTS d.c.	TIME (SECS)	
NEUTRAL C/T RATIO					
PRIMARY CABLE TERMINAL & MARKING		PRIMARY WINDING			
SECONDARY CABLE TERMINAL & MARKING		SECONDARY WINDING			
NEUTRAL CABLE TERMINAL & MARKING					
BUCHHOLZ CABLE TERMINAL & MARKING					
TAPPING SWITCH SET & PADLOCK		INSULATION TEST	INSULATION RESISTANCE MEG. OHMS.		
OIL LEVEL					
OIL LEAKS		H.V. WINDING			
EARTH CONNECTION SECURE		L.V. WINDING			
COMPOUND GATES PADLOCK		H.V. AND L.V. WINDINGS			
OIL TEST TO IEC 296		NETURAL/EARTH			
SILICA GEL		PILOT CABLE			

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

(to be continued)

APPENDIX G (continued)

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

(SHEET 2 OF 3)

TRANSFORMERS
TAP CHANGE RATIO TEST (IF APPLICABLE)

TRANSFORMER REFERENCE NO.		SERIAL NO.	
RATING KVA		LOCATION ON PLANT	
MANUFACTURER			

TAP POSITION OR % TAPPING	H.V. WINDING			L.V. WINDING		
	MAGNETISING CURRENTS			SECONDARY LINE VOLT		
	R	Y	B	R-Y	Y-B	B-R

SIGNATURE:	DATE	SIGNATURE (CLIENT)	DATE

(to be continued)

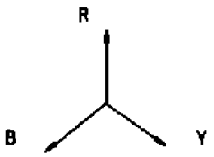
APPENDIX G (continued)

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

(SHEET 3 OF 3)

PHASING AND SYNCHRONISING TESTS

EQUIPMENT .....
DATE TESTED .....
TESTED BY .....
SIGNATURE .....
SIGNATURE(CLIENT).....



	RUNNING V.T.SECY.	INCOMING V.T.SECY.
R-N		
Y-N		
B-N		
R-Y		
Y-B		
B-R		
PHASE ROTATION METER		

INCOMING CIRCUIT	RUNNING CIRCUIT				
		R	Y	B	N
	R				
	Y				
	B				
	N				

SIGNATURE:	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX H
GENERATORS CHECK LIST / TEST SHEET

REF. RAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

GENERATORS: CHECK LIST/TEST SHEET (SHEET 1 OF 2)
AREA LOCATION

K.W.	VOLTAGE	PHASE	WIRE	50Hz
PRIME MOVER MANUFACTURER	SERIAL NO.			
GENERATOR MANUFACTURER	SERIAL NO.			

	DESCRIPTION	RESULT
A	CHECKS AND TESTS BEFORE STARTING	
	1. ENCLOSURE: 1.1 CLEANLINESS 1.2 SIGN OF DAMAGE 1.3 SIGN OF CORROSION 1.4 SIGN OF OIL LEAK 1.5 SIGN OF MOISTURE 1.6 ALIGNMENT 1.7 AIR GAP CLEARANCE OF ALL QUADRANTS	
	2. EARTHING OF BASE PLATE 3. NEUTRAL EARTHING 4. CABLE TERMINATION 5. TEMPERATURE DETECTORS CONTINUITY 6. INSULATION RESISTANCE OF STATOR WINDING 7. INSULATION RESISTANCE OF EXCITER WINDING 8. HIGH VOLTAGE TEST 9. LUBRICATION 10. WEATHER PROTECTION IF OUTDOOR	
B	CHECKS AND TEST AFTER STARTING	
	1. BERINGS: A. VIBRATION B. NOISE C. END PLAY D. OVERHEATING	

SIGNATURE:	DATE	SIGNATURE (CLIENT)	DATE

(to be continued)

APPENDIX H (continued)

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

GENERATORS: CHECK LIST/TEST SHEET (SHEET 2 OF 2)
AREA LOCATION

K.W.	VOLTAGE	PHASE	WIRE	50Hz
PRIME MOVER MANUFACTURER	SERIAL NO.			
GENERATOR MANUFACTURER	SERIAL NO.			

	DESCRIPTION	RESULT
	2- FREE CIRCULATION OF AIR	
	3- PROTECTION	
	4- INDICATIONS/METERS/ALARMS	
	5- PHASE SEQUENCE	
	6- INTERTRIP BETWEEN DRIVE AND DRIVEN UNITS	
	7- INTERLOCKS WITH NORMAL SUPPLY	
	8- VOLTAGE BETWEEN PHASES:	
	R & Y	
	R & B	
	B & Y	
	9- VOLTAGE BETWEEN PHASES AND NEUTRAL:	
	R & N	
	Y & N	
	B & N	
	10- OVER HEATING OF STATOR TO BE CHECKED	
C	CHECK OF A.V.R. WHILE GENERATOR SET IS ON LOAD ACCORDING TO BS 4999 PART 140	
	a- Instruction of manufacturer shall be fully adhered to while generating set is tested.	
	b- Prime mover shall be tested according to manufacturers recommendation.	

SIGNATURE:	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX I
LOW VOLTAGE SWITCHGEAR ASSEMBLY CHECK LIST / TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

LOW VOLTAGE SWITCHGEAR ASSEMBLY CHECK LIST / TEST SHEET	(SHEET 1 OF 1)
AREA LOCATION	
MANUFACTURER	
EQUIPMENT NO.	
RATED VOLTAGE	RATED BUSBAR CAPACITY .....Amps
SERVICE VOLTAGE	BUSBAR S/C RATING: .....M.V.A. .....AMPS
PHASE	FREQUENCY

BUSBARS SECURED AND CONTINUITY CHECKED	
CUBICLES COMPLETE AND SATISFACTORILY INSTALLED	
ASSEMBLY EARTH SECURED AND CONTINUITY CHECKED	
LABELLING SATISFACTORY	
CONTROL CIRCUIT, TRIP CIRCUIT AND SPRING CHARGING SUPPLIES AVAILABLE	
VOLTAGE TRANSFORMER SATISFACTORY	

BUSBARS INSULATION RESISTANCE TEST BY .... VOLT MEGGER		BUSBARS PRESSURE TEST		
TEST APPLIED BETWEEN	INSULATION RESISTANCE	PRESSURE VOLTAGE ac/dc	DURATION MINUTES	LEAKAGE MILLI AMPS
R & B	MEG Ω	KV		
R & Y	MEG Ω	KV		
B & Y	MEG Ω	KV		
R + Y + B AND EARTH	MEG Ω	KV		

INSULATION RESISTANCE OF SMALL WIRING AND LOW VOLTAGE CIRCUIT ..... MEG. OHMS

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX J
MEDIUM VOLTAGE SWITCHGEAR ASSEMBLY (PHYSICAL CHECK AND TEST)

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

MEDIUM VOLTAGE SWITCHGEAR ASSEMBLY (PHYSICAL CHECK)				(SHEET 1 OF 2)
SWITCHGEAR REF.		MANUFACTURER		
SERVICE VOLTAGE		LOCATION ON PLANT		
CIRCUIT BREAKER DUTY		V.T. RATIO		
RATING		V.T. FUSE RATING	PRIMARY	
			SECONDARY	
SERIAL NO.		VOLTAGE RANGE		
TYPE		AMMETER RANGE		
O/C C.T. RATIO		K.W.H. METER	TYPE	
			SER. NO	
E/L C.T. RATIO		TRIPPING	TYPE	
			FUSE	
NEUTRAL C.T. RATIO		CLOSING MECHANISM		
AMMETER C.T. RATIO		TRIPPING VOLTAGE		
		CLOSING VOLTAGE		

SWITCHGEAR PRESSURE TEST	... K.V. FOR ... MINUTES	

PHYSICAL CHECKS		CIRCUIT BREAKER TRUCK & TOOLS	
ALIGNMENT OF PLUG CONTACTS		EARTHING SECURE	
ALIGNMENT OF AUX. PLUG CONTACTS		DANGER SIGNS	
HAND OPERATION (LATCHING) 10 TIMES		NEON DANGER INDICATING LIGHT(S)	
HAND TRIPPING			
MAIN CONTACT ALIGNMENT			
MAIN CONTACT SPRING PRESSURE			
AUX. CONTACT ALIGNMENT			
OPERATION OF AUX. SWITCHES			
ELECTRICAL CONNECTIONS SECURE			
MAIN & PILOT CABLE JOINTING & MARKING			
OPERATION OF MECHANICAL INTERLOCKS			
NUTS & BOLTS SECURE		SIGNATURE / DATE / SIGNATURE (CLIENT) / DATE	
OIL TESTED BEFORE FILLING TANK (IF OIL FILLED)			

(to be continued)

APPENDIX J (continued)

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

(SHEET 2 OF 2)

MEDIUM VOLTAGE SWITCHGEAR ASSEMBLY
(PRIMARY INJECTION AND INSULATION TESTS)

CIRCUIT BREAKER DUTY	CIRCUIT BREAKER VOLTAGE

RELAY TYPE SERIAL NO.	SETTING			CURRENT/TIME CURVE TEST						REMARKS
	PLUG	TMS		TEST 1		TEST 2		TEST 3		
				TEST AMPS	TRIP TIME	TEST AMPS	TRIP TIME	TEST AMPS	TRIP TIME	
O/C										
E/F										

	INSULATION RESISTANCE						
EQUIPMENT	R-E	Y-E	B-E	R-Y	R-B	Y-B	
CIRCUIT BREAKER							
AUX. WIRING							
MAIN CABLE							
PILOT CABLE							

ELECTRICAL CHECKS		SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE
AMMETER					
VOLTMETER		REMARKS			
KWH METER					
INDICATING LAMPS					
REMOTE OPERATION CLOSE/TRIP					
INTERTRIPPING					
INTERLOCKS					
NEON DANGER INDICATING LAMP					

APPENDIX K
ISOLATOR/FUSE SWITCH/CHECK LIST TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

ISOLATOR/FUSESWITCH CHECK LIST/TEST SHEET	AREA LOCATION MANUFACTURER, (SHEET 1 OF 1)
TYPE	RATED VOLTAGE
BOARD TITLE.	RATED CURRENT

CIRCUIT TITLE.		EARTH SECURED& CONTINUITY CHECKED	
EQUIPMENT NO.		OPERATION SATISFACTORY	
FUSE RATING		LABELS SATISFACTORY	
*I.R. READING	MEG. Ω		
CIRCUIT TITLE.		EARTH SECURED&CONTINUITY CHECKED	
EQUIPMENT NO.		OPERATION SATISFACTORY	
FUSE RATING		LABELS SATISFACTORY	
*I.R. READING	MEG. Ω		
CIRCUIT TITLE.		EARTH SECUR & CONTINUITY CHECKED	
EQUIPMENT NO.		OPERATION SATISFACTORY	
FUSE RATING		LABELS SATISFACTORY	
*I.R. READING	MEG. Ω		
CIRCUIT TITEL.		EARTH SECURED&CONTINUITY CHECKED	
EQUIPMENT NO.		OPERATION SATISFACTORY	
FUSE RATING		LABELS SATISFACTORY	
*I.R. READING	MEG. Ω		
*NOTE: I.R. STANDS FOR INSULATION RESISTANCE			

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX L
DISTRIBUTION BOARD TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

DISTRIBUTION BOARD TEST SHEET (SHEET 1 OF 1)

DISTRIBUTION BOARD TITLE
MANUFACTURER
LOCATION ON SITE

TYPE		RATED VOLTAGE	
EQUIPMENT NO.		INCOMING SWITCH/FUSE RATING	
BUSBARS. NEUTRAL AND CONNECTIONS SECURE		NAME PLATE AND CIRCUIT LABELS CORRECT	
BUSBARS PHASED CORRECTLY		CABLE TERM & MARKING SATISFACTORY	
OPERATION OF ISOLATOR/FUSE SWITCH SATISFACTORY		BOX EARTHED AND CONTINUITY CHECKED	
FOR FLAMEPROOF UNIT, CHECK ALL FLANGES ARE SECURE & SATISFACTORY			

CIRCUIT NO.	CABLE SIZE	DUTY/TITLE	FUSE RATING (AMPS)	CABLE OR CONDUIT EARTH CONTINUITY CHECKED	INSULATION RESISTANCE IN MEG. Ω	
					R.Y.B.TO E.	BETWEEN PHASES

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX M
ALARMS (INSULATION AND FUNCTION TESTS)

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

ALARMS
(INSULATION AND FUNCTION TESTS) (SHEET 1 OF 1)

INITIATING DEVICE	LOCA-TION	FUNCTION	TERMINAL SECURE	AUX. RELAY	ALARM SATISFACTORY	CABLE NO.	WINDOW ENGRAVE	OPERA-TION	CANCEL	I.R.

*NOTE: I.R. STANDS FOR ISULATION RESISTANCE IN MEG. OHMS

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX N
METERS CHECK LIST

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

METERS CHECK LIST — AREA LOCATION — MANUFACTURER — (SHEET 1 OF 1)

TITLE	LOCATION	TYPE OF METER	CLASS OF ACCURACY	CALIBRATION	REMARKS

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX O
INSULATION RESISTANCE TEST SHEETS FOR SECONDARY WIRING

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS			

INSULATION RESISTANCE TEST SHEETS FOR SECONDARY WIRING. (SHEET 1 OF 1)

EQUIPMENT MANUFACTURER
EQUIPMENT REFERENCE NO.

LOCATION ON SITE

CIRCUIT NO	CONTROL CIRCUIT I.R. MEG - Ω		CLOSING CIRCUIT I.R. MEG. Ω		TRIPPING CIRCUIT I.R. MEG. Ω		INDICATION CIRCUIT I.R. MEG. Ω		METERING CIRCUIT I.R. MEG. Ω		ANTI COND. HEATER CIRCUIT I.R. MEG. Ω	
	A	B	A	B	A	B	A	B	A	B	A	B

NOTES: I.R. STANDS FOR INSULATION RESISTANCE.
"A" IS FOR INSULATION RESISTANCE BETWEEN CORES
"B" IS FOR INSULATION RESISTANCE BETWEEN CORE AND EARTH

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX P
CURRENT TRANSFORMERS CHECK LIST / TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

CURRENT TRANSFORMERS CHECK LIST / TEST SHEET — AREA LOCATION — MANUFACTURER — (SHEET 1 OF 1)

C.T. TITLE	PHASE LOCATION
C.T. SERIAL NO.	EQUIPMENT NO.
C.T. RATIO	ACCURACY
BURDEN	SHORT TIME FACTOR
FREQUENCY	

C.T. SECURELY MOUNTED	
C.T. MOUNTING ASSEMBLY SECURED AND EARTHED SATISFACTORILY	
C.T. TERMINAL MARKINGS SATISFACTORY	

C.T. RATIO CHECKED BY INJECTION TEST

SECONDARY MAGNETISATION CURVE:

VOLTS													
m. A.													

INSULATION RESISTANCE TEST:

VOLTAGE LEVEL Volts		MEG. Ω	DURATION SECS.
d.c. RESISTANCE MEASURED (OF C. T.)		MEG. Ω	TEMP.
d.c. RESISTANCE MEASURED (OF LEADS)		MEG. Ω	TEMP.

d.c. POLARITY TEST: (FLICK TEST) SATISFACTORY

MANUFACTURERS MAGNETISATION CURVE AVAILABLE

MANUFACTURERS ROUTINE/TYPE TEST RESULTS AVAILABLE

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX Q
VOLTAGE TRANSFORMERS PHYSICAL CHECK LIST / TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

VOLTAGE TRANSFORMERS CHECKLIST/TEST SHEET (SHEET 1 OF 1)

AREA LOCATION
MANUFACTURER

V.T. TITLE	
V.T. SERIAL NO.	EQUIPMENT NO.
V.T. RATIO	ACCURACY
BURDEN	FREQUENCY
CONNECTION	

V.T. SECURELY MOUNTED	
V.T. CONNECTIONS SECURED AND CONTINUITY CHECKED	
V.T. CORRECTLY EARTHED AND CONTINUITY CHECKED	
V.T. TERMINAL MARKINGS SATISFACTORY	
TANK AND FITTINGS SATISFACTORY	
OIL LEVEL SATISFACTORY (IF APPLICABLE)	
V.T. RATIO CHECKED	
MANUFACTURERS ROUTINE/TYPE TEST RESULTS AVAILABLE	

INSULATION RESISTANCE TEST BY ...VOLT MEGGER		PRESSURE TEST		
TEST APPLIED BETWEEN	INSULATION RESISTANCE	PRESSURE VOLTAGE d.c. / a.c.	DURATION MINUTES	LEAKAGE MILLI-AMPS
R & B	MEG Ω	KV		
R & Y	MEG Ω	KV		
B & Y	MEG Ω	KV		
R + Y + B AND EARTH	MEG Ω	KV		
SIGNATURE:	DATE	SIGNATURE (CLIENT)		DATE

APPENDIX R
SMALL TRANSFORMERS PHYSICAL CHECK LIST / TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS			

(SHEET 1 OF 1)

SMALL TRANSFORMERS
PHYSICAL CHECK AND TEST SHEET

TRANSFORMER REFERENCE		MANUFACTURER	
SERVICE VOLTS		SERIAL NO.	
RATING K.V.A. VECTOR GROUP %IMPEDANCE		LOCATION ON PLANT	

CHECKS AND TESTS	CHECK	INSUL. RESIST MEG. OHMS	REMARKS
BETWEEN HIGHER VOLTAGE AND LOWER VOLTAGE WINDINGS			
HIGHER VOLTAGE WINDING TO EARTH			
LOWER VOLTAGE WINDING TO EARTH			
PRIMARY CABLE TERMINATION & MARKING			
SECONDARY CABLE TERMINATION & MARKING			
EARTH CONNECTION SECURED			
TRANSFORMER SECURELY MOUNTED			
TRANSFORMER NUTS AND BOLTS CHECKED			

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX S
MEDIUM VOLTAGE CABLES INSULATION RESISTANCE AND PRESSURE TESTS

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

MEDIUM VOLTAGE CABLES (SHEET 1 OF 2)
INSULATION RESISTANCE AND PRESSURE TEST BETWEEN PHASES AND EARTH
("R" , "Y" AND "B" PHASES BUNCHED)

MANUFACTURER .....
LOCATION ON SITE .....

CABLE REF. NO.	CABLE SIZE, TYPE AND VOLTAGE	MEGGER TEST VOLTAGE	INSULATION RESISTANCE MEG. Ω	PRESSURE TEST KV ac/dc	DURATION MINUTES	LEAKAGE CURRENT MILLI AMPS	SIGNA-TURE	DATE	SIGNA-TURE	DATE

SIGNATURE:	DATE	SIGNATURE (CLIENT)	DATE

(to be continued)

APPENDIX S (continued)

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS			

MEDIUM VOLTAGE CABLES (SHEET 2 OF 2)
INSULATION RESISTANCE AND PRESSURE TEST BETWEEN PHASES

MANUFACTURER................
LOCATION ON SITE............

CABLE REF. NO.	CABLE SIZE, TYPE AND VOLTAGE	TEST PHASE CONNEC-TION	MEGGER VOLTAGE	INSULA-TION RESIST-ANCE MEG. Ω	PRESSURE TEST VOLTAGE ac/dc	DURA-TION OF TEST: MINUTES	LEAKAGE CURRENT: MILLIAMPS	SIGNA-TURE	DATE	SIGNA-TURE (CLIENT)	DATE
		RY TO B									
		RB TO Y									
		RY TO B									
		RB TO Y									
		RY TO B									
		RB TO Y									
		RY TO B									
		RB TO Y									
		RY TO B									
		RB TO Y									
		RY TO B									
		RB TO Y									
		RY TO B									
		RB TO Y									
		RY TO B									
		RB TO Y									
		RY TO B									
		RB TO Y									
		RY TO B									
		RB TO Y									

SIGNATURE:	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX T
LOW VOLTAGE CABLES INSULATION RESISTANCE TESTS SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

LOW VOLTAGE CABLES
INSULATION RESISTANCE TESTS SHEET

LOCATION ON SITE. .....

(SHEET 1 OF 1)

CABLE REF. NO.	CABLE SIZE, TYPE AND VOLTAGE	TEST PHASE CONNECTIONS	INSULATION RESISTANCE (meg. Ω)	SIGNATURE	DATE	SIGNATURE	DATE
		RY TO B					
		BR TO Y					
		RYB TO E					
		RY TO B					
		RB TO Y					
		RBY TO E					
		RY TO B					
		RB TO Y					
		RYB TO E					
		RY TO B					
		RB TO Y					
		RYB TO E					
		RY TO B					
		RB TO Y					
		RYB TO E					
		RY TO B					
		RB TO Y					
		RYB TO E					
		RY TO B					
		RB TO Y					
		RYB TO E					
		RY TO B					
		RB TO Y					
		RYB TO E					

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX U
MICC CABLE AND CONDUIT INSTALLATIONS

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

MICC CABLE AND CONDUIT INSTALLATIONS	(SHEET 1 OF 1) LIGHTING & POWER CIRCUITS TEST SHEET
LOCATION	DISTRIBUTION BOARD NO.

CIRCUIT NO.	DESCRIPTION	CONTINUITY OHMS	INSULATION RESISTANCE TEST IN MEG. Ω		
			BETWEEN CORES	CORE TO EARTH	COMPLETE INSULATION TO EARTH

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX V
BATTERIES AND CHARGERS CHECK LIST / TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

(SHEET 1 OF 1)

BATTERIS & CHARGERS
CHECK LIST/TEST SHEET

UNIT TITLE

BATTERY

MANUFACTURER		RATED OUTPUT-VOLTAGE	VOLT
EQUIPMENT NO.		ELECTROLYTE LEVEL SATISFACTORY	
CELL VOLTAGE	VOLT	SPECIFIC GRAVITY	
BATTERY TYPE		CONNECTIONS SECURE, POLARITY & CONTINUITY CHECKED	

BATTERY CHARGER

MANUFACTURER		SERIAL NO.	
EQUIPMENT NO.		INPUT VOLTAGE	VOLT
RATING		OUTPUT VOLTAGE	VOLT

INSULATION RESISTANCE OF BUSBARS AND AUX. WIRING SATISFACTORY		VOLTAGES ON FULL LOAD	FLOAT	VOLT
			BOOST	VOLT
MECHANICAL/ELECTRICAL INTERLOCKS SATISFACTORY		CHECK OPERATION OF LOW BATTERY VOLTS DETECTOR		
EARTH CONNECTION SECURE AND CONTINUITY CHECKED		METER OPERATION SATISFACTORY		
LABELS SATISFACTORY				
POLARITY CORRECT				
CHARGER PROTECTION SETTING CHECKED				
CHARGER FAIL ALARM CHECKED				
VOLTAGES ON NO LOAD	FLOAT V			
	BOOST V			
EARTH LEAKAGE ALARM CHECKED.				

SIGNATURE	DATE	SIGNATURE (CLINT)	DATE

APPENDIX W
INVERTERS CHECK LIST / TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

INVERTERS CHECK LIST/TEST SHEET	AREA LOCATION MANUFACTURER.	(SHEET 1 OF 1)

UNIT TITLE	
MANUFACTURER	SERIAL NO.
EQUIPMENT NO.	RATING
INPUT VOLTAGE RANGE VOLT	OUTPUT VOLTAGE VOLT

EARTHING CONNECTION SECURED AND CONTINUITY CHECKED	
LABELS SATISFACTORY	
INVERTER PROTECTION SETTING CHECKED	
OUTPUT VOLTAGE AT HALF LOAD	VOLT
OUTPUT VOLTAGE AT FULL LOAD	VOLT
VOLTAGE REGULATION WITHIN LIMITS	
FREQUENCY OUTPUT SET AT	Hz
OUTPUT VOLTAGE WITH MINIMUM INPUT VOLTAGE	VOLT
OUTPUT VOLTAGE WITH MAXIMUM INPUT VOLTAGE	VOLT

SIGNATURE:	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX X
TRANSFORMER RECTIFIER CHECK LIST / TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

(SHEET 1 OF 1)

TRANSFORMER RECTIFIER CHECK LIST/TEST SHEET			
AREA LOCATION			
TRANSFORMER/RECTIFIER TYPE			
MANUFACTURER			
SERIAL NO.		EQUIPMENT NO:	
RATING	KVA	INPUT VOLTAGE (a.c.)	VOLT
CURRENT OUTPUT	d.c AMPS	OUTPUT VOLTAGE (d.c.)	FROM: ..... VOLT TO: ..... VOLT
TRANSFORMER DIAGRAM NO.			
TRANSFORMER TANK FITTINGS SECURED AND COMPLETED			
TRANSFORMER TANK EARTH SECURE AND CONTINUITY CHECKED			
TRANSFORMER TANK OIL LEVEL SATISFACTORY			
TRANSFORMER INCOMING SWITCH FUSE RATING			AMP
TRANSFORMER CABLE CONNECTION SECURE AND SATISFACTORY			
*I.R. READING OF TRANSFORMER PRIMARY			MEG. Ω
MEASURING INSTRUMENTS, PROTECTIVE DEVICES ALARMS ETC			
SELECTOR SWITCH OPERATION			
NOTE: * I.R. STANDS FOR INSULATION RESISTANCE			

SIGNATURE	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX Y
EARTHING SYSTEM TEST SHEET

REF. DRAWINGS NO.	DATE	REVISION	BY	CK	APPROVALS

EARTHING SYSTEM TEST SHEET (SHEET 1 OF 1)

ELECTRODE NO.	TYPE AND MATERIAL	LENGTH (M)	LOCATION	RESISTANCE (OHMS)	CONDUCTOR SIZE	EARTH LEAD CONTIN-UITY OHMS	TERMINAL BOLT AND NUT SECURED	REMARKS

SIGNATURE:	DATE	SIGNATURE (CLIENT)	DATE

APPENDIX Z
GENERAL WIRING TEST AND CHECK LIST

REF.DRAWING NOS.	DATE	REVISION	BY	CK	APPROVALS

GENERAL WIRING TEST AND CHECK LIST (SHEET 1 OF 1)

LOCATION .....

ITEMS TO BE INSPECTED CHECKED AND/OR TESTED:

NO.	DESCRIPTION	RESULTS
1	IMPEDANCE OF EACH CONTINUITY CONDUCTOR.	
2	EARTH LOOP IMPEDANCE.	
3	EARTH LEAKAGE PROTECTION.	
4	POLARITY THROUGH THE INSTALLATION.	
5	FOR SINGLE POLE SWITCH, PHASE TO BE IN LIVE CONDUCTORS ONLY.	
6	THE INSULATION RESISTANCE OF THE FIXED WIRING TO EARTH IS NOT LESS THAN 1 MEG. OHMS.	
7	THE INSULATION RESISTANCE TO EARTH OF EACH ITEM OF APPARATUS TESTED SEPARATELY IS NOT LESS THAN 0.5 MEG. OHMS.	
8	PHASE IS CONNECTED TO TOP CONTACT OF EDISION SCREW LAMP HOLDERS. NOT TO SCREWED PART.	
9	ALL FLEXIBLE CORDS, SWITCHES, FUSES, PLUGS AND SOCKET OUTLET ARE IN GOOD SERVICEABLE CONDITION. EXCEPT THOSE LISTED IN INSPECTION REPORT.	
10	COLOUR IDENTIFICATIONS ARE CORRECT AND COMPLIES WITH I.E.E. REGULATIONS(16th EDITION)	
11	THERE IS NO SIGN OR INDICATION OF UNSAFE CONDITION.	

SIGNATURE:	DATE	SIGNATURE (CLIENT)	DATE

CONTENTS :

PAGE No.

ATTACHMENTS:

Note:

Copy of certificates formats follows.

ATTACHMENTS

ATTACHMENT 1
CERTIFICATES

The following certificates shall be issued where necessary:

1.1 Safety Clearance Certificate "A"

This certificate will be issued by the Engineer on completion of the work or part of it, and signifies that the work is considered fit to be subjected to the acceptance or precommissioning tests, in accordance with the relevant articles of general conditions of contract. This certificate must be signed by the Company representative involved before any testing etc. may commence.

After issue of this certificate the contractor must sign and return the original to the Engineer, since it signifies that he undertakes not to carry out any further work on the equipment without first being issued with a permit to work. This certificate does not imply satisfaction on the part of the Engineer. Defects/omissions to the plant will be issued on certificate "B".

1.2 Plant Clearance Certificate "B"

This certificate will be issued by the Engineer after it has been signed by the Contractor's representative and the Company representative, on completion of the initial operation of the equipment, and it signifies the contractors confirmation of any defects/omissions listed at that time. It also records the date and time that the plant was given its initial operation.

1.3 Clearance Certificate for Company Operation (Certificate "C")

This certificate will be issued by the Engineer and must be signed by the Contractor to signify his permission for the plant to be operated where necessary by the Engineer for operational purposes.

1.4 Internal Taking over Certificate "D"

This certificate will be issued by the Company's site Engineer to the Company's Contract Department, and indicates that the equipment can in part be paid for, to the exclusion of any defects and/or omissions as listed. This certificate will be issued in accordance with the relevant articles of general conditions of contract.

This certificate also details the date from which the maintenance period will commence.

1.5 Taking over Certificate "E"

This certificate will be issued by the Company to the Contractor informing him of:

1) The release of some of the monies against the contract.
2) The date of the commencement of the maintenance period.
3) The agreed list of defects and/or omissions at that stage.

The issue of the certificate will be in accordance with the general conditions of contract but it does not imply an admission that the work has been completed in every respect.

1.6 Internal Contract Acceptance Certificate "F"

This certificate will be issued by the Company's site Engineer to the Company's Contract Department and indicates that the maintenance period has been completed and signifies his satisfaction that the works have been completed in every respect excepting for the minor work outstanding as listed on the certificate.

1.7 Final Contract Acceptance Certificate "G"

This certificate will be issued by the Company to the Contractor informing him of the release of the outstanding money (less any sum set against minor outstanding work as listed) on the satisfactory completion of the maintenance period at the plant.

The issuance of this certificate relieves the Contractor of his contractual obligations excepting the completion of the minor work outstanding.

1.1 Safety Clearance Certificate "A"

Project .....
Date .....
Number .....

Description and Location of Plant:

To Contractor:

Notice is hereby given that the equipment listed above is being made alive/put into service or by reason of its proximity or relation to other apparatus must be regarded as being alive/in service, and from hrs.....on.....will come under the control of the Company in so far as the area safety is concerned. No further work may be carried out on or near this equipment after this time and date unless the person in charge of this work is in possession of a permit to work, issued by an authorized person employed by the Company.

Will you please sign this form in the space provided below and return the original and retain the duplicate.

Signed .....
Company Engineer

Acknowledgement:

I/We acknowledge recepit of the above notice and confirm that all men in my/our have been duly warned of the above.

Signed ..... **For Contractor** ..... **Time** ..... **Date** .....

1.2 Plant Clearance Certificate "B"

Project .....
Date .....
Number .....

Description of Plant:

To Contractor:

Contract No.: .....

The above plant was given its initial operation run..... hrs on..... in the presence of the following witnesses. The Contractor is not authorised to work unless separate work permit is issued by an authorized person.

For the Company **(Signed)** .....

For Contractor **(Signed)** .....

Date ..... **.....** **Signed**
For the Company

1.3 Clearance Certificate for Company Operation (Certificate "C")

Project .....
Date .....
Number .....

Description and Location of Plant:

To Contractor:

As from .....hrs on.....date, the above listed plant/services/circuits may be operated and run by the Engineer and/or his staff, as required for operational purposes, with/without* the Contractors representative present.

Please sign the lower portion of this certificate in the space provided and return the original and retain the duplicate.

Date..... **Signed** .....
For the Company

To the Company:

We have noted the above and agree to the operation of the equipment specified.

Date..... **Signed** .....
Contractor's Representative

*** Delete as applicable.**

1.4 Internal Taking Over Certificate "D"

Project .....
Date .....
Number .....

Description of Plant:

To Company Contracts Department:

Contract Number: .....

In accordance with the condition of contract, the Contractor is entitled to a Taking Over Certificate "E" for the above plant. It is proposed that, subject to the exclusion of the following items, the taking over date shall be .....and that it will be, the commencement of the maintenance period.

Release of Retention Money

It is recommended that up to .....% of the contract price be released on the above equipment subject to a deduction of list of Defects and Omissions.

Date ..... **Signed** .....
Company site Engineer

1.5 Taking Over Certificate "E"

Project .....
Date .....
Number .....

Description of Plant Taking Over:

To Contractor:

Contract Number: .....

It is hereby certified that the taking over/completion date for the plant detailed above, apart from the exception listed, is ..... and that the maintenance period of .....months will commence on that date.

Release of Retention Money

Up to .....% of the contract price is release on the above plant subject to a deduction of ..... in respect of the defects.

List of Defects and Omissions

Date..... **Signed** .....
For the Company

1.6 Internal Contract Acceptance Certificate "F"

Project .....
Date .....
Number .....

Description of Plant Accepted:

Minor Work Outstanding:

To Company Contracts Department:

This is to certify that the.....months maintenance period on the above plant was completed on .....and that all defects omissions and modifications have been satisfactorily cleared with the exception of the minor items listed below and that the plant meets all existing operation requirements.

Date..... **Signed** .....
Site Engineer

1.7 Final Contract Acceptance Certificate "G"

Project .....
Date .....
Number .....

Description of Plant Accepted:

Minor Work Outstanding:

To Contractor:

Contract Number: .....

This is to certify that the .....months maintenance period on the above plant was completed on ..... .The final payment is now made on the above plant, subject to and in respect of defects and omissions as listed below.

Date ..... .**Signed**.....
For the Company