

Annexure 1**Drawing list for Anikadavu project:**

S. No.	Title	Drawing No.	Remarks
1	Single line diagram	TB-2-364-510-001	Attached
2	Layout Plan drawing	TB-0-364-316-002	Attached
3	Section drawing	TB-2-364-316-003	Attached
4	Structure loading drawing	TB-1-364-316-004	To be issued at contract stage
5	Single line diagram of 415V AC and DC distribution board	TB-2-364-302-004	Attached
6	Trench Layout outdoor	TB-0-364-316-005	To be issued at contract stage
7	Erection key diagram	TB-3-364-316-006	To be issued at contract stage
8	Earthmat layout drawing	TB-0-364-509-007	
9	Control room Layout	TB-2-363-316-005	
10	Equipment earthing details	TB-4-364-509-011	

SECTION - 26

SWITCHYARD ERECTION

1.0 EQUIPMENT ERECTION DETAILS

- 1.1 For equipment interconnection, the surfaces of equipment terminal Aluminium tube, conductor & terminal clamps and connectors shall be properly cleaned. After cleaning, contact grease shall be applied on the contact surfaces of equipment terminal pad, Aluminium tube/conductor and terminal clamps to avoid any air gap in between. Subsequently bolts of the terminal pad/terminal connectors shall be tightened and the surfaces shall be cleaned properly after equipment interconnection.
- 1.2 Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators.
- 1.3 All support insulators, circuit breaker, interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.
- 1.4 Bending of Aluminium tube should be avoided. The equipments /Supports height to be designed to have uniform height of aluminium busbar.
- 1.5 Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.
- 1.6 Handling of equipment shall be done strictly as per manufacturer's/supplier's instructions/instruction manual.
- 1.7 Handling equipment, sling ropes etc, should be tested periodically before erection for strength.
- 1.8 The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.
- 1.9 For inter connection of 400 KV Breaker,CT, Isolators and supports 4 " Aluminium bus to be used. For 230 KV & 110 KV Breaker, CT and Isolator interconnection double moose conductor to be used. For Bus selection Isolators and Isolator to supports 3' Busbar to be used. (As per layout)

2.0 STORAGE

- 14.4.1 The Contractor shall provide and construct adequate storage shed for proper storage of equipments, where sensitive equipments shall be stored indoors. All equipments during storage shall be protected against damage due to acts of nature or accidents. The instructions of the equipments manufacture/Owner shall be strictly adhered to. rolled provided they are rolled slowly and in proper direction as marked on the drum.

3.0 INSTALLATION OF CABLES

- 3.1 Cabling in the control room and switch yard shall be done on ladder type cable trays. Trays should be neatly laid and inter connected in the trench as per standard practice.
- 3.2 All cables from bay cable trench to equipments including and all interpole cable (both power and control) for all equipment, shall be laid in PVC pipes of minimum 50 mm nominal outside diameter of class 4 as per IS 4985 which shall be buried in the ground at a depth of 250 mm below finish formation level. Separate PVC pipe shall be laid for control and power cables.
- 3.3 Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the floor, in the case of equipment located away from cable trench either pipe inserts shall be embedded in the floor connecting the cable trench and the equipment or in case the distance is small, notch/opening on the wall shall be provided. In all these case necessary bending radius as recommended by the cable manufacturer shall be maintained.
- 3.4 Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint. The red oxide and zinc chromate shall conform to IS 2074
- 3.5 Suitable arrangement should be used between fixed pipe/cable trays and equipment terminal boxes, where vibration is anticipated.
- 3.6 Power and control cables in the cable trench shall be laid in separate tiers. The order of laying or various cables shall be as follows, for cables other than directly buried.
 - a) Power cables on top tiers.
 - b) Control instrumentation and other service cables in bottom tiers
- 3.7 Power and control cables shall be securely fixed to the trays/supports with self locking type nylon ties with de-inter locking facility at every 5 metre interval for horizontal run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminum strip clamps at every 2m.
- 3.8 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows;

Table of cable and	Minimum bending radius
Power cable	12 D
Control cable	10 D D is overall diameter of cable

- 3.9 Where cables cross roads, drains and rail tracks, these shall be laid in reinforced spun concrete or steel pipes buried at not less than one metre depth.
- 3.10 In each cable run some extra length shall be kept at a suitable point to enable one for LT cable straight through joints to be made in case the cable develop fault at a later date.
- 3.11 Selection of cable drums for each run shall be so planned as too avoid using straight through joints. Cable splices will be permitted except where called for by the drawings, unavoidable or where permitted by the owner. If straight through joints are unavoidable, the contractor shall used the straight through joints kit of reputed make.
- 3.12 Control cable terminations inside equipment enclosures shall have sufficient lengths so that changing of termination in terminal blocks can be done without requiring any splicing.
- 3.13 Metal screen and armour of the cable shall be bonded to the earthing system to the station, wherever required by the owner.
- 3.14 Rollers shall be used at intervals of about two metres while pulling cables
- 3.15 All due care shall be taken during unreeling, laying and termination of able of avoid damage due to twist, Kinks, sharp bends, etc.
- 3.16 Cables ends shall be kept sealed to prevent damage. In cable, vault, fire resistant seal shall be provided underneath the panels.
- 3.17 Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS:1255 and other Indian Standard Codes of practices
- 3.18 Wherever cable pass through floor or through wall openings or other partitions, GI/PVC wall sleeves with bushes, having a smooth curved internal surface so as not to damage the cable, shall be supplied, installed and properly sealed by the contractor at no extra charges.
- 3.19 contractor shall remove the RCC/steel trench covers before taking up the work and shall repiace all the trench covers after the erection work in that particular area is completed or when further work is not likely to be taken up for some time.
- 3.20 Contractor shall furnish three copies of the report on work carried out in a particular week, indicating cable numbers, date on which laid, actual length and route, testing carried out, terminations carried out, along with the marked up copy of the cable schedule and interconnection drawing wherever any modifications are made.
- 3.21 Contractor shall paint the tray identification number on each run of trays at an interval of 10 m.
- 3.22 In case the outer sheath of a cable is damaged during handling/installation, the contractor shall repair it at his own cost to the satisfaction of the owner. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra

cost to the owner, I.e the contractor shall not be paid for installation and removal of the damaged cable.

- 3.23** All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulation tape, sleeve or paint.

3.24 Cable Trays.

- a) The cable trays shall be of G.S. sheet and minimum thickness of sheet shall be 2mm.
- b) The contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.
- a) Test of galvanizing (Acceptance Test)
The test shall be done as per approved standards.
- b) deflection Test (Type Test)

A 2.5 metre straight section of 300 mm, 600mm, wide cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall Be applied along the length of the tray. The maximum deflection at the mid span shall not exceed 7 mm.

4.0 TESTING AND COMMISSIONING

- 4.1** An indicative list of test for testing and commissioning is given below contractor shall perform any additional test based on specialties of the items as per the field Q.P/instructions of the equipment contractor, or all equipments instruments and auxiliaries required for testing and commissioning of equipments along with calibration certificates and shall furnish the list of instruments to the owner for approval.

4.2 GENERAL CHECKS

- a) Check for physical damage
- b) Visual examination of zinc coating/plating
- c) Check from name plate that all items are as per order/specification.
- d) Check tightness of all bolts, clamps and connecting terminals using torque wrenches.
- e) For oil filled equipment, check for oil leakage, if any also check oil level and top up wherever necessary.
- f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanized surfaces.
- g) Check cleanliness of insulator and bushings
- h) All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant code of erection.
- i) Check for surface finish of grading rings (corona control ring)
- j) Pressure test on all pneumatic lines at 18.5 times the rated pressure shall be conducted.

4.3 STATION EARTHING

- a) check soil resistivity
- b) check continuity of grid wires
- c) check earth resistance of the entire grid as well as various sections of the same
- d) check for weld joint and application of zinc rich paint on galvanized surfaces.
- e) Dip test on earth conductor prior to use.

4.4 'MOOSE' ACSR STRINGING WORK, TUBULAR BUS WORK AND POWER CONNECTORS.

- a) physical check for finish
- b) electrical clearance check
- c) testing of torque by torque wrenches on all bus bar power connector and other accessories.
- d) millivolt drop test on all power connector
- e) sag and tension check on conductors

4.5 ALUMINIUM TUBE WELDING

- a) physical check
- b) millivolt drop test on all joints
- c) dye penetration test& Radiography test on 10% sample basis on weld joints.
- d) Test check on 5% sample joints after cutting the weld piece to observe any voids etc.
- e) Necessary inner sleeves to be provided for all joints in addition to welding.

4.6 INSULATOR

Visual examination for finish, damage, creepage distance etc.

- 4.7 All pre/ commissioning activities and works work for substation equipment shall be carried out in accordance with owner's pre commissioning procedure and formats for substation equipments" by the contractor.

4.9 OTHERS :-

Sand drum made out of oil drum of Size 580mm dia and 420 mm height with conical cover made out of tin sheet provided with handle including the cost barrel, sand and consumables as directed by the field Engineer.

Supply of different sizes of identification boards for Equipments, Earth pits, Fire stand etc, duly painted and writing details as directed by field engineer.

KEY BOARD/LC BOARD

One Number each Key board and LC Board to be supplied and fixed in the control room duly drawing SLD and other required details. LC / Key board of size 3000 mm , length 1500 mm height made out of 75 x 25 mm aluminium frame embedded with 12mm pre laminated wood particle board using screws rear 2 Nos. of plain glass of 5mm thick fixed with metal roller moving on aluminium channel should be provided on front with locking arrangements. Glass pieces should be fastened on the glass shutter for opening and closing. Wall clamps made out of 6mm GI plate / Angle should be provided on top & Bottom. Single line drawing & Other required details to be written in finished surface on boards with good quality enamel paint.

SECTION - 27 EARTHING

1.1 The earth mat design shall be done by the Contractor as per IEEE-80. The main earthmat shall be laid in the switchyard area in accordance with the approved drawing.

1.2 Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise

1.3 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the systems in installed.

- a) code of practice for Earthing IS:3043
- b) Code of practice for the protection of Building and allied structures against lightning IS: 2309.
- c) Indian Electricity Rules 1956 with latest amendments.
- d) National Electricity safety code IEEE 80.

1.4 Details of Earthing System

Item	Size	Material
a) Main Earthing Conductor to be buried in ground	40mm dia	Mild Steel rod
b) Conductor above ground & earthing leads (for equipments)	75X12mm M.S. flat	Mild Steel
c) Conductor above ground & earthing leads (for columns & aux. structures)	75X12mm	Mild Steel
d) Earthing of indoor LT panels, Control panels and out door Marshalling boxes, MOM Boxes, junction boxes & Lighting panels etc.	50X8mm	Mild Steel
e) Rod Earth Electrode	40mm dia, 5000mm long	Mild Steel
f) Earthing conductor along outdoor cable trenches	50X8mm MS Flat	Mild Steel
g) Earthing of Lighting Poles	50 x 8 mm MS Flat	Mild steel

The size of the earthing conductor indicated above are the minimum sizes.

- 1.5 Earthing Conductor Layout (Not in ETC Contractor's Scope)
 - 1.5.1 Earthing conductors in outdoor areas shall be buried at least 800mm below finished ground level and refilled unless otherwise.
 - 1.5.2 Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc, it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundations.
 - 1.5.3 Tap connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment/structure.
 - 1.5.4 Earthing conductor or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding/cleating at intervals of 750 mm. wherever it passes through walls, floors, etc., galvanized iron sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.
 - 1.5.5 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500 mm away from such location.
 - 1.5.6 Earthing conductors crossing the road shall be laid 500 mm below road or at greater depth to suit the site conditions.
- 1.6 Equipment and Structure Earthing (ETC Contractor's Scope)
 - 1.6.1 Earthing pads shall be provided for the apparatus/equipment at accessible position. The Connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with owner.
 - 1.6.2 Whether specifically shown in drawings or not, steel/RCC columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different section of hand rails and metallic stairs.
 - 1.6.3 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing systems.
 - 1.6.4 Metallic conduits shall not be used as earth continuity conductor.

- 1.6.5 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.
- 1.6.6 Light poles, junction boxes on the poles, cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.
- 1.6.7 Earthing conductor shall be buried 2000 mm outside the switchyard fence. All the gates and every alternate post of the fence shall be connected to earthing grid.

The stone spreading shall also be done 2000 mm outside switchyard fence. The criteria for stone spreading shall be followed in line with requirement specified elsewhere in the specification.

- 1.6.9 Flexible earthing connecting of the moving parts.
- 1.6.10 All lighting panels, junction boxes, receptacles fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. rules.
- 1.6.11 A continuous ground conductor of 16 SWG GI wire shall be run all along each conduit run. The conductor shall be connected to each panel ground bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG ground conductor.
- 1.6.12 50mmX8mm MS flat shall run on the top ties and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of post Office red enamel paint.
- 1.6.13 A 40 mm dia, 5000 mm long MS earth electrode with test link, CI frame and cover shall be provided to connect down conductor of lightning mast and towers with peak.
- 1.7 Jointing
 - 1.7.1 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with and corrosive paint/compound.
 - 1.7.2 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type for rust protections, the welds should be treated with red lead and afterwards coated with two layer bitumen compound to prevent corrosion.
 - 1.7.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
 - 1.7.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

- 1.7.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- 1.7.6 Bending of earthing rod shall be done preferably by gas heating.
- 1.7.7 All arc welding with large dia, conductors shall be done with low hydrogen content electrodes.
- 1.7.8 All the earth flat shall be clamped with the equipment support structures atleast 1000mm interval.

1.8 Power Cable Earthing Metallic sheaths and armour of all multi core power cable shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

1.9 Specific Requirement for Earthing Systems.

- 1.9.1 Each earthing lead from the neutral of the power transformer/Reactor shall be directly connected to two electrodes in treaded earth pit (as per IS). All the earth pits in the yard to be provided with cement collar and permanent water arrangement to be done. All accessories associated with transformer/reactor like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points.
- 1.9.2 Earthing terminal of each lightning arrester & Capacitor voltage transformer shall be directly connected to rod earth electrode which in turn, shall be connected to station earthing grid.
- 1.9.3 Auxiliary earthing mat comprising of 40mm dia M.S rods closely spaced (300mm x 300mm) conductors shall be provided at depth of 300mm from ground level below the operating handless of the M.O.M box of the isolators. M.O.M boxes shall be directly connected to the auxiliary earthing mat.
- 1.9.4 All earthing flats connecting to the equipments above the yard levels and upto the equipments to be painted with one coat of red oxide and green paint as per standard.
- 1.10 The earth electrode to be fabricated for 5 mts length without joints with provision for inter connecting at least two numbers earth flats from main earth mat /structures etc. The electrode to be erected by rigging 140/150 mm dia. bore using power rig and to be filled with mixer of A4 grade Bentonite powder, salt and available site soil.

1.11 Earth spikes to be fabricated for 3 Mts length and to be erected in lightening mast in the 400 KV yard and in 230KV, 110 KV tower structures as per standard and to be connected to the earth mat.

600mm mean dia, 300mm height, 36mm thick cement collar for identification of earth electrode location including 1 primer and 2 coat of colour wash to be provided.

PROCEDURE FOR WELDING OF ALUMINIUM BUSES

A. Recommended welding procedures to insure a sound weld are as follows:

Pure aluminum melts at 660 Deg. C while aluminum alloy melts in the range of 519 Deg. C depending on the alloy content of the particular metal involved. When aluminum alloy are heated there is no change in color. This makes it difficult, if not impossible; to tell metal is near the welding temperature.

The ever present surface oxide films on aluminum have a melting point of 1982 Deg. C. The parent aluminum or aluminum alloy can therefore be melted without fusing the surface oxides. Unless this film is removed, cleanliness of the molten filler metal and the parent metal cannot be completed and both strength and conductivity may be sacrificed. Therefore, it is of prime importance that aluminum oxides be removed from the aluminum alloys before welding is started. In the shielded arc welding method the shielding gas has a tendency to clean the material as welding progresses.

B. CLEANING OF BUSES & FITTINGS:

It is very important to remove all greases and oxides from the surfaces to be welded. This can be accomplished by using a mild alkaline solution or standard degreasing solution. The preferred method is to use a stainless steel wire brush and vigorously scrub the surfaces to be welded. The stainless steel brushes are specified because the stainless steel has fewer tendencies to pick up particles of aluminum.

C. WELDING METHODS

The following types of welding methods for welding aluminum fittings and buses are recommended.

1. TUNGSTEN-ARC WELDING (TIG)

The inert-gas shielded tungsten arc process is widely used for welding aluminum bus fittings. In this process the arc is established between a non-consumable tungsten electrode and the section to be welded. Inert gas envelopes the arc to prevent oxidation during welding.

Hence no flux is required. A bare filler rod supplies filler metal to the weld area. To initiate the arc the tungsten electrode is placed in contact with the component and then withdrawn to establish an arc length of approximately 3/16". The arc is given a circular motion until the base metal liquefies and the weld puddle is established. Filler metal is added by hand as required. In this process, if more than one pass is required for a sufficient weld, the weld should be wire brushed between passes, to remove any surface dirt or oxides which have accumulated from the previous pass. Since no flux is used the finished weld does not require cleaning. In this process the heat of the tungsten arc is concentrated in a smaller area and is much faster than the conventional type of welding and distortion of the weld is negligible since the heat is concentrated in a small area. In this process, if thickness is greater than 0.5" arc to be welded, pre-heating of parts will increase the arc speed.

2. METALLIC ARC INERT GAS SHIELDED WELDING

MIG welding process combines the advantages of tungsten arc welding with the increased welding speed. Welding can be done from any position and the process can be either manual or automatic, Manual welding techniques are somewhat different from other methods. However, a welder can be trained to use the MIG process with only a few days concentrated training. In the MIG process the bare filler rod is supplied as a coil of bare wire. In the commercially available equipment this wire is added to the weld at predetermined rate by a motor driven feed that can be adjusted to the magnitude of the welding current. In this process as well as the tungsten arc process, gas forms a shield around the arc to prevent oxidation during welding.

Either helium, argon or a mixture of helium and argon are suitable shielding gases. Pure argon is most widely used on the gas arc usually mixed to combine the hotter arc argon. If exceptionally hot arc characteristics are required pure helium can be substituted for the gas mixture. Precaution should be exercised if this substitution is made in that it is very easy to burn through the items that are to be welded with a pure helium atmosphere.

As it is readily apparent, the basic difference between the two types of welding apparatus is the automatic feeding mechanism for the filler wire. In both types of apparatuses the electrode holder and the welding gun can or cannot be cooled by water. If welding currents of more than 125 Amps are required, both methods will have to have water cooling apparatuses to the electrode holder and the welding gun.

D.WELDERS QUALIFICATIONS

No welding should be done until the operator has had experience with welding aluminum alloys by the methods described above. Men with previous experience with in metal welding should be selected for training in welding aluminum for a period of training of not less than one week after which time the man can be considered to be proficient in the use of the equipment and in the welding of aluminum joints. After this period there should be no difficulty experienced in welding aluminum alloys. It is suggested, if practical, that welders should practice on actual fittings or buses before proceeding with the welding of the required job.

The following is the recommended specification for the current fittings wire feeds, gas flows etc. These specifications are of a general nature to the extent that many factors have to be considered such as:

1. Type of equipment used, whether water cooled or not.
2. The size and mass of the piece to be welded.
3. The position of the weld.
4. And most important of all, the operator's skill
5. All persons in the welding area would wear the proper shields. The arc is approximately twice as strong as the standard AC welding arc. Extreme caution should be exercised for the protection of eyes.

ACCEPTANCE STANDARDS FOR NON-DESTRUCTIVE TESTING **LIQUID PENETRANT EXAMINATION OF WELDED JOINTS**

- a) Evaluation of indications:
- Relevant indications are those which result from mechanical discontinuities.
 - Linear indications are those indications in which the length is more than three times with width.
 - Rounded indications or indication, which are circular or elliptical with the length less than three times, the width.
 - Any questionable or doubtful indications shall be re-tested to verify whether or not actual defects are present.
 - Localised surface imperfections, such as may occur from machining marks, surface conditions, may produce similar indications, which are not relevant to detection of unacceptable discontinuities.

b) Acceptance standards:

- Linear indications
- Four or more rounded defects with any dimensions more than 1.6 mm in a line separated by 1/16 inch (1.6 mm) or less (edge to edge)

c) Defect removal and repair:

Unacceptable imperfections shall be removed and reexamination made to assure the complete removal. Whenever a defect is removed and subsequent repair by welding is not required, the excavated area shall be blended into the surrounding surface so as to avoid sharp notches, crevices or corners. Where welding is required after removal of a defect, the area shall be cleaned and welding performed in accordance with a qualified welding procedure. Completed repairs shall be re-examined by the method originally used for detection of the defection.

d) Treatment of imperfections believed non-relevant.

Any indication of an imperfection, which is believed to be non-relevant, shall be regarded as defect unless, on re-evaluation, it is shown by re-examination by the same method or by the use of other non-destructive methods and/ or by surface conditioning that no unacceptable defect is present.

e) Examination of areas form which defects have been removed:

After a defect is thought to have been removed and prior to making weld repairs, the area shall be examined by suitable methods to ensure the defect has been eliminated.

f) Re-examination of repaired areas:

After repairs are made, the repaired areas shall be blended.

ACCEOTANBCE STANDARDS FOR NON-DESTRUCTIVE TESTING
RADIOGRAPHIC EXAMINATION OF WELDED JOINTS

Radiographic examination shall cover minimum 10% of weld seam and acceptance standard for visual examination and Radiography shall be as follows:

Any of the following imperfections shall not be acceptable.

1. Cracks
2. Zone of incomplete fusion or penetration, which exceed 10% of the weld length of the joint in longitudinal or transverse butt weld, where full penetration is intended by the weld procedure, some lack of penetration acceptable. The total length of weld with lack of penetration shall not exceed 10% of the overall weld length. At no place, shall weld penetration be less than 90% of the thickness of the material. Continuous occurrence of lack of penetration is permitted, but shall not exceed 50 mm in any 500 mm length of weld.
3. Inadequate weld dimensions, root cavity (shrinkage) and incompletely filled groove greater than 10% effective throat thickness.

4. Excess penetration shall be permitted provided it does not exceed 25% of the wall thickness or 4 mm whichever is smaller.
5. Weld reinforcement: Build up in excess of 25% of the effective throat thickness shall be dressed. Any reinforcement shall be substantially symmetrical about the center line of the weld and shall be of smooth contour blending smoothly at the toes with the parent material.
6. Undercutting and overlapping, greater than 10% effective throat thickness.
7. Elongated cavities and/or worm holes exceeding 3 mm dia or equivalent area in length provided the limitations on porosity are met with.
8. Copper, tungsten or oxide inclusions greater than $t/1$ or 3 mm whichever is smaller.
9. Crater pipes exceeding 25% effective throat thickness or 3 mm whichever is smaller.
10. Porosity: Scattered porosity not exceeding 0.5% by volume is acceptable. In general, the size of the pores shall not exceed 0.8 mm dia, but occasional 1.6 mm dia pores may be acceptable, provided the following limits are not exceeded.
 - a) Where pore size is 0.4 mm or less, up to 150 pores may be permitted in 1000 mm sq. area of radiograph.
 - b) Where pore size is 0.8 mm or less, up to 19 pores may be permitted in 1000 mm. sq. area of radiograph.
 - c) Where pore sizes are generally 0.8 mm dia or less, but occasional 1.6 mm dia/pores are present, up to 9 pores of 0.8 mm dia may be permitted in 1000 sq. mm area of radiograph, provided the number of pores up to 1.6 mm in dia does not exceed it.
 - d) However, visible surface porosity > 1mm dia is not acceptable.

Note:

- i. In all cases, t thickness of the thinnest section of the weld under examination.
- ii. Unacceptable weld defects shall be repaired in accordance with the original welding procedure. All repairs shall be 100% inspected in accordance with original testing procedure.

Annexure-5

Project : 400/230-110 KV Substation at Anikadavu
Customer : M/s Tamil Nadu Transmission Corporation Limited

FIRE PROOF SEALING & FIRE BREAKS

1.0 FIRE-PROOF SEALING OF CABLE PENETRATION

Cables / cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another, between the units and within the same unit, shall be sealed by a fire-proof sealing system. The fireproof sealing system (FPSS) shall effectively prevent the spread of fire from the flaming to the non-flaming side, in the event of a fire. The FPSS shall conform to relevant standard in addition to the following requirements:

- (a) FPSS shall have a fire rating of one hour.
- (b) The FPSS shall be subjected to fire endurance test, hose stream test as per ASTM-E-814/BS:476
- (c) Under fire condition, the FPSS material shall not emit excessive smoke or any corrosive or toxic fumes.

2.0 FIRE BREAK

2.1 Firebreak shall be provided by applying a suitable fire-resistant coating on cables for the required length to meet the fire rating of thirty minutes.

2.2 Firebreak shall be provided at an interval of 15 metres in the straight portion of each of the cable tray above ground, at intervals of 30 metres in cable trenches and at 5M for all vertical trays. All cable inter section and tee offs shall be provided with firebreaks.

3.0 TESTS

All routine tests shall be carried out as per relevant standards and approved GTP/QAP. For type tests, certificates for tests carried out earlier shall be furnished.