SPECIFICATIONS AND GUIDELINES FOR 11 KV SUBSTATIONS CONSTRUCTION

Planning and Engineering (P&E)

Technical Process Re-Engineering (TPRE) | Distribution Network Academy (DNA)

1 Substation design

1.1 Substation types

Various types of Substations layouts are used within KE as per the requirement of the system. Following is the details of overall size:

Type of Substation	No of rooms	Size of Substations
HT Bulk Supply	1 Room	15 ft x 15 ft
Distribution Substation with Transformer	2 Room	30 ft x 20 ft

1.1.1 Single Room Sub-Station (HT Switch Room):

- 1.1.1.1 These types of single room substation shall be constructed for the applicants requiring 11 KV bulk supply or for switching purpose of 11 KV feeders / network.
- 1.1.1.2 A typical Single room substation shall consist of maximum 04 Nos. of HT Switches. Size of the substation shall be 15' x 15' (225 Sq ft) with min clear height of 12 ft, with placement/orientation of equipment and trenches as per enclosed Drawing.

1.1.1.3 Additional panels in HT Switch Room

1.1.1.3.1 If the required switches are more than 4, then the proposed HT room size should be increased accordingly (additional 2'-2" for every switch), maintaining the necessary clearances as per the drawing.

1.1.2 Two Rooms Sub-Station (HT Switch and Transformer Rooms):

- 1.1.2.1 These types of substation shall be constructed for the applicants applying for load requiring Transformer **rated up to 1000 kVA** & will be constructed in the premises of applicant.
- 1.1.2.2 It shall consist of 2 separate rooms with separate gates, one with the transformer placed along with LT panel and the other room containing HT switches.
- 1.1.2.3 In case, the number of transformer increases, then the applicant shall provide / construct additional room for transformer equal to the size of transformer room specified in the Drawing. The additional room shall have a separate gate for Entry/Exit. (see attached drawing in Annexure).
- 1.1.2.4 In case additional HT switches are required as per 11KV network necessities the additional space equivalent to the size of HT switch i.e. 2'-2" must be considered for each type of substation, maintaining the necessary clearances as per the drawing.

1.2 Substation Structure

1.2.1 Raised design (Hollow type)

- 1.2.1.1 The substation shall have a raised floor, casted as a slab with hollow space below for cable management etc. (Refer drawing)
- 1.2.1.2 Separate entry to be provided for the lower level with MS gate and anti-theft lock as per the details mentioned in the drawing.
- 1.2.1.3 Any decision to change the structure type of the substation, to be jointly taken by Substation Technical committee (TPRE/Operation/NC etc).

1.3 Check Meter Installation

1.3.1 Check Meter for monitoring losses of local transformer shall be provided in LT panel. (polymer type).

1.4 Material / Equipment's:

- **1.4.1** All equipment's as HT Switches / Transformer / LT panels / HT and LT cables and hardware material used in substation shall be confirming to relevant (Latest) KE Standard Specifications.
- **1.4.2** Proper tagging on HT- switches, as well as route and destination of in-comings, out-goings & local transformer cables plus LT circuit destination should be clearly mentioned.

1.5 Ventilation requirement

- **1.5.1** Proper ventilation shall be provided in trafo room to dissipate heat from the electrical Equipment.
- **1.5.2** Only **CC type ventilators** to be installed, with maximum width of 1 ft. (refer Picture). No metallic ventilators to be used as these are prone to corrosion and can be a reason of theft.



- **1.5.3** The openings (slits) of the CC ventilators shall not be more than 1 inch in width.
- **1.5.4** All the ventilators to be placed on the top portion of walls as per the drawing.
- **1.5.5** Minimum Natural air ventilation to be provided as per below criteria as per NFPA-70 NEC Article 450, shall be atleast 3 inch sq per kVa of transformer rating. E.g 1000 kVa to have at least 3000 inch sq (approx. 21 sq ft) ventilation in trafo room.
- **1.5.6** Natural airflow directly from outside of the building is preferred, position of ventilator should be such as to provide cross ventilation.

2 Substations Construction

2.1 Site selection for Substation Construction:

- **2.1.1** Applicant shall provide the undertaking / legal document as per attached format for ownership of Sub-Station. (Annexure A).
- **2.1.2** Following points to be considered for selecting the site/location of the substation.
- 2.1.2.1 Access to the substation shall be clear and easy to avoid any hindrance while maintenance/ operation. The access should be from the main road with no lockable gate up to the substation. If access from the front road is not possible, then it may be on the side road at **least 18 ft wide** for easy movement of crane/loader.
- 2.1.2.2 The main gate of the substation shall be accessible from Open area for the crane movement.
- 2.1.2.3 There shall be provision of free movement of cranes, loader or lifter for handling of the heavy equipment's placed inside the substation
- 2.1.2.4 The sub-station area should be free from the risk of sewerage/rain/flood and storm water damages.
- 2.1.2.5 The personnel access to Sub-station for authorized field staff must be safe.
- 2.1.2.6 The services such as drains, sewers, HVAC Ducts, piping or wiring are not permitted to pass through the sub-station area (Minimum clearance to be maintained 3 ft)
- 2.1.2.7 For HT/LT cables, the entry and exit of the cables into the trench/lower level must be from the front side of the substation and as per enclosed drawings.

2.2 Substation Drawing / Layout

2.2.1 The Applicant shall be given an Approved Schematic layout as well as detailed structural drawings of the substation prior to start of construction works. NC department will be responsible for the issuance of all the drawings. The Schematic layout shall be vetted from the Concerned User/Cluster before the issuance. This Schematic layout shall be prepared by NC showing the placement of the different equipment and trench position. Schematic layout shall be signed off by GM of both NC and User/Cluster.

- **2.2.2** Detailed drawings of substation are attached in Annexure-B of this document.
- **2.2.3** The Schematic layout shall contain all the necessary information regarding the size/orientation and equipment placement, including but not limited to the following.
- 2.2.3.1 Exact size of the substation along with clear height and height from road level.
- 2.2.3.2 Equipment placement
- 2.2.3.3 Location and dimensions of trenches (if present).
- 2.2.3.4 Cable entry and exit points (Sealing arrangements)
- 2.2.3.5 Gates location
- 2.2.3.6 Position and size of Ventilators
- 2.2.3.7 Fire extinguisher placement
- 2.2.3.8 Lighting arrangements etc

2.3 Construction Activity

- **2.3.1** The applicant shall start the construction works after the approved Drawing is issued to them by KE.
- **2.3.2** The applicant is required to notify the KE on different stages of the construction of Substation. The KE team will visit and check the Construction as per the Checklists (attached in Annexure-C), after the go ahead the applicant may continue the construction till the next inspection stage.

2.4 Construction requirements

- **2.4.1** Substation to be constructed by the applicant following all the construction requirements defined in this document. All the construction work to be done as per the structural and dimensional drawings issued.
- **2.4.2** Materials to be used for the substation construction should be of the best quality available.
- **2.4.3** Excavation to be done as per the footing size.
- **2.4.4** Stone soling to be provided and compacted properly, min thickness to be provided 6", It is recommended to use 3 inch and 4 inch down stones for 6 inches and 8 inches thickness of stone soling respectively. The stones should be laid in two layers and proper compaction should be done.
- 2.4.5 Lean concrete with ratio 1:4:8 to be done as per the drawing, thickness to be maintained 4"
- **2.4.6** Proper concrete spacers to be used for maintaining concrete cover as per the ACI. The compressive strength of the spacers shall be same or greater than the concrete.
- 2.4.7 Concrete to be used for all structural members shall be of minimum strength of 3000 psi.

- 2.4.8 Steel reinforcement shall have minimum tensile strength of 60 ksi
- 2.4.9 Proper curing to be done for all structural concrete members as per the required curing times.
- **2.4.10** RCC slab to be provided as per the structural drawing with enough strength to bear the weight and the normal wear and tear during placement and shifting of equipment.
- **2.4.11** All the concrete up to Plinth level to be done using Modified OPC cement to prevent the risk of sulfate and chloride attack, modified OPC to be used as per the following criteria:

C3A should be more than 5% and should be less than 8%. C4AF + 2C3A should be less than 25%. AL2O3 should be less than or equal to 6%.

Ordinary Portland Cement (OPC) meeting the above chemical composition can be used in lieu of modified cement and above plinth level OPC should be used.

- 2.4.12 The plinth level of substation shall be atleast 5.5 feet above the road level/Ground level.
- **2.4.13** Internal walls plaster to be $\frac{1}{2}$ " and the external walls plaster to be $\frac{3}{4}$ " thick.
- **2.4.14** PCC SITU wall to be provided below the plinth beam, with ratio of 1:3:6. As per the details shown in the drawing
- **2.4.15** Machine made blocks of best quality to be used for construction, with the compressive strength of minimum 1000 psi. Blocks shall be non load bearing type, and shall conform to **ASTM C129.**
- **2.4.16** Block masonry to be at least 6 inches thick for walls construction.
- **2.4.17** Slope to be given in the RCC roof slab as per the drawing, for avoiding rain water ingress inside structure.
- 2.4.18 Slab projection to be provided on all four sides, of at least 2 ft.
- **2.4.19** Drip course shall be provided all over the projection (Chajja).
- **2.4.20** Floor openings for cables, to be provided as per the approved drawing handed over by NC department. Details regarding the construction of the openings in floor, to be followed as per the structural drawing and the typical section provided.
- **2.4.21** The floor of the substation shall be perfectly levelled, and cured before handing over.
- **2.4.22** The ceiling shall be of RCC Cement Concrete construction as per the drawing.
- **2.4.23** The finish of internal wall and ceiling must be clean, smooth and must be painted.
- **2.4.24** The sub-station floor, including openings conduits etc. is to be formed in accordance with the position and details shown on KE drawing/specifications

- 2.4.25 The floor must have a level steel troweled finish.
- **2.4.26** The sub-station shall be constructed using approved water proofing materials. All sub-structure to be applied with waterproofing to avoid contact with sub soil water. Example are any bituminous waterproofing membranes etc.
- **2.4.27** To protect the Sub-Station equipment, expose to dampness / water throughout its life requires proper site drainage and water proofing
- **2.4.28** Sub-station requires special attention to ventilation in order to dissipate heat from electrical equipment, wherever possible natural air flow to the outside of the building will be used.
- **2.4.29** Forced ventilation should be used where natural ventilation is not practicable. Forced ventilation by mean of industrial fan (s) with timer switch must be designed, supplied and installed by the owner as per KE's requirements (The power supply to meter shall be on account of KE) The air flow through the ventilation will be checked by KE before the final approval.
- **2.4.30** The position of the vent must be directly to outside air, if this is not achievable then forced ventilation is required
- **2.4.31** A buried earthing/ grounding system is necessary for sub-station and installed equipment, the earthing system shall be provided as per KE's design/specification
- **2.4.32** Opening in floor will be made as per the Equipment placement. With a drop beam below for extra clamps for HT cable.
- **2.4.33** The owner will supply and install the light & power distribution board and the necessary light fittings and power outlets in the sub-station including all wiring. KE will connect the distribution board to the supply point on the low voltage board.

2.4.34 Requirements for Anti-Theft type door

- 2.4.34.1 The doors for the substation will be Antitheft type door, louvers should be provided as enclosed Drawing # K-TPRE-SS-05.
- 2.4.34.2 The door to be painted with EPOXY paint, with a minimum thickness of 240 Microns, including epoxy primer.
- 2.4.34.3 Steel surface of the door to be cleaned by sandblasting and cleaned before applying Primer.
- 2.4.34.4 Gate delivered at site shall be painted at least with a coat of primer. (unpainted/bare steel gate not allowed at site).
- 2.4.34.5 Small gate of same specifications to be fixed at lower level of the substation , and to be fixed with Antitheft type lock. Size of the gate to be 5'x3'.

2.5 Earthing Requirement

- **2.5.1** Earthing shall be done as per **KE Standard SOP** (Earthing for HT/LT Equipment and Poles) for Grounding (Latest Applicable).
- **2.5.2** After completion of civil works & installation of equipment's, the substation shall be handed over to KE. (Agreement / Undertaking / Deed for Handing/ Taking over of Sub-Station)

2.6 Provision of Fire Extinguisher

2.6.1 For each room of Sub Station 2 units of the fire extinguisher shall be provided/ installed by the applicant as per below specification. This unit shall be used only for minor fire especially during and switching & preventive maintenance, and to be mounted on celling with Hooks.

2.6.1.1	Capacity:	6 kg
2.6.1.2	Make:	Imported
2.6.1.3	Extinguishing Agent:	ABC Dry Chemical Powder
2.6.1.4	Propellent:	Nitrogen
2.6.1.5	Area of Coverage:	Approx 130 sq feet
2.6.1.6	Duration of discharge:	14-16 seconds
2.6.1.7	Installation:	Ceiling mounted above fire risk
2.6.1.8	Operating Mechanism;	Automatic Sprinkler Head
2.6.1.9	Operating Temperature	::68 C
2.6.1.10	Shelf life:	6 years



2.7 Marking

- **2.7.1** The following permanent marking to be provided:
- 2.7.1.1 SLD (laminated) to be displayed in HT room.
- 2.7.1.2 Name with Logo & code/ID in front /elevation side of Substation
- 2.7.1.3 11KV/.4KV & Danger sign on HT/LT Room of Substation
- 2.7.1.4 Year of Construction of Substation to be written inside the substation.
- 2.7.1.5 Destination of HT/LT incoming & outgoing cables should be marked/ paint on HT/LT panel.
- 2.7.1.6 Marking to be done on HT Switches using stencil.
- 2.7.1.7 Emergency Contact Numbers to be displayed outside the substation
- 2.7.1.8 Danger Signs to be pasted outside the substation.

Annexure – B

Drawings showing Equipment layout, sizes and structural details are appended in the following pages:

Structural Drawings

Raised Hollow Design

(Distribution Substation with Transformer)





SECTION AT A-A



GROUND FLOOR FRAMING/REINFORCEMENT PLAN @ LEV.+5'-0" NOTE:- ALL SLABS ARE 6" TH. U.N.O. SCALE :-3/16"=1'-0"



SCHEDULE OF GROUND FLOOR BEAMS @ LEV.+5'-6"													
	BOTTOM STEEL			TOP STEEL				STIRRUPS					
NOTATION	BEAM SIZE (WXD)	В	1	B2	T1		T2		T3		ENE) STIRRUPS	MID STIRRUPS
GB-1	12"X24"	4-5/8"	Ø	-	3-5/8"	Ø	2-1/2"	Ø	2-1/2"	Ø	3/8"	Ø@4''C/C	3/8" Ø@6"C/C
GB-2	10"X18"	2-5/8"	Ø	-	2-1/2"	Ø	-		-		3/8"	Ø@4"C/C	3/8" Ø @6"C/C
GB-3	12"X24"	5-3/4"	Ø	-	2-5/8"	Ø	3-5/8"	Ø	-		3/8"	Ø@4''C/C	3/8" Ø@6"C/C

SCHEDULE OF ROOF BEAMS @ LEV.+18'-10"										
		BOTTOM ST	EEL		TOP STEEL	STIRRUPS				
NOTATION	BEAM SIZE (WXD)	B1	B2	T1	T2	T3	END STIRRUPS	MID STIRRUPS		
RB-1	8"X24"	2-5/8'' Ø	-	2-1/2" Ø	1-1/2" Ø	-	3/8" Ø@4"C/C	3/8" Ø@6"C/C		
RB-2	8"X24"	2-1/2" Ø	-	2-1/2" Ø	-	-	3/8" Ø@4"C/C	3/8" Ø@6"C/C		
RB-3	8"X24"	2+2-5/8" Ø	-	2-5/8'' Ø	-	-	3/8" Ø @4"C/C	3/8" Ø@6"C/C		



TYP. ELEVATION OF COLUMN



Equipment layout Drawing





Equipment Layout Drawing (2 trafos)

Raised Hollow Design

(HT Bulk Supply Room)

















SCHEDULE OF GROUND FLOOR BEAMS @ LEV.+5'-6"												
	во	тто	M STEEL	TOP STEEL				STIRRUPS				
NOTATION	BEAM SIZE (WXD)	B	1	B2	T1		T2		ТЗ		END STIRRUPS	MID STIRRUPS
GB-1	12"X24"	4-5/8"	Ø	-	3-5/8"	Ø	2-1/2"	Ø	2-1/2"	Ø	3/8" @4"C/C	3/8" @6"C/C
GB-2	10"X18"	2-5/8"	Ø	-	2-1/2"	Ø	-		-		3/8" @4"C/C	3/8" @6"C/C
GB-3	12"X24"	5-3/4"	Ø	-	2-5/8"	Ø	3-5/8"	Ø	-		3/8" @4"C/C	3/8" @6"C/C

SCHEDULE OF ROOF BEAMS @ LEV.+18'-0"										
		BOTTOM ST	EEL	TOP STEEL			STIRRUPS			
NOTATION	BEAM SIZE (WXD)	B1	B2	Τ1	T2	T3	END STIRRUPS	MID STIRRUPS		
RB-1	8"X24"	2-5/8'' Ø	-	2-1/2" Ø	1-1/2'' Ø	-	3/8" @4"C/C	3/8" @6"C/C		
RB-2	8"X24"	2-1/2'' Ø	-	2-1/2" Ø	-	-	3/8" @4"C/C	3/8" @6"C/C		
RB-3	8"X24"	2+2-5/8'' Ø	-	2-5/8'' Ø	-	-	3/8" @4"C/C	3/8" @6"C/C		



FRONT ELEVATION







A ∕



Anti-Theft Door Details