**L-S15**

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# SPECIFICATION FOR 11 KV METAL- ENCLOSED SWITCHGEAR

Cawangan Kejuruteraan Elektrik
Jabatan Kerja Raya Malaysia

This section of the specification describes and specifies requirements of the supply, installation, testing, commissioning, handing over in approved working order and maintenance during the Defects Liability Period (DLP) of the 11 kV circuit breaker equipment all in accordance with the specification, supplementary notes, Bill of Quantities, Conditions of Contract, Drawings, etc.

All standards shall conform to Malaysian Standards (MS), International Electrotechnical Commission (IEC) and British Standard Institution (BS).

The 11 kV switchgear equipment shall be accommodated for instruments, metering and protection relays at the front of the cubicle. In the cubicles, accommodation shall be provided for the busbar, circuit breaker (CB), plugging contacts, instrument transformers, main and auxiliary cable connection, small wiring, circuit breaker control selector switches, earthing switches, complete with indicating devices for CB and earthing switch.

The switchgear equipment shall comply with the latest relevant Malaysian Standards or IEC Recommendations or British Standard Specification and shall be of the type approved by JKR.

If the Electrical Contractor offers equipment which conforms to standards/recommendations other than those published by the British Standards Institution or the IEC or Malaysian Standards, full details of the difference between the proposed standard and the equivalent British Standard or IEC Recommendation, in so far as they affect the design and performance of the equipment, shall be submitted with the Tender.

Electrical Contractors shall submit at the time of tendering detailed Technical Particulars and Guarantees in respect of the equipment offered, which shall be binding. No departure from these Technical Particulars and Guarantees will be permitted except with the written approval of the S.O.'s Representative. Not withstanding any description, drawings, illustrations or pamphlets which may be submitted with the Tender, all details other than those stated by the Electrical Contractor in the Schedule of Departures from Specification, at the time of tendering, will be deemed to be in full conformity with the Specification.

The Electrical Contractors shall guarantee the equipment to be supplied under this Contract against faulty design, materials and workmanship at the manufacturer's works within the Defects Liability Period.

The switchgear equipment shall be suitable for service on an electrical power system of 11kV, 3-phase, 50 Hz. They shall be fully tropicalised and suitable for continuous operation at an ambient temperature up to 40 degree Celsius, relative humidity up to 100% and at altitude up to 1000 metres above sea level. The equipment shall be of the single busbar, metalclad, floor mounting, indoor type with horizontal isolation and horizontal draw out features having air insulated busbar, current transformer and voltage transformer chambers. The equipment shall be fully extensible both to the left and right such that it is possible to couple individual units of circuit breaker together to form switchboard of different number of circuit breakers.

The equipment shall have fully interlocked foolproof operation system, provided with pressure relief flap and designed to prevent accidental contact with live parts such that the equipment will provide the highest degree of protection for personnel and totally safe for operation. The equipment shall also be designed to prevent ingress of vermin and to minimise the ingress of dust and dirt. Materials which may be liable to attack by termites and other insects should not be used. The switchgear equipment covered by this specification shall be suitable for:-

**A. Feeder Circuit:**

Type A1 - with non-directional overcurrent and earth fault protection using IDMT relay.

Type A2 - with differential pilot wire protection using Translay relay, without back up protection.

Type A3 - with differential pilot wire protection using Translay relay with back up overcurrent and earth fault protection using IDMT relay.

**B. Transformer Circuit:**

Type B1 - with non-directional overcurrent and earth fault protection using IDMT relay.

**C. Bus Section:**

Type C1 - non-automatic, i.e. no protection relays involved.

## 4.1 TYPES OF SWITCHGEAR

The type of switchgear shall be of Vacuum Circuit Breaker type.

## 4.2 RATING OF SWITCHGEAR.

The switchgear equipment shall be suitable for continuous operation on 11 kV, 3-phase, 50 Hz, neutral earthed electrical system with fault level up to 350 MVA. The impulse withstand level, on 1.2/50 micro second, shall not be less than 75 kV peak. The various components of the switchgear equipment shall have the following rating:-

**(i) Fix Portion**

(a) Rated voltage : 12 kV.

(b) Rated normal current : 630A.

(c) Rated short time withstand current : 18.4 kA r.m.s at 3 second, 11 kV

**(ii) Circuit Breaker**

(a) Rated voltage : 12 kV.

(b) Rated normal current : 630A.

(c) Rated short circuit making current 46.9 kA peak at 11 kV.

(d) Rated short circuit breaking current 18.4 kA r.m.s. at 11 kV

(e) Rated short time withstand current : 18.4 kA r.m.s at 3 second, 11 kV

**(iii) Earth Switch**

(a) Rated voltage : 12 kV

(b) Rated short circuit making current 46.9 kA peak at 11 kV.

(c) Rated short time withstand current : 18.4 kA r.m.s at 3 second, 11 kV

**(iv) Circuit Breaker (Bus Section)**

(a) Rated voltage: 12 kV

(b) Rated short circuit making current: 630A

(c) Rated short time withstand current: 18.4 kA r.m.s at 3 second, 11 kV

An ASTA or KEMA or PEHLA or approved accredited laboratory type test certificate shall be submitted with the Tender.

## 4.3 BUSBARS

Busbars shall conform to BS 159 and shall be totally enclosed air insulated type. They shall be made of high conductivity hard drawn copper bars shrouded with epoxy resin or heat shrinkable material with high dielectric strength.

Except for those associated with the bus section panels, all busbars for circuit breaker shall be of a standard unit length with provision for mounting on a panel basis at the busbar orifice tee off connectors.

## 4.4 STATIONARY PORTION

The stationary cubicle portion of the switchgear equipment shall comprise a fabricated steel structure with sheet steel cladding of rigid construction and shall withstand repeatedly without distortion shocks caused by closing and opening impacts under all conditions.

Each cubicle shall be fully compartmentalized into circuit breaker, busbar, cable, relay and metering chambers. There shall be no vertical partitioning in the air insulated busbar chamber. Each cubicle shall be fitted with a flap to relieve any pressure which might build up due to an internal fault. The fixed isolating contacts shall be insulated and shrouded by resin moldings. Provision shall be made at the rear of the panel to run a continuous earth bar to earth frames of all panels of a switchboard.

## 4.5 SAFETY SHUTTERS

Main plugging contact apertures shall be fitted with fully automatic metal safety shutters arranged to close the apertures and access to live parts when the circuit breaker is withdrawn and to open when the circuit breaker is being plugged in. The shutters shall form reasonably dust, drip, fire and insect proof covers over the apertures and shall be arranged in two sets, one to cover the busbar spout apertures and the other to cover the circuit spout apertures, normally opening and closing simultaneously. Means shall be provided to uncouple each set from the mechanism and to lock in the closed position with padlocks. The safety shutters shall be so designed as to facilitate the insertion of test plugs, when necessary.

Busbar and circuit shutters shall be indicated and boldly labelled 'BUSBAR' and'CABLE' respectively.

## 4.6 HEATERS

In view of the extreme tropical and humid climatic conditions under which the equipment are required to operate, suitable low temperature anti-condensation heater with individual thermostat control with faulty light indicator. The heater shall be rated at 240 V a.c. and be provided in each circuit breaker panel together with a protective fuse/circuit breaker as necessary. The heater shall mounted as to prevent moisture condensation building up within the busbar chamber,

current transformer chamber, busbar and feeder spouts etc., and yet not to cause any undue overheating of the cables, cable terminations, busbars, current transformers etc.

Wiring from nearby low voltage (LV) board to the switchgear panel for the heater shall be carried out by the Electrical Contractor.

## 4.7 CIRCUIT BREAKER

The circuit breaker equipment shall be of steel construction, rigid and designed to resist tension and to withstand the shocks under fault conditions. It shall accommodate the circuit breaker, operating mechanism, auxiliary switches, main and auxiliary plugging contacts etc.

The circuit breaker shall be of vacuum type with the interrupter contacts housed in a sealed vacuum cylinder.

The interrupter of the vacuum circuit breaker shall consist of a sealed cylindrical insulating glass/ceramic enclosure containing the fixed and moving contacts, condensation metal shields and metal bellows. The alloy materials used for the interrupter contact surfaces shall represent the best choice from an arc stability point of view and when combined with the system or magnetism arc control, produces low arc energy and minimum contact wear. The interrupter shall be mounted in epoxy resin monobloc or monoblocs and to form a robust assembly.

The circuit breaker shall be provided with a suitable mechanically operated 'OPEN' 'CLOSED' (alternatively 'OFF' and 'ON') indicating device, conspicuously positioned and clearly visible. The indicating device shall be positively driven in both directions so as to show whether the circuit breaker is open or closed in the service or isolated positions.

The circuit breaker main plugging contacts shall be self aligning type and shall be mounted on cast resin bushings incorporating stress controlled condenser layer. The secondary connection between the fixed and moving portion shall preferably be made of self-aligning plugs and sockets. The circuit breaker of identical rating shall be fully interchangeable with one another.

Unless otherwise specified in BQ it shall be capable on close door operation (plug in type remotely operated) and clearly label with the respective functions.

### 4.7.1 CIRCUIT BREAKER TRUCK TYPE

The truck shall be equipped with suitable wheels for movement on normal floor surfaces and are also to act as guides in conjunction with suitable alignment rails, pins and sockets to ensure correct and accurate engagement of the plug and socket contacts.The circuit breaker truck shall be able to be pushed in until it comes to a stop, with the moving isolating contacts still sufficiently far from the fixed contact to avoid discharge. The last few centimeters of travel to contact touch and on to fully plugged in position shall be controlled by a detachable handle or other means. A suitable form of manually operated draw out isolation shall be provided with mechanical interlocks to prevent the circuit breaker from being moved into or out of the fully plugged in position with the circuit breaker in the closed position and to prevent closing of the circuit breaker unless it is in the fully plug in or fully isolated positions.

Means shall be provided for locking the truck in the fully plugged in position with padlocks.

Means shall also be provided for the efficient earthing of the truck portion to the stationary cubicle when the truck is fully plugged in.

### 4.7.2 CIRCUIT BREAKER CASSETTE TYPE

The circuit breaker shall be able to withdraw from the fixed portion of busbars and outgoing circuit connections through a manually operated or motorized means.

A suitable rigid steel trolleys shall be provided and equipped with suitable wheels for movement on normal floor surfaces for each substation for the purpose of maintenance.

Means shall also be provided for the efficient earthing of the circuit breaker portion to the stationary cubicle when the circuit breaker is fully plugged in.

## 4.8 MECHANICAL INTERLOCK

A fully complement of mechanical interlocks shall be provided to prevent the following:-

(a) The circuit breaker being withdrawn from or inserted into the isolating contacts when it is closed (attempted isolation shall not trip a closed circuit breaker).

(b) The circuit breaker being closed unless correctly located in the service or isolated positions or unless the circuit breaker is fully withdrawn from the stationary portion of the switchgear equipment.

(c) The moving portion being withdrawn or replaced unless the circuit breaker is fully isolated and in the appropriate position for withdrawal or replacement.

(d) The circuit breaker being closed in the service position without completing the auxiliary circuits between the fixed and moving positions.

(e) The auxiliary circuits plug and socket been uncoupled when the circuit breaker is in the service position.

(f) The earthing switch being closed when the circuit breaker is in the service position or between the service and isolated position.

(g) The circuit breaker being inserted into the service positions with the earthing switch closed.

(h) Access to the high voltage (HV) fuse orifices of the voltage transformer unless the voltage transformer is isolated.

All manually operated mechanical interlocks shall be clearly labeled to indicate their respective functions. Means shall be provided for padlocking to affect the above mechanical interlocking systems.

## 4.9 OPERATING MECHANISM

Circuit breaker mechanism shall be the trip free type and shall be robust enough to withstand the forces produced under such conditions. Unless otherwise specified, each circuit breaker shall be fitted with a spring operated, power closing mechanism for closing the circuit breaker by means of energy which has previously been stored in by hand charged, with direct mechanical release and having the following requirements:-

(a) It shall not be possible under any circumstances for the circuit breaker to close while the spring is being charged.

(b) It shall be necessary for the spring to be fully charged before it can be released to close the circuit breaker.

(c) The circuit breaker shall always open at normal speed even if the mechanism fails to latch on closing.

(d) It shall be possible to charge the spring when the circuit breaker is closed, thus allowing the circuit breaker to be reclosed immediately it opens. While the spring is thus charged, it shall be possible to release the spring either mechanically or electrically without opening the circuit breaker.

(e) A visual mechanical indicating device shall be provided to indicate include the state of the spring.

Manual tripping shall be effected by a push button. An operation counter shall be provided to register the number of switching operation.

## 4.10 AUXILARY CONTACTS

All auxiliary contacts shall be positively driven in both directions. They shall be mounted so as be readily accessible for maintenance and shall be designed to facilitate inspection, cleaning and adjustment.

Unless otherwise specified each breaker shall be fitted with a minimum of four auxiliary contacts, two normally open and two normally closed. All auxiliary contacts shall be wired to appropriate terminal boards, whether or not these are used in the first instance.

## 4.11 SECONDARY ISOLATING CONTACTS

The secondary wiring shall be carried from the mechanism, via a flexible tube, through secondary isolating contacts, into the bottom of the instrument chamber. The isolating sockets shall be contained in moulded blocks fastened to the bottom of the instrument chamber. The isolating plugs shall be contained in a detachable plug box tray fastened to the mechanism. With the breaker in its isolated position, it shall be possible to plug the plug tray into the sockets at the bottom of the instrument chamber, thus allowing checking of secondary circuits without having the circuit breaker in service.

## 4.12 EARTHING DEVICE

Earthing switch shall comply with IEC 60129 and MS IEC 62271-102. An integral earthing switch of the quick make type shall be provided for earthing the circuit side of the switchgear equipment.

The earthing switch shall be located in the cable compartment and shall be operated from the front of the switchgear cubicle. This earthing switch shall be able to close against the rated short circuit current and shall have only two positions, open or closed. Means shall be provided to enable the earthing switch to be locked in both positions with padlocks.

The position of integral switch shall be clearly visible from the front of the switchgear cubicle.

Mechanical interlocks shall be provided to prevent:-

(a) Closing the earthing switch when the circuit breaker is in the stationary portion of the switchgear equipment.

(b) Inserting the circuit breaker into or withdrawing the circuit breaker from the stationary portion of the switchgear equipment when the earthing switch is closed.

In case the switchgear equipment offered cannot comply with the above requirements, the Electrical Contractor may, at the time of tendering, submit alternative offer. In which case, the Electrical Contractor shall clearly indicate the deviations and provide full technical particulars of the alternative offer.

## 4.13 CURRENT TRANSFORMERS

Current transformers shall comply with the requirements of IEC 60044-1 and shall have short circuit ratings not less than that of the associated switchgear. They shall be capable of carrying the rated primary current for a period of one minute with the secondary open circuited as specified in the standard.

The rating of current transformers shall be as stated in the Drawings. Unless otherwise specified, the output and class of accuracy for protection current transformers shall be 15 VA, Class 5P10 for protection and utility metering current transformers shall be 15 VA Class 0.2 or instrument metering current transformer shall be 15VA Class 0.5.

Each current transformer shall be provided with an identifying label giving its type reference, ratio, output, class accuracy, voltage rating and serial number. The label shall be fixed to current transformer in such a position so that the details of the label can be easily visible.

The secondary windings of current transformers shall be wired to suitable terminal boards and earthed at one point in the circuit.

Switchgear equipment for circuit's type A1, A2 and B1 shall be fitted with one protection current transformer per phase, and in addition to the protective relay element, the yellow phase current transformer shall also cater for the panel ammeter instrumentation. In the case of switchgear equipment for circuits type A3, two separate current transformers shall be provided in each phase, one for Tran slay pilot wire feeder protection and the other for back up over current and earth fault protection and also for panel ammeter instrumentation in the yellow phase.

In addition to the protection current transformers mentioned above, a current transformer shall be provided separately on each of the two outer phases of each incoming feeders for kWH and kVARH metering. The Electrical Contractor shall supply and install the metering panel for HV metering by Licensee/Supply Authority. The panel shall be fabricated to suit Licensee/Supply Authority's requirements.

Cabling from the switchgear panel to the metering panel and other associated accessories as required shall also be supplied and installed by the Electrical Contractor.

In addition to the utility metering current transformer being acceptable to the S.O.'s Representative, the Electrical Contractor shall also ensure that they are approved by Licensee/Supply Authority for the installation under this Contract.

## 4.14 VOLTAGE (POTENTIAL) TRANSFORMERS

Voltage transformers, if specified in the Drawings, shall be of 3-phase, 3 limb, star-star, withdraw able type having a ratio of 11,000/110 volts complying IEC 60044-2. They shall be of cast epoxy resin filled type suitable for installation in the switchgear equipment.

The connection between the main circuit and voltage transformer shall be capable of carrying the rated short time current of the switchgear equipment. The primary windings shall be connected through suitable HRC fuses to the circuit side of the transformers remote from the busbars or, when specified otherwise, to the busbars. The secondary windings shall be connected through fuses to the appropriate circuits and labelled to indicate their respective functions and phase colours.

The voltage transformers shall be capable of being padlocked in the isolated position. Safety shutters normally closed and positively driven by the voltage transformers isolating switch shall open to enable the fuses to be replaced when the transformers are in isolated position and shall shield the access to the voltage transformers HV fuses as soon as the isolating switch is closed.

When voltage transformers is specified to be connected to the busbar side, the voltage transformers assembly shall be clearly and conspicuously sign painted on the outside with the inscription 'BUSBAR VT'.

Unless otherwise specified the voltage transformers shall be minimum of 100VA class 0.5.

## 4.15 INSTRUMENT AND METERS

All electrical measurement/indication instrument and meters shall be electronic type complying with IEC 60359, IEC 60688, MS 925 and MS IEC 61000.

## 4.1.6 PROTECTIVE RELAYS.

Unless otherwise specified the protection relay shall be of Microprocessor Based Relay.

### 4.1.6.1 Microprocessor Based relay

The protection device shall provide either instantaneous or inverse time lag characteristics in the overload range and instantaneous with or without time delay in the short circuit range as specified in the Drawings and/or Bill of Quantities. The protection device shall be of the type acceptable to the Supply Authority or Licensee and JKR. The protection relays shall be of panel flush mounting type. All relays shall comply with relevant parts of IEC 60255.

Overcurrent and earth fault protection shall be provided by externally connected current transformers.

**Unless specified in drawing or BQ** the incomer Circuit Breaker shall be equip, the microprocessor based protection relays shall be rated at 30 Volt D.C. The relays shall be housed in robust panel flush mounting case to IP54 and shall be fully tropicalised and suitable to be used up to an ambient temperature of 50$^{o}$C and relative humidity of 95%.

Unless otherwise specified, the microprocessor based protection relays shall be of combined two phase over current and earth-fault protection with instantaneous, definite time and inverse time characteristics. Time / current characteristic of IDMT over current and earth fault relays shall be of standard inverse curve.

The microprocessor based protection relays shall give numerical digital readout of set values, actual measured values and recorded values. The relays shall include a serial communication port for external connection to facilitate external reading, setting and recording of relay data and parameters by a personal computer (PC). PC connecting cable and parameter reading/setting /recording PC program shall be provided.

The microprocessor based protection relays shall incorporate with built-in self-supervision system with auto-diagnosis. The self-supervision system shall continuously monitor the relay microprocessor programs. If a permanent fault is detected, an alarm indication shall be given. An alarm contact for connection to external alarm shall be provided.

If current and voltage measurements are specified, the microprocessor based protection relays shall make available these measurements for local display. The measurements shall include phase currents and phase-to-phase voltages.

The microprocessor based protection relays shall comply with relevant parts of IEC 60255 and shall also comply with relevant parts of IEC 61000 on electromagnetic compatibility.

### 4.1.6.2 Electromechanical Relay

Relays shall be draw out types complying with IEC 60255 and shall be flush mounted in draw out type dust proof cases.

Relay contacts shall be of the self resetting type and shall be adequately rated. They shall make firmly without bounce and the whole of the relay mechanism shall, as far as possible, be unaffected by vibration or external magnetic fields.

Relays shall be provided with coloured flag indicators of the hand reset pattern capable of being reset without opening the case. In the case of multi-element relays, separate flag indicators shall be provided for each element, appropriately phase coloured.

Relays with provision for manual operation from outside the case, other than for resetting the flag indicators, will not be accepted. They shall be provided with clearly inscribed labels describing their application and rating.

To minimize the effect of electrolysis, relay coils shall be so connected that the coils are not continuously energized from the positive pole of the d.c, auxiliary supply.

Each non-directional over current and earth fault protective relay shall have a rated current of 5A and shall comprise of three induction disc, inverse definite minimum time lag in a common case. The over current elements shall be provided with adjustable settings for both operating current and time, the adjustment being possible on load.

The range of current settings for over current elements shall be from 50 to 200% of rated full load with tapping at 25% intervals and the time setting adjustment shall be 0 to 3 seconds at 10 times the normal operating current. The earth fault elements shall comply with the foregoing but shall have a range of current settings from 10 to 40% with tapping at 5% intervals.

## 4.17 PREVENTIVE INTERNAL ARC FAULT PROTECTION

Unless specified in drawing or BQ, the arc protection shall be installed against the internal arc in the panels in order to improve personnel safety and to minimize damage to the switchgears in accordance with MS IEC 62271-200. In case of internal arc faults, the arc protection shall be integrated with protection relays or of stand alone type. The relays shall be in accordance to the requirements in Section 4.17. The protection shall able to accept the realistic possibility of an arc, but which reacts before a high-current and destructive arc fault exists. Only a simultaneous occurrence of arc and over-current incidence(s) will activate the trip signal in the relay.

The arc sensors for detecting the arc shall be of photo transistor sensors. The arc sensors shall be in practice be installed to the cable compartments, circuit breaker and busbar compartment. The Arc protection system shall include a self-supervision function covering all equipment, including the arc sensors. All internal faults shall be indicated on the central unit and an alarm contact shall be activated. The arc-monitoring unit shall contain a display capable of indicating the exact fault location after the tripping. The Arc protection Relay shall provide a fully selective, reliable and intelligent protection scheme. If the arcing takes place in cable, busbar or breaker compartment, the unit should capable to trip the individual feeder.

## 4.18 SMALL WIRING

All small wiring shall be erected with single core black coloured PVC insulated 2.5 $mm^2$ plain annealed copper conductor cables 600/1000 V grade to MS 274.

Wires connected to stud type terminals shall be terminated with claw washers, one for each individual wire. No wire may be teed or jointed between terminal points. All wires shall have numbered ferrules at both ends in accordance with the wiring and connection diagrams. The ferrules shall be of insulating material and the characters shall be indelibly marked in black. Additional ferrules marked "TRIP' or 'T' shall be fitted to the wires interconnecting the relay trip contacts and the shunt trip coils. All metallic cases of instruments, relays etc. mounted on the panels, shall be connected by means of green PVC insulated plain annealed copper cables of not less than 4 sq. mm. section to the nearest earth bar. Where auxiliary wiring cleats are used to support insulated wires, these shall be of the insulated compression type.

## 4.19 TERMINAL BOARDS

All terminal boards shall be mounted in accessible positions with provision for making the connections at the front of the terminal boards without exposing any live metal at the back. Where stud type terminal boards are provided, the studs shall be fitted with washers, nuts and locknuts or lock washers. Insulated barriers shall be fitted between adjacent terminals studs. 415/240V terminals shall be segregated from other terminals and shall be fitted with non-inflammable transparent plastic covers to prevent accidental contact. These shall have warning labels with red lettering mounted thereon in a conspicuous position. Where pinch type terminations are used, these shall be of the approved type such as 'Klippon' terminals.

## 4.20 FUSES AND ISOLATING LINKS

A fuse and a link in the positive and negative poles respectively shall be provided on each unit to isolate the tripping circuit from the d.c. bus wires. These shall be of an approved type, the carriers and bases being coloured in accordance with the following code:

| *COLOUR* | *FUNCTION* |
|---|---|
| Black ..... ..... ..... | 5A fuse. |
| Light Green ..... ..... ..... | 15A fuse. |
| White ..... .... .... ..... | Isolating link. |

All fuses and isolating links shall be appropriately labelled to indicate their respective functions.

## 4.21 AUXILIARY CABLE BOX

Switchgear panels fitted with differential pilot wire feeder protection shall be equipped with a small auxiliary cable box together with a compression type gland at the rear end of the panels suitable for the termination of a 7 core PVC/PVC/SWA/PVC pilot cable leading to the corresponding relay at the Licensee/Supply Authority's end of the feeder. Likewise, equipment fitted with metering current and voltage transformer shall also be fitted with a small auxiliary cable box with a compression type gland for connecting the current and voltage secondary leads to the remote metering equipment, using a 7 core PVC/PVC/SWA/PVC cable.

## 4.22 CABLE TERMINATION

The cable termination shall be of heat shrinkable type suitable for 11 kV 1 or 3 core cables. The termination shall be normally for cable entering vertically from below. However, due to site conditions, a bottom angled entry or a vertical top entry may be required. In such case, the Electrical Contractor shall supply the appropriate termination accessories at no extra cost.

## 4.23 PADLOCKS

The Electrical Contractor shall supply 40 mm padlock of hardened steel type for every switchgear panel approved by S.O.'s Representative. All padlocks in the same substation shall be supplied with keys alike and a master key.

One 30V d.c. Ni-Cad battery tripping unit of sufficient AH capacity (5 hour rate) to trip minimum three circuit breakers at the same time shall be supplied and installed in each substation room by the Electrical Contractor. It shall be self-contained, floor standing steel cabinet type with automatic 2 rate (boost and trickle) charging feature and complete with isolator, d.c. milliammeter, d.c. ammeter, d.c. voltmeter, indicator light for 'Mains on', 'Trickle Charge', A.C. Failure' etc. Charge fail visual and audio alarm, alarm cancellation, reset facilities and protective fuses shall also be provided. Input voltage to the charger shall be 240V a.c. single phase via a 13A 3 pin switched socket outlet. Catalogue and technical details of the battery and calculation to prove the adequacy of the capacity of the battery shall be submitted together with the Tender.

All earthing system and accessories shall comply with Electricity Regulations 1994, MS IEC 60364-5-54, BS EN 13601 and BS 7430.

All metal parts of the switchgear equipment shall be interconnected and connected to the switchgear panel earthing bar running along the switchboard. The earth bars shall be of not less than 25 mm x 6 mm flat hardrawn copper. The earth bar shall be bolted to the main frame and located so as to provide convenient facilities for earthing cable sheaths and for use with earthing device. Means shall be provided for coupling earth's bars of adjacent units. The joints shall be bolted. A similar earth bar shall run around the four walls of the switch room at a height of 300 mm from the finished floor level.

Earth electrodes shall be of copper jacketed steel core rods with 16 mm nominal diameter and supplied in 1500 mm length and shall have provision for screw coupling with another standard length. The copper jacket of 99.9 % pure electrolytic copper shall be of minimum radial thickness 0.25 mm and shall be molecularly bonded to the steel case to ensure that the copper jacket and steel core are not separable. Each earth electrode shall be driven 3000 mm in depth. The earth resistance of the HV switchboard earthing shall not exceed 1 Ohm. Where the desired earth resistance value cannot be achieved after the first set of earth electrodes have been driven, sufficient number of sets of earth electrodes in parallel shall be installed outside the resistance area until required value is reached. Each set of earth electrode shall be provided with brass connecting clamp and approved type of precast heavy duty concrete inspection chamber with removable cover.

Mutual separation between two earth electrodes shall be more than, but less than twice, the driven depth of the earth electrode. Earth electrodes shall not be installed close to a metallic fence. Unless the metallic fence is separately earthed, the fence shall be separated from the electrical earthing system by at least 2000 mm. Interconnection between different earth electrodes shall be by means of 25 mm x 3 mm annealed copper tape.

The connection of the earthing conductor and/or the earth electrode to the earth electrode shall be soundly made by the use of plumbed joints, either by brazing using zinc-free material with a melting point of at least 600 $^{0}$C or by exothermic welding.

Each earth electrodes shall be provided with heavy duty type inspection chamber with removable cover. The inspection chamber shall be of square or round type and tested in accordance with MS 26: Part 2. The minimum size of square type inspection chamber shall be 300 mm (width) x 300 mm (length) x 180 mm (height) and for round type inspection chamber, the minimum size shall be 300 mm (diameter) x 180 mm (height). The working load of the inspection chamber shall be minimum 4500kg. Lifting hook shall be provided in the cover. The brand name shall be durably marked on the removable cover.

The earthing points shall be identified by permanent label durably marked with the words `HV Switchgear Frame Earthing' permanently fixed at the point of connection of every earthing conductor to an earth electrode.

## 7.1 LABELLING

The panel shall be labelled to indicate panel type for Feeder, incomer & inter-connector, bus-section and pairing inter-connectors.

Labels of size not less than 50 mm x 150 mm shall be fitted on then front of all switchgears by means of non-corrodable screws or any other method approved by the S.O.'s Representative. The labels shall be of black laminated plastic with engraved white lettering with details such as rating, over current setting, earth fault setting to which it is connected etc. The exact wording of the labels shall be agreed with the S.O.'s Representative.

The exact wording of the labels shall be agreed with the S.O.'s Representative. Single line mimic schematic circuit diagram shall be provided at the facial of the switchgear indicating the direction of supply incoming to the switchgears.

## 7.2 PAINTING

The switchgear equipment shall have one coat of primer, one undercoat and athord finishing coat of paint applied at the manufacturer's works. The final coat shall be of oil resisting enamel paint.

The Electrical Contractor shall ensure that the installation of the circuit breaker equipment on site shall meet to the manufacturer requirement, drawings and the approval of the S.O.'s Representative.

The circuit breaker equipment installed on the site shall have a minimum space clearance of 600mm between back /side of the equipment and wall. In test mode, the space required for the drawn out equipment shall be minimum of 1500mm clearance from the front panel.

It is the responsibility of the Electrical Contractor to discuss with the structural engineer of the project to verify the switchgear room structure is able to withstand the load of the switchgear.
The Electrical Contractor must ensure the floor to be rated for the anticipated load of the equipment, including any point loads that might occur.

The battery compartments installed shall be easily accessible for transporting batteries. In addition, the compartment should be proof against groundwater and flooding, well ventilated – either natural or forced ventilation as per appendix 4.

## 9.1 AT FACTORY

The whole of the plant and equipment to be provided under the Tender may be subjected to inspection and test by the S.O.'s Representative in the factory prior to installation. The approval by the S.O's Representative of the results of any such inspection or test shall not prejudice the right of the Superintending Officer to reject the plant if it fails to comply with the specification when erected or to give complete satisfaction in service within the DLP. The costs of all tests including the provision of the necessary test equipment shall be deemed to be included in the Tender Price.

Adequate notice shall be given when the plant is ready for inspection or test and every facility shall be provided by the Electrical Contractor to enable the S.O.'s Representative to carry out the necessary inspection and tests. The tests to be carried out by the Electrical Contractor shall consist of the following tests as the minimum requirements as shown in Appendix 3.

## 9.2 ON SITE

On completion of the installation work on site, the Electrical Contractor shall, at his own expense, arrange for all necessary tests to be carried out on the equipment by either Licensee/ Supply authority or a Electrical Service Engineer registered with Suruhanjaya Tenaga as part of the tests required of him for the whole installation under this Contract. The tests to be carried out shall be visual inspection and routine as prescribed in the relevant standard for High Voltage Switchgear, The IEE wiring Regulation of the latest Edition, and other tests deemed necessary by the S.O.'s Representative. In the event the installation fails to pass any of these tests, The Electrical Contractor shall take such measures as are necessary to remedy the defects and the installation shall not be considered as completed until all such tests have been passed.

## 9.3 COMMISSIONING

On successful testing of the complete installation, the Electrical Contractor shall arrange to commission the equipment in the presence of the S.O.'s Representative on a date to be decided by the S.O.'s Representative.

Any item of plant or component which fails to comply with the requirements of the specification in any respect whatsoever at any stage of manufacture, test or erection or on completion at site within the contract period may be rejected by the S.O Officer either in whole or in part as he considers necessary. After adjustment or modification if so directed by the–S.O, The Electrical Contractor shall submit the item for further inspection and/or tests. Plant or components with defects of such nature that, in the opinion of the S.O, the requirements of this specification cannot be fulfilled by adjustment or modification shall be replaced by the Electrical Contractor at his own expense and to the satisfaction of the S.O.

## 11.1 MANUFACTURER'S CATALOGUE AND DRAWINGS

Manufacturer's catalogues and drawing giving detailed information on the general arrangement of the switchgear equipment, overall dimensions, general construction, position of cables, grouting bolts, loading on foundation, minimum clearance to rear end wall, trenching details, technical specification and other useful details shall be submitted together with the tender.

## 11.2 RECOMMENDED SPARES

The Electrical Contractor shall submit with his tender separate Schedule of Spares recommended with part numbers by the supplier of the equipment.

All the spare parts shall be original and fully interchangeable with the corresponding part used in the main items of the equipment and with each other without having to resort to machining or additional, fittings at site.

Within two weeks after award of the Tender or such shorter period as may be required by the S.O.'s Representative, the Electrical Contractor shall submit to the S.O.'s Representative for his approval four sets of the details of the layout of the switchgear equipment in the switch room provided in the form of hardcopy (A1 size) and softcopy (AutoCAD version). The drawings submitted are to be amended if necessary as requested by the S.O.'s Representative and resubmitted for final approval. It is to be understood, however, that approval of the drawing will not exonerate the Electrical Contractor from any responsibility in connection with the work.

Approved type of rubber mat shall be provided in front of the switchgear panels. The rubber mat shall extend to the full length of the switchgear panels and shall be of thickness not less than ~~5~~ 6 mm and width 1000 mm.

'BAHAYA' sign, 'DILARANG MASUK' sign, sign indicating 'Substation No: ' and shock treatment chart shall be installed to the requirement of the Electricity Regulations 1994 and to the satisfaction of the S.O.'s Representative. 'DILARANG MEROKOK' sign shall also be installed and 2 sets of 'BAHAYA - KERJA-KERJA SEDANG DIJALANKAN' sign complete with hanging string (200mm x 300mm, background red and letter white in colour) shall be provided.

All trenches in the switch rooms shall be filled up with clean sand to a level above cable ducts.

As installed layout plans, schematic wiring diagrams, and plans showing cable routes and positions of earthing point with reference to easily recognized buildings and structures shall be suitably framed up in the switch room. These plans and diagrams shall be in addition to the four sets of prints required to be submitted to the S.O.'s Representative after completion of the project as stated in section 16.0 below.

One 9 kg. dry powder fire extinguisher for A/B/C class of fire and complete with discharge hose, nozzle and wall bracket shall be supplied and installed in every switch room.

During the DLP, The Electrical Contractor shall be responsible for the service and maintenance work for the complete installation. All works shall be carried out by competent personnel. All labour, material, tools and parts necessary to rectify the defects due to manufacturing/installation faults shall be supplied/executed at the Electrical Contractor's cost.

The service and maintenance to be performed shall include but not be limited to the following:-

(a) Replacing or making good all components of the switchgear equipment, fuses, wiring, battery, battery charger etc.

(b) Replacing or making good all loose and burnt cables and terminations, all mechanical support and linkage, earth electrodes, earth electrode chambers and covers, conduits, trunking etc.

(c) Making good any damage to roads, buildings drains, cables, pipes, concrete areas, paved areas etc. which had not been properly made good arising out of his work.

(d) All other works as deemed necessary by the S.O.'s Representative.

All works shall be carried out as soon as the Electrical Contractor has been informed by the S.O.'s Representative or the Occupant and shall be completed within a reasonable time except under emergency situation as stipulated in the Electrical Works Additional General Conditions. If the Electrical Contractor fails to comply with the above requirement, the S.O.'s Representative reserves the right to engage another party to carry out the works, in which case, the Electrical Contractor shall be responsible for all the expenses incurred.

The drawings, manuals, tools etc. as mentioned below shall be provided whether or not they are separately itemized in the Bill of Quantities of the Tender Document. The cost of all these drawings, manuals, tools etc is deemed to be included in the Tender Price.

In addition to the aforesaid prints, as-installed drawings, Installation manual, Operation manual, Service and Maintenance Manual, Parts List, Product data, catalogues and Test Certificates shall be properly arranged, indexed and stored in electronic media or any other media as specified. For electronic media they shall be in CD rewritable (CD-RW) optical disks format. The software programmed shall be AutoCAD of latest release for drawings. Four (4) sets or of hard copies and one set of CD form shall be submitted.

## 15.1 AS INSTALLED DRAWINGS

On practical completion of the project, four sets of prints for each of the following drawings shall be submitted.

(a) Site plan.
(b) Schematic Wiring Diagrams and Electrical Layout Plans.
(c) Layout Plans of cable routes and earthing points with reference to easily recognizable buildings and structures.

These drawings shall be properly stenciled and shall have at the lower right hand corner the Electrical Contractor's name and address, date of commissioning, scale, drawing number (the drawing number to be obtained from S.O.'s Representative), title and the following particulars:-

**JABATAN KERJA RAYA**
**CAWANGAN KEJURUTERAAN ELEKTRIK**
**CONTRACT NO :**
**TENDER NO :**

If the drawings submitted are not acceptable by the S.O.'s Representative, the Electrical Contractor shall amend and resubmit the drawings within two weeks from the date of return of the drawings. Each of the above four (4) sets of prints shall be arranged, indexed and filed in a stiff cover ring file together with the manuals stated hereinafter.

## 15.2 MANUALS

As soon as the general arrangement and details of the equipment to be supplied have been finalized at and before the delivery of the equipment, the Electrical Contractor shall submit to the S.O.'s Representative copies of detailed installation, operation and maintenance instructions in respect of the equipment to be supplied. The instructions shall cover the main as well as any associated equipment. For this purpose, manufacturer's standard brochures will be acceptable provided that they refer particularly to the equipment to be supplied and are free from extraneous matter.

The instruction shall include essential details, drawings and sketches of the equipment installation, operation and maintenance techniques, make mention of special materials where used and include schedules of recommended parts etc. The cost of these manuals shall be deemed to be included in the Tender Price.

Four sets of the following manuals and documents of the switchgear equipment, battery and battery charger shall be supplied:

(a) Installation manual.
(b) Operation manual.
(c) Service and Maintenance Manual.
(d) Parts List.
(e) Product data and catalogues.
(f) Test Certificates.

Each of the four sets of drawings described in section 16.1 and manuals, parts list etc. described above shall be in a stiff cover ring file.

## 15.3 TOOLS

One set of portable 3 phase test plugs for insertion into the busbars side or circuit side isolating contacts of the circuit breaker equipment, or other similar test accessories, shall be provided for each substation. The test plugs or test accessories shall be insulated to withstand 25 kV d.c. to earth for 15 minutes and shall be capable of carrying at least 200 A continuously.

One set of standard tools and any special tools, gauges, handling appliance etc. as recommended by the manufacturer for the assembly, operation, checking adjustment and normal maintenance of the switchgear equipment, battery, battery charger etc. shall also be provided for each substation.

A steel cabinet of suitable dimensions shall be supplied and installed in the switchgear room for storing tools, spare parts etc. The cabinet shall be completed with lock and keys. The design of the cabinet shall be submitted to the S.O.'s Representative for approval prior to fabrication.

(To be filled by the Electrical Contractor)

## 1.0 General*

| | | |
|---|---|---|
| (a) | Name of Manufacturer | |
| (b) | Name of Supplier | |
| (c) | Model/Type Reference No. | |
| (d) | Type Testing Authority | |
| (e) | Test Certificate Report/ Reference | |
| (f) | Rated Voltage (kV) | |
| (g) | Rated Continuous Normal Current (A) | |
| (h) | Rated Frequency(Hz) | |
| (i) | Number of Phase | |
| (j) | Impulse Withstand Voltage On 1.2/50 micro second (kVp) | |
| (k) | One-minute Power * Frequency Withstand * Voltage (kV r.m.s) | |

**2.0 Circuit Breaker***

| | | |
|---|---|---|
| (a) | Rated Continuous Normal Current (A) | |
| | | |
| (b) | Breaking Capacity (MVA and kA) | |
| | | |
| (c) | Making Capacity (MVA and kA) | |
| | | |
| (d) | Short Time Current Rating. 3 seconds at 11 kV. (kA r.m.s) | |
| | | |
| (e) | Number of Seals in the Vacuum Bottle | |

**3.0 Busbars***

| | | |
|---|---|---|
| (a) | Material | |
| | | |
| (b) | Rated Continuous Normal Current (A) | |
| | | |
| (c) | Short Time Current Rating. 3 seconds at 11 kV. (kA r.m.s) | |

**4.0 Relays***

| | | |
|---|---|---|
| (a) | Name of Manufacturer | |
| | | |
| (b) | Model/Reference No | |
| | | |
| (c) | Test Certificate Report | |

**5.0 D.C. Tripping System***

| | | |
|---|---|---|
| (a) | Name of Battery Manufacturer | |
| | | |
| (b) | Type of Battery | |
| | | |
| (c) | Model No of Battery | |
| | | |
| (d) | Capacity of Battery(AH) | |
| | | |
| (e) | Rated Voltage per Cell | |
| | | |
| (f) | Rated Battery Voltage (Rated Voltage per Cell x Number of Cells | |
| | | |
| (g) | Name of Battery Charger Manufacturer | |
| | | |
| (h) | Type of Battery Charger | |

| | | |
|---|---|---|
| (i) | Make of Battery Charger | |
| | | |
| (j) | Rated Current of Battery Charger | |
| | | |
| (k) | Rated Output Voltage | |
| | | |
| (l) | Boost Charge Current | |
| | | |
| (m) | Trickle Charge Current | |
| | | |
| (n) | Energy required for each tripping (In ampere and at 30 V d.c) R | |

**6.0 Earth Switches ***

| | | |
|---|---|---|
| (a) | Rated Normal Current (A) | |
| | | |
| (b) | Making Capacity (kAp) | |
| | | |
| (c) | Short Time Current Rating. 3 seconds at 11 kV. (kA r.m.s) | |

**7.0 Arc Fault Detection ***

| | | |
|---|---|---|
| (a) | Arc-Light Detector Sensor Manufacturer /Model | |
| | | |
| (b) | Arc Fault Monitor Relay Manufacturer/Model | |

**8.0 Schedule of Departures from Specification:-***

……

……

* Electrical Contractor should enter details at time of tendering. If no details are entered, the equipment shall deem to fully comply with the requirements of the Specification.

Signature : ……..

Name of Electrical Contractor : ……..

Chop of Electrical Contractor :

Date : ……

| | | |
|---|---|---|
| IEC 60129 | - | Alternating Current Disconnectors and Earthing Switches |
| MS IEC 62271-102 | - | High-voltage Switchgear and Control gear – Part 102: Alternating Current Disconnectors and Earthing Switches |
| IEC 62271-1 | - | High-voltage Switchgear and Control gear – Part 1: Common specifications |
| IEC 60056 | - | High-voltage Alternating-current Circuit-breakers |
| IEC 62271-100 | - | High-voltage Switchgear and Control gear – Part 100: Alternating-current Circuit-breakers |
| IEC 60298 | - | A.C. Metal-enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and Up to and Including 52 kV |
| MS IEC 62271-200 | - | High-voltage Switchgear and Control gear – Part 200: A.C. Metal-enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and Up to and Including 52 kV |
| IEC 60044-1 | - | Instrument transformer - Part 1: Current transformer |
| IEC 60044-2 | - | Instrument transformer - Part 2 : Inductive voltage transformer |
| IEC 60255-5 | - | Electrical Relays - Part 5: Insulation coordination for measuring relays and protection equipment- Requirements and tests |
| MS 136 | - | Specification for PVC Insulated Cables (Non-Armoured) for Electric Power and Lighting |

| | | |
|---|---|---|
| MS 274 | - | Specification for PVC-Insulated Cables for Electricity Supply |
| BS EN 13601 | - | Copper and copper alloys. Copper rod, bar and wire for general electrical purposes |
| BS 7430 | - | Code of practice for earthing |
| BS 7671 | - | Requirement for Electrical Installation |
| BS 159 | - | Specification for high-voltage busbars and busbar connection |
| IEC 60359 | - | Electrical and electronic measurement equipment-Expression of performance |
| IEC 60688 | - | Electrical measuring transducers for converting a.c. electrical quantities to analogue or digital signals |
| MS 925 | - | Specification for direct acting indicating electrical measuring instruments and their accessories |

**INSPECTION**

During inspection at the factory and site installation, each part of the switchgear shall be checked against damage. The following inspection on parts shall as follows:

Housing

(a) Ensure that the interior of the housing is clean.

(b) Check the operation of the primary isolating contact spout shutter mechanism.

(c) Check that the primary, secondary isolating contact and earthing contacts are clean.

Circuit Breaker

(a) Primary and secondary isolating contacts.

(b) Earthing contacts.

(c) Surface of insulation components.

(d) Check when CIRCUIT BREAKER LOCKING SELECTOR is in the 'LOCKED' position that circuit breaker position indicator is in the 'SERVICE' position.

(e) Check the spring in the 'CHARGED' indicator flag is displayed when completes spring charging.

(f) Operating the control handle for manual close and trip control.

## TESTING

Routine test shall be carrying out accordance to IEC as follows:

(a) 2.0 kV insulation resistance tests on the circuit breaker equipment, current transformers, voltage transformers etc.

(b) 24 kV A.C. pressure test for 1.0 minute on the circuit breaker equipment and voltage transformers.

(c) Magnetization curve and ratio checks on current transformers.

(d) Testing and setting of all protection relays.

(e) Current Injection test for Current and Potential transformers.

(f) Dielectric and Power frequency voltage test at least one unit of circuit breaker shall be subjected to entire series according to Clause 6.2 in IEC 62271 part 200 include of partial discharge tests but excluding artificial pollution tests.

(g) Vacuum Circuit Breaker Auxiliary Relay Test.

(h) Vacuum Circuit Breaker Mechanical and Electrical function test.

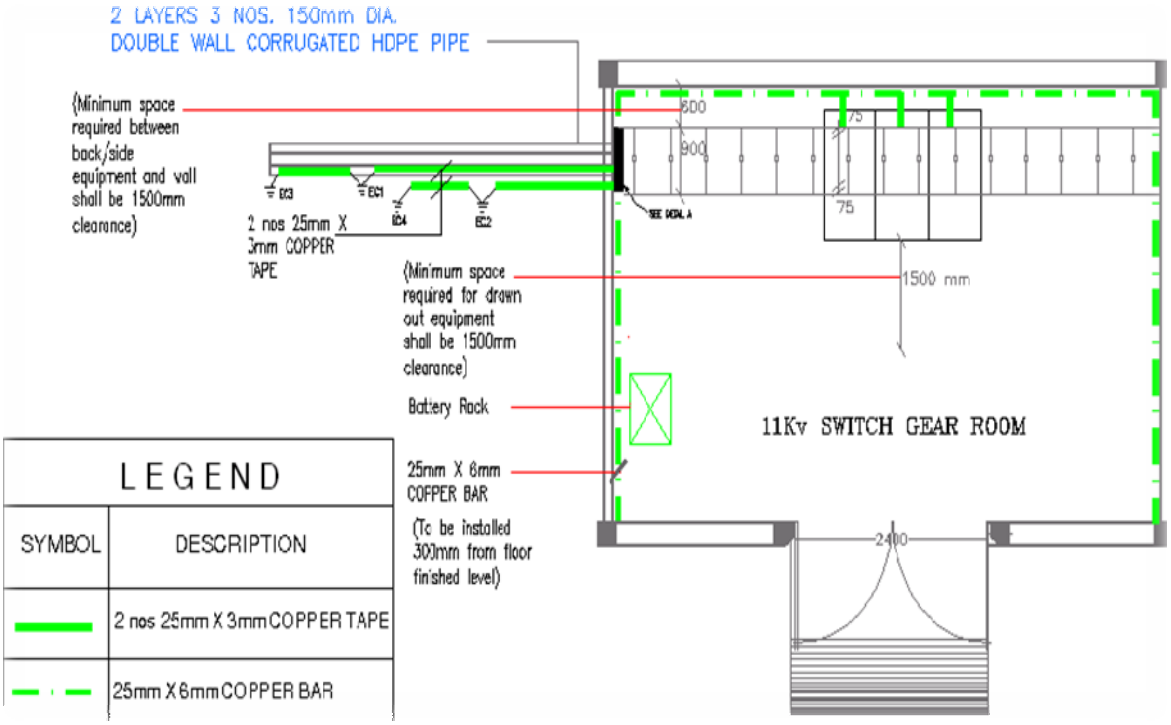
(i) Heaters circuit test.

(j) Any other tests as recommended by the manufacturer and the supplier.

## COMMISSIONING

On successful testing of the complete installation, the Electrical Contractor shall arrange to commission the equipment in the presence of the S.O.'s Representative on a date to be decided by the S.O.'s Representative.

| | | |
|---|---|---|
| | **SPECIFICATION FOR 11 kV METAL-ENCLOSED SWITCHGEAR (L-S15)** | **CKE.LS.01.15.(01).2011**<br>**Date: April 1999** |
| **SECTION:**<br>**APPENDIX** | **TYPICAL LAYOUT FOR 11 kV METAL-ENCLOSED SWITCHGEAR EQUIPMENT SWITCHROOM** | **Revision: 1(2011)**<br>**Date: July 2011**<br>**Page: Appendix 4** |




DETAIL FOR EARTHING