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Hellenic Gas Transmission System Operator

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TECHNICAL JOB SPECIFICATION
721/1
REVISION 1
DATE 01/11/2011

LNG PLANT

SECONDARY DISTRIBUTION SUBSTATIONS

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QUALITY ASSURANCE PAGE

CHANGES LOG

- para 3.6

REVISIONS LOG

1	01-11-2011	DESFA Internal Comments	PQ DPT	V.G.
0	29-06-2011	FIRST ISSUE	PQ DPT	V.G.
Rev. No	Rev. Date	REASON FOR CHANGE	Made By	Approved By

CONTENTS

REFERENCE DOCUMENTS

DESFA Job Spec. No. 710/1
[General Earthing and Bonding System]

DESFA Job Spec. No. 721/2
[Electrical Substation]

ELOT EN 50272-2
[Safety requirements for Secondary Batteries and Battery Installations]

ELOT EN 60950-1
[Information Technology Equipment – Safety, Part 1 : General Requirements]

ELOT EN 61547
[Equipment for general lighting purposes - EMC immunity requirements]

IS: 12332
[Code of practice for Ventilation in Petrochemical Plants and Refineries]

EU REGULATION 244-2009
[of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for non-directional household lamps]

1.0 SCOPE

Scope of this Specification is to give a guide for the layout and construction details for the building of indoor secondary substations, to uniform design, layout, shape and architecture of substations throughout the entire complex. This Specification applies to normal type substations; particular requirements for "blast resistant substations" are given in **para 4.**

2.0 GENERAL

This Specification shall be read in conjunction with the **DESFA Job Specification No. 721/2.** It shall be applied to:

- secondary, low voltage, single or double ended substations,
- secondary, low and medium voltage, single and double ended substations (separate primary supply or tapped feeder supply).

Different solutions depending on substation with respect to main access road and to unit plant, have been considered.
For the selection of the applicable layout see **TABLE 1.**

3.0 BASIS OF DESIGN

This specification of substations is conceived taking into consideration:

- safety clearance from sources of hazard of fire and explosion,
- easy of access from roads,
- modular construction of building,
- expansion possibility,
- equipment layout,
- battery room,
- safety of personnel,
- cable laying,
- lighting, sockets outlets and telecommunication,
- earthing,
- architectural

3.1 SUBSTATION LOCATION

The substation building and relevant outdoor facilities (transformers, link disconnecting boards etc.) shall be located in an unclassified location (unless otherwise specified at least 15 m away from the nearest source of hazard) and the substation will be considered as "naturally non hazardous location".

Pressurizing of the substation room will be provided only where specified, to prevent possible entrance of sand and dust. Being the Substation cable room open all around (except along the transformer yard for fire protection, see **figure 13,** the substation is suitable to be positioned over a 0,6 m aboveground classified hazardous location.

Safety distances from sources of hazard shall be considered for future substation expansion (building and transformer yard).

The substation building in respect to the orientation shown on the layout figure is indicative; if required to minimize the length of outgoing cables, the building may be overturned, leaving the transformers yard still at road side.

3.1.1 PARTICULAR REQUIREMENTS FOR LNG PLANT SUBSTATIONS

The substations should be located, as far as possible, away from the prevailing winds down-wind the LNG storage tanks.

The substations should be protected by the radiated heat resulting from an LNG fire. (i.e. selection of location, or other fire protection means should be considered).

The substations dedicated to serve the LNG tanks should be located in such a way that fire in one tank will not adversely affect the substation of another tank.

Central Heating Ventilating and Air Conditioning system will be provided for the substations. The system will also keep a positive overpressure inside the building.

3.2 ACCESSIBILITY FROM THE ROAD

The substation building and the outdoor facilities shall be easily accessible from the road.

To make easy the transformer installation and removal, transformer yard shall be located along the main access road.

A 6 m wide free area for transportation and unloading of equipment to be installed inside the substation building shall be provided at equipment door side, as shown on the layout figures. In case of expansion, same free area shall be foreseen, from future substation limit.

3.3 BUILDING CONSTRUCTION

3.3.1 SUBSTATION BUILDING

Substation building construction shall be "modular type" this will allow a considerable economy in substation structural design. Two standard modules have been adopted:

a. 5 χ 4 m module, to be used for small substation buildings, having single row of switchboards;

b. 10 χ 4 m module, to be used for substation buildings having two rows of switchboards and common operating aisle.

Both module (a. and b.) of substation buildings shall be designed having the total length multiple of 4 m. The total length of substation shown in **FIGURES 1** to **12** is indicative and referred to an hypothetical amount of switchboards; the substation lengths may be modified depending on actual switchboards dimensions.

3.3.2 SWITCHROOM FLOOR

Switchroom floor shall be designed for an average weight of switchboard of 1000 kg per m^2.

To enable the construction of substation building before the finalization of internal layout of switchroom positioning of switchboards, the substation structure shall be designed to permit the erection of switchroom floor at later time, by adopting the following criteria (*):

a. the floor supporting beams shall form part of substation structure;
b. the floor slab may be cast-in-place after definition of internal layout, leaving required holes for cables (see **FIGURE 24**); or alternatively to b.;
c. prefabricated beams placed according switchroom layout and holes for cables to be made on the concrete casted-in-place on corrugated metal flashing laid on beams (see **FIGURE 23**).

3.4 EXPANSION

If specified, the switchroom shall be designed taking into account equipment future expansion requirements. Expansion space shall be foreseen at one end for single ended switchboards and at both ends for double ended switchboards.

If specified, building extension, including transformer yard shall be considered.

(*) The position of holes for cable entry depends on definition of switchboard type and arrangement of switchroom, which is generally possible only at advanced stage of engineering.

Extension space shall be foreseen at one side of the building (generally at equipment door side), to permit addition of future modules.

The wall and building structure, at site of future extension shall be foreseen to permit the works for building extension and wall removal with the minimum disturbing of plant operation.

3.5 EQUIPMENT LAYOUT

Equipment inside substation building shall be arranged to allow easy operation, easy transportation and installation, considering also the future installations. **Table 2** gives the minimum clearances; they shall be increased on the base of equipment manufacturer's requirements.

Ventilation pressurizing and cooling.
Definition of ventilation pressurizing and cooling shall be scope of **DESFA Job Specification No. 721/2**.
In the **FIGURES 1 to 12** is indicated only position of possible pressurizing and cooling equipment.

The position of transformers boxes in relation to the building shall be fixed depending on power center layout and bus-bar duct arrangement, if this solution is adopted (see **FIGURE 16**).
Clearances inside distribution transformer boxes are shown on **FIGURES 14** & **15**.

3.6 BATTERY ROOM

The battery room (if any) shall be completely separated from the switchroom to avoid propagation inside the switchroom of gases released by the battery during the fast recharging (1).

Two openings on different walls and elevations shall be provided to permit or natural ventilation in order to facilitate, the outflow of battery gases. A filter shall be placed on the lower opening of the battery room to prevent the insert of dust and other impurities.
1 The louver installed in the battery room openings shall be shut down in the case the fire extinguish system is activated.

Air inlets to be located near the floor & outlet openings at the high point in the room.
Minimum Inlet & Outlet Area (A): With natural ventilation, the minimum inlet and outlet area is calculated as follows:
A should be greater than or equal to **28 x Q** (sq. cm).
The following formula is to calculate the hourly exchange of air volume, **Q** in Cubic Meters / hour recommended for battery rooms.
Q = 0.05 x n x I (cubic meter / hour)
Where:
n = number of cells
I = Value for the current from table of **ELOT EN 50272-2**

(1) Battery type, capacity and charging rate limits requiring separate battery room are under consideration.

Access to battery room shall be direct from outside of building.

The battery room floor shall be acid resistant; the possible acid liquid leakages shall be collected and discharged to the acid sewer or basin.

For pressurized substations, the pressurizing system shall be completely separated from the rest of substation building; in order to limit the leakage of pressurizing air, the two openings for out-flowing of hazardous gases shall be provided with suitable adjustable flappered closing.

1 Details of battery room are shown indicatively in **FIGURE 17**.

3.7 SAFETY OF PERSONNEL

Two doors, located on the opposite side of substation building shall be provided to facilitate the operating personnel to escape in case of fire or explosion inside the substation.

The doors (personnel and equipment) must be provided with quick opening devices (panic bolts); the same concept shall be extended to battery room door and transformer box doors. For pressurized substation the doors shall be gasketed and permanently closed to prevent the out-flow of the pressurizing air.

Safety provisions against direct and indirect contacts with live parts are not considered in this specification.
Safety signs and portable safety provisions.
Refer to specification for safety signs and portable safety provisions.

3.8 CABLE LAYING FACILITIES

To facilitate cable laying from/to equipment, a cable room 2 m high (from grade to switchroom finished floor) shall be provided under the switchroom floor.

Suitable continuous ladder type cable racks shall be installed in this cable room (2). The space under cable room from grade to the cable laying bed depth (1 m about) shall be sand filled after cable laying. Power cables shall be as far as possible laid in sand up to the point of vertical projection of cable entry into the switchboard; this type of laying shall be maximized for substations located in countries where the ambient temperature is high.

3.9 LIGHTING, SOCKETS OUTLETS AND TELECOMMUNICATIONS

Normal and emergency lighting shall be provided at substation building.

a. Normal lighting.

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(2) Typical details of cable racks are under consideration.

- Normal lighting shall preferably be by fluorescent lighting fixtures fed by the auxiliary board (lighting section).

- Normal lighting inside substation building shall be controlled by changeover switches positioned at doors.

- Normal lighting outdoor substation building and in transformer boxes shall be automatically controlled together with general outdoor lighting.

b. Emergency lighting.

- A skeleton emergency lighting system shall be provided by means of connecting to the emergency circuit some fluorescent tubes belonging to normal lighting fixture.

The emergency circuit shall be fed from D.C. board, and shall be controlled by change-over switches at doors.

- A portable lighting fixture with incorporated battery and battery charger shall be provided in each substation building.

- Safety autonomous lighting fixtures will be provided above the substation doors (i.e. EXIT signs).

c. Lighting fixture and switch in battery room shall be explosion proof: (EExd-II C-T3).

d. Telecommunication.
If specified, the following telecommunication apparatus shall be provided at substation.

- A sound powered telephone set connected with the primary distribution substation.

- A sound powered telephone set connected with the primary

- A manual operated fire alarm station, positioned outside substation building.

- The suitable number of automatic fire alarm detectors, positioned inside the substation building, on ceiling, preferably above main switchboards.

e. Sockets Outlets.
Unless otherwise specified, the following sockets outlets shall be provided at substation:

- inside substation building, three 16 A, single phase plus protective earth (SPH + PE) lighting sockets;

- inside each transformer box, one 63 A, three phase plus protective earth (3 PH + PE) power socket and one 16 A, single phase plus earth (SPH + PE) lighting socket.

f. The indicative layouts, for lighting and telecommunication are shown on **FIGURE 18**.

3.10 For earthing of substation equipment, metal structures, concrete structure (steel reinforcement bars), doors and fences, refer to **DESFA Job Specification No. 710/1**.

3.11 SUBSTATION ARCHITECTURE

Substation (building and outside facilities) shall be finished, painted etc., as per architectural drawings.

4.0 ADDITIONAL REQUIREMENTS FOR BLAST RESISTANT SUBSTATIONS

4.1 SCOPE

Scope of this paragraph is to indicate the particular additional requirements, which applied to normal standard secondary substation, give the design guide for the standard of blast resistant secondary substation.

a. Building Construction

Building walls, floor, roof, doors and platform shall be structured to withstand the applicable blast pressure.

b. Substation Equipment

All outdoor equipment such as transformers, link disconnecting boards, bus bars ducts cables, fences, lighting fixtures etc. shall be anchored to withstand the blast pressure.

c. Battery Room Openings

To prevent damaging inside battery room in case of blast, the battery room opening shall be provided with suitable steel plate shutter (see indicative detail 2 in **FIGURE 17**).

TABLE 1

SUBSTATION LAYOUT SELECTION

Voltage Distribution Level	Typical Diagram	Primary Supply	Substation Location		Remarks
			Plant and Access Road at Same Side	Plant and Access Road at Opp. Side	
Low voltage (Power motor control center)	Single ended	Direct	FIGURE 1	FIGURE 2	
	Double ended		FIGURE 3	FIGURE 4	
Low voltage (Power motor control center) and medium volt. (switchgear)	Single ended		FIGURE 5	FIGURE 6	
		Trough link disc. Board	FIGURE 7	FIGURE 8	
	Double ended	Direct	FIGURE 9	FIGURE 10	
		Through link disc. board	FIGURE 11	FIGURE 12	

TABLE 2

CLEARANCE DIMENSIONS (REFER TO FIGURES 1 TO 12)

Symbol	Minimum (*) Clearances	Description	Remarks
A	1500	Swithgear, in front of operating side	
B	1200	L.V. control center, in front of operating side	
C	750	L.V. switchgear and control center from each end and from non operating side	
D	1200	Auxiliary boards, in front of operating side	
E	100 mm more than depth of largest equip. but not less than dimension A	Common operating aisle for switchgear, Control center & auxiliary boards (if any)	
F	200 mm more than depth of largest equipment	Equipment door with	For standard doors see **FIGURE 26**
G	200 mm more than highest equipment	Equipment door height	
(*) Clearances shall be increased if required by equipment manufacturers standards			

FIGURE 1 – LAYOUT–L.V. SINGLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT SAME SIDE)

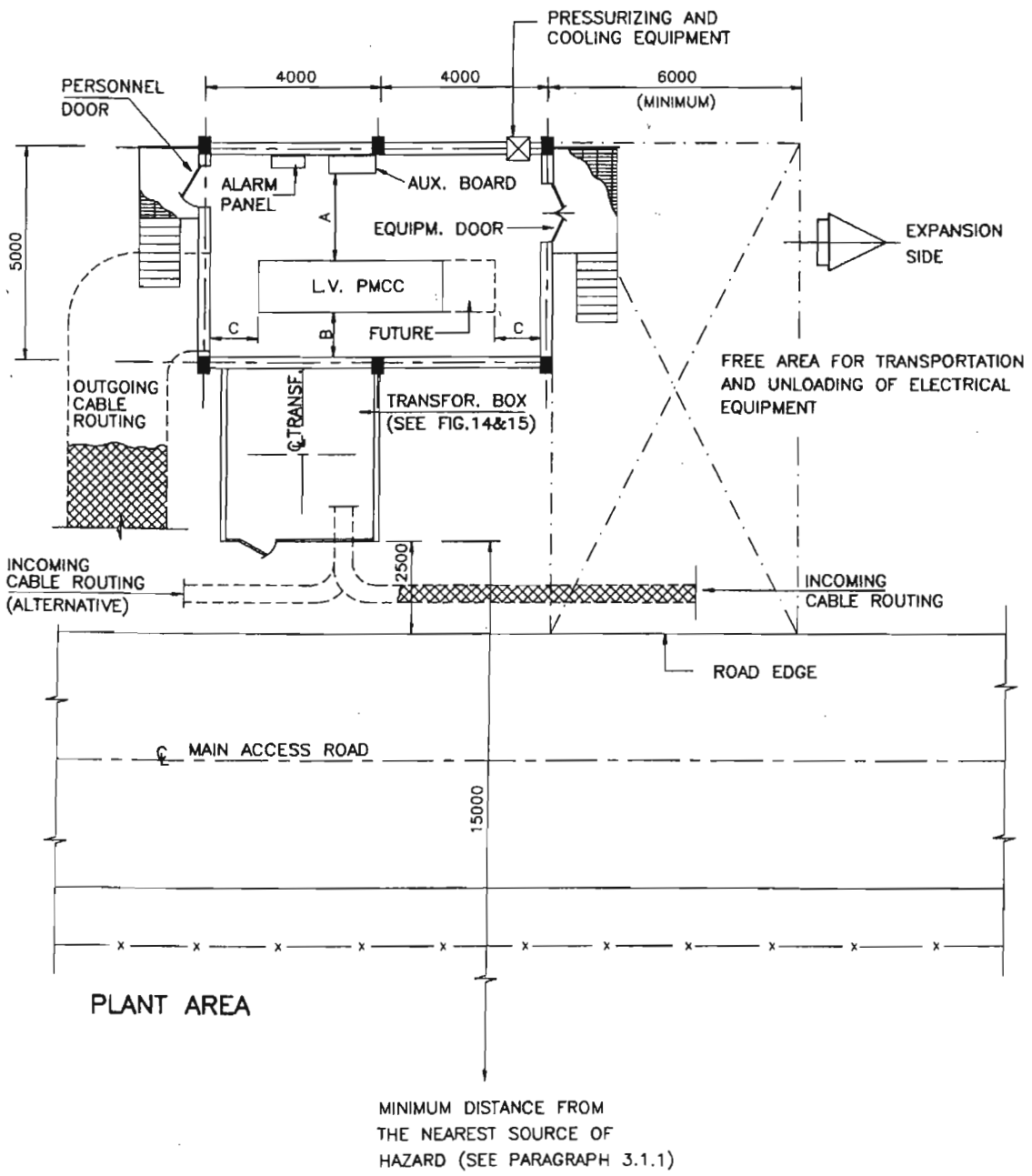


FIGURE 2 – LAYOUT–L.V. SINGLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT OPPOSITE SIDES)

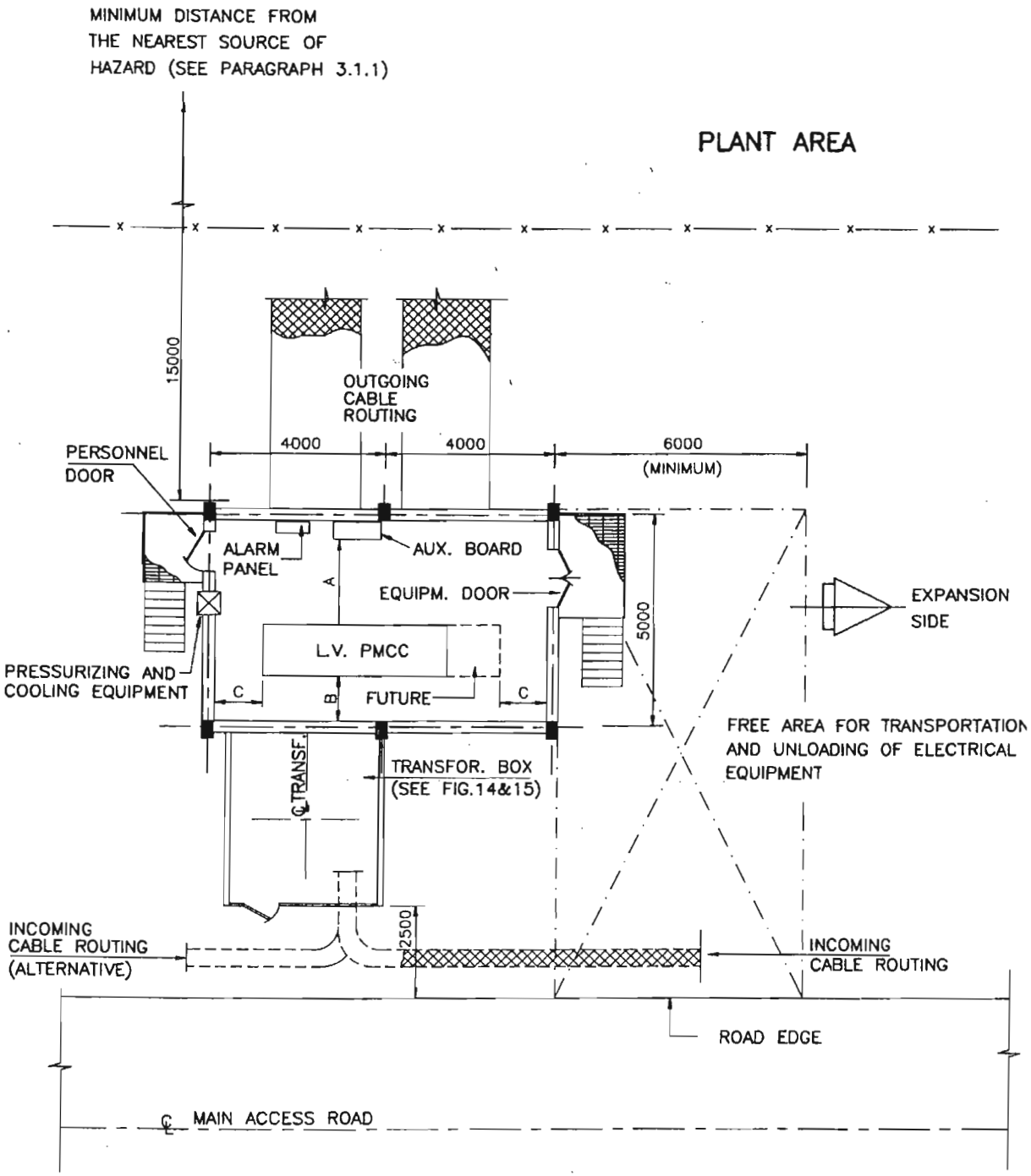


FIGURE 3 – LAYOUT–L.V. DOUBLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT SAME SIDE)

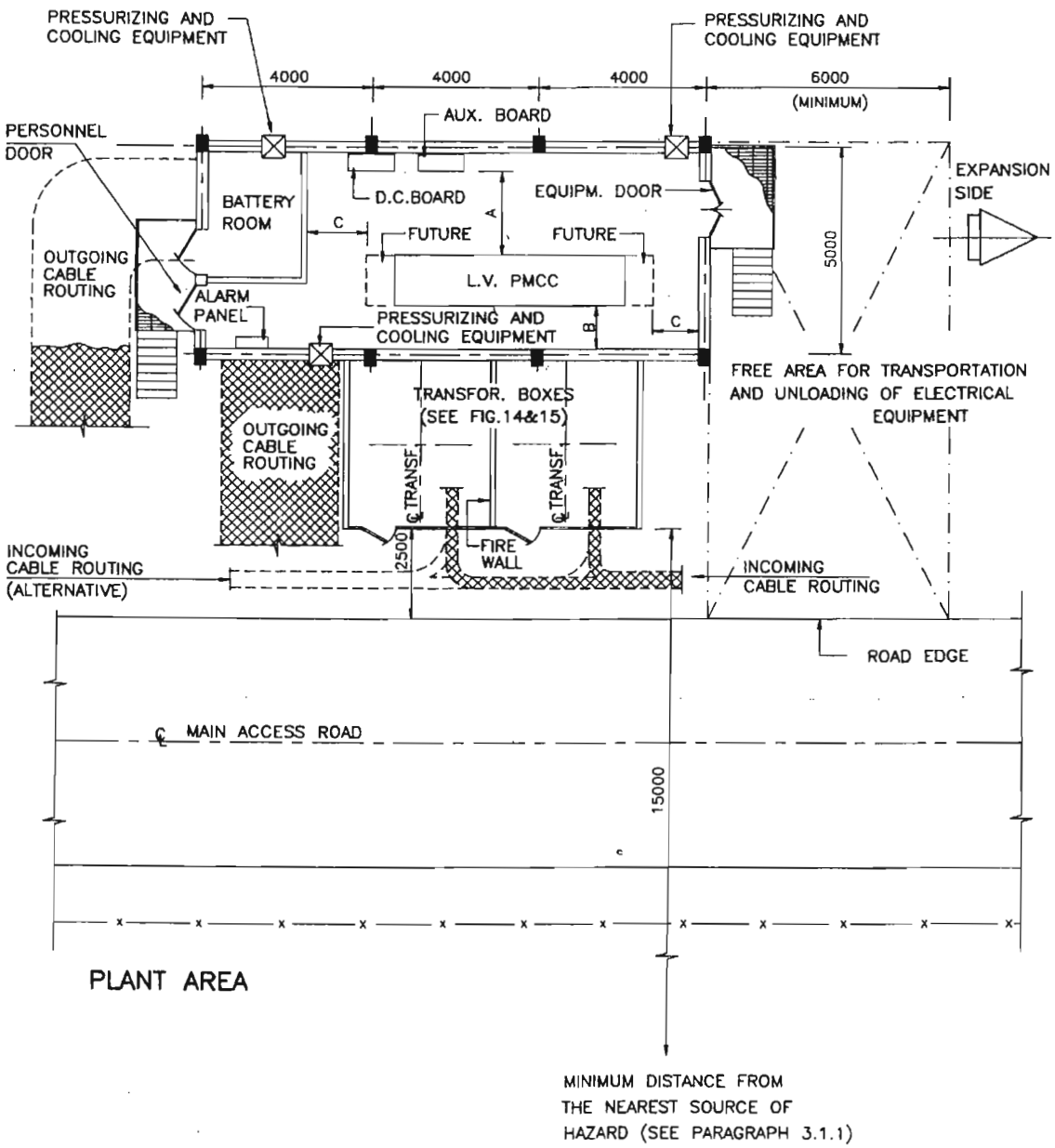


FIGURE 4 – LAYOUT–L.V. DOUBLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT OPPOSITE SIDES)

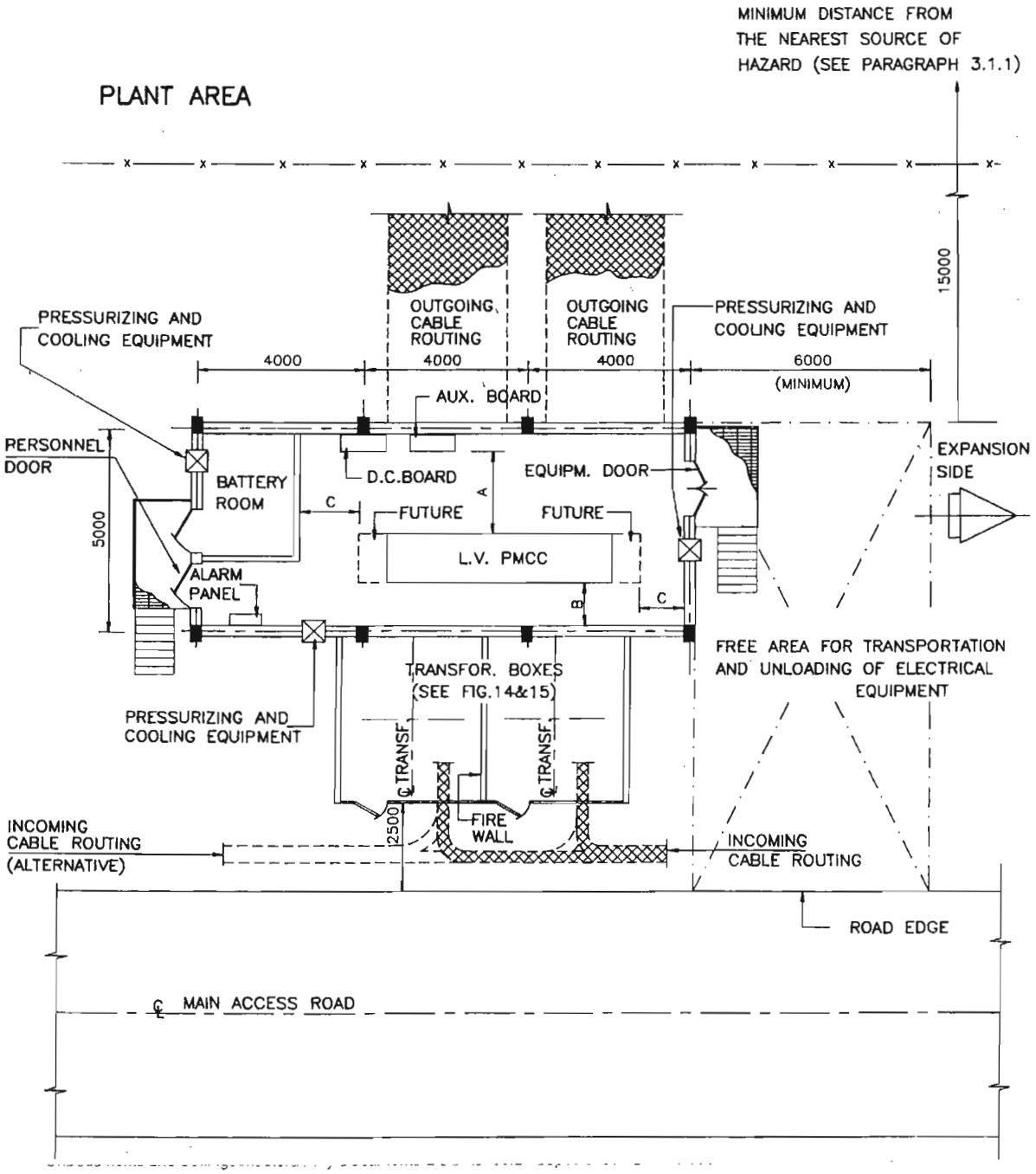


FIGURE 5 – LAYOUT–L.V.& M.V. SINGLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT SAME SIDE)

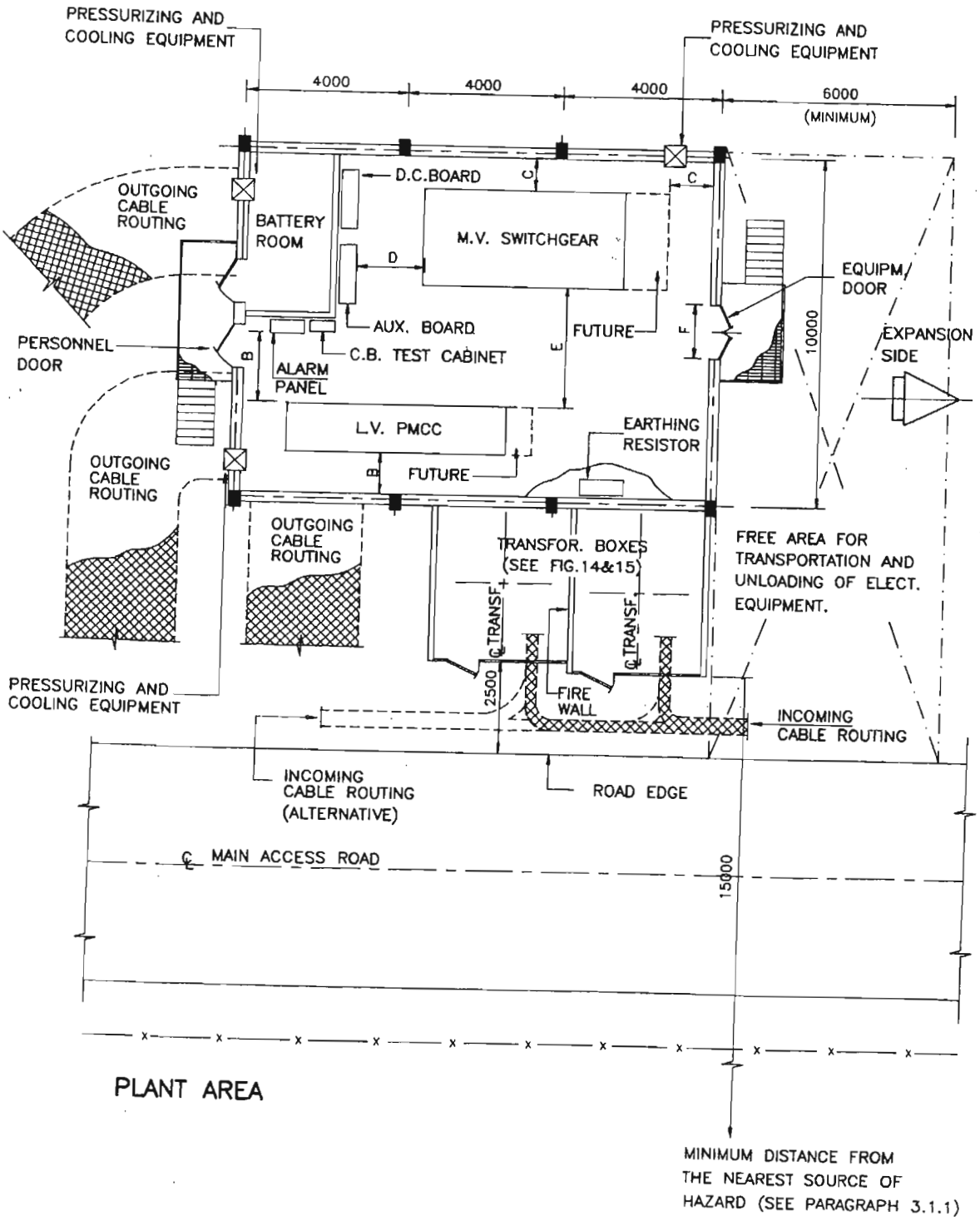


FIGURE 6 – LAYOUT–L.V.& M.V. SINGLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT OPPOSITE SIDES)

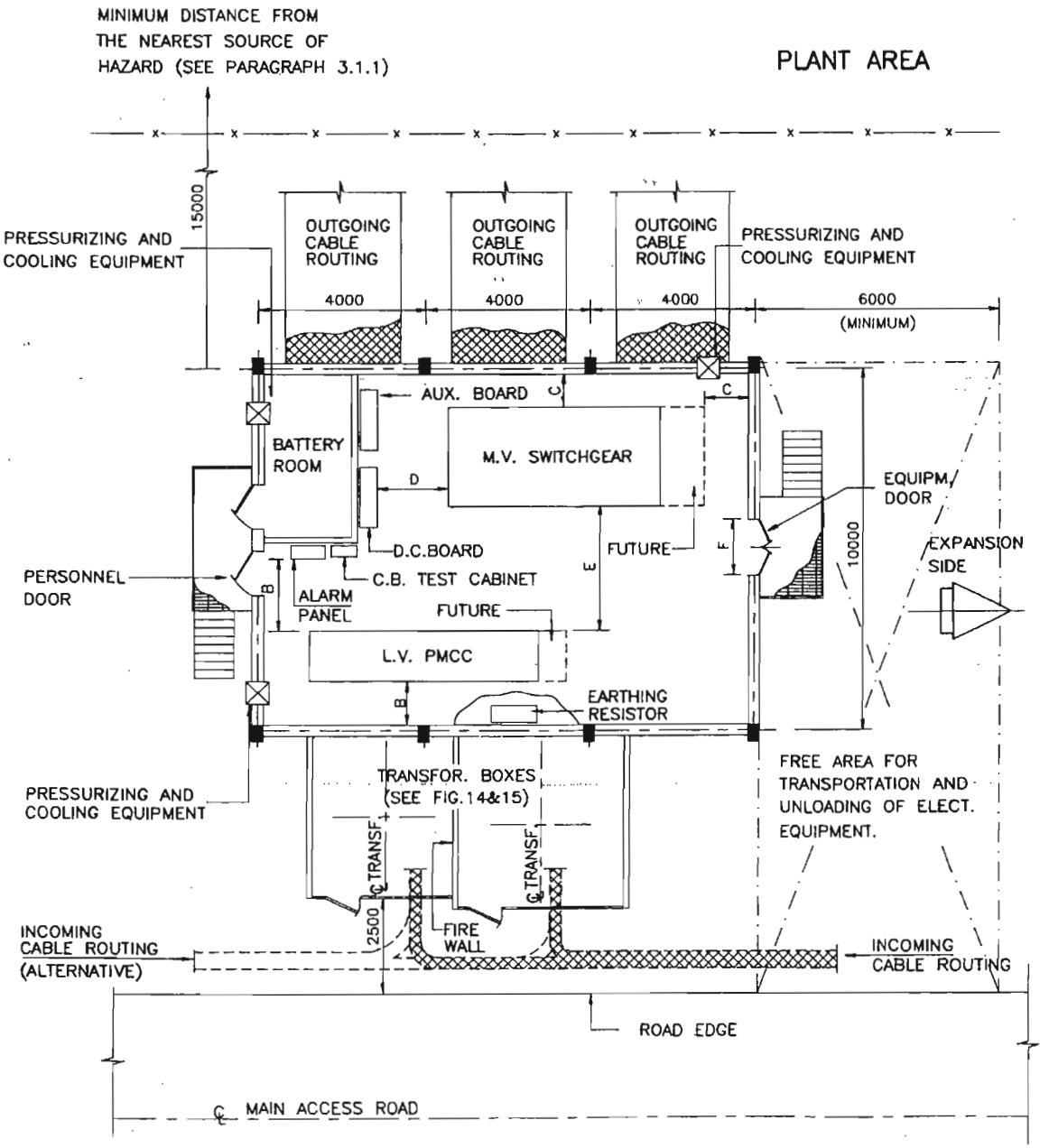


FIGURE 7 – LAYOUT–L.V.& M.V. TAPPED FEEDER,SINGLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT SAME SIDE)

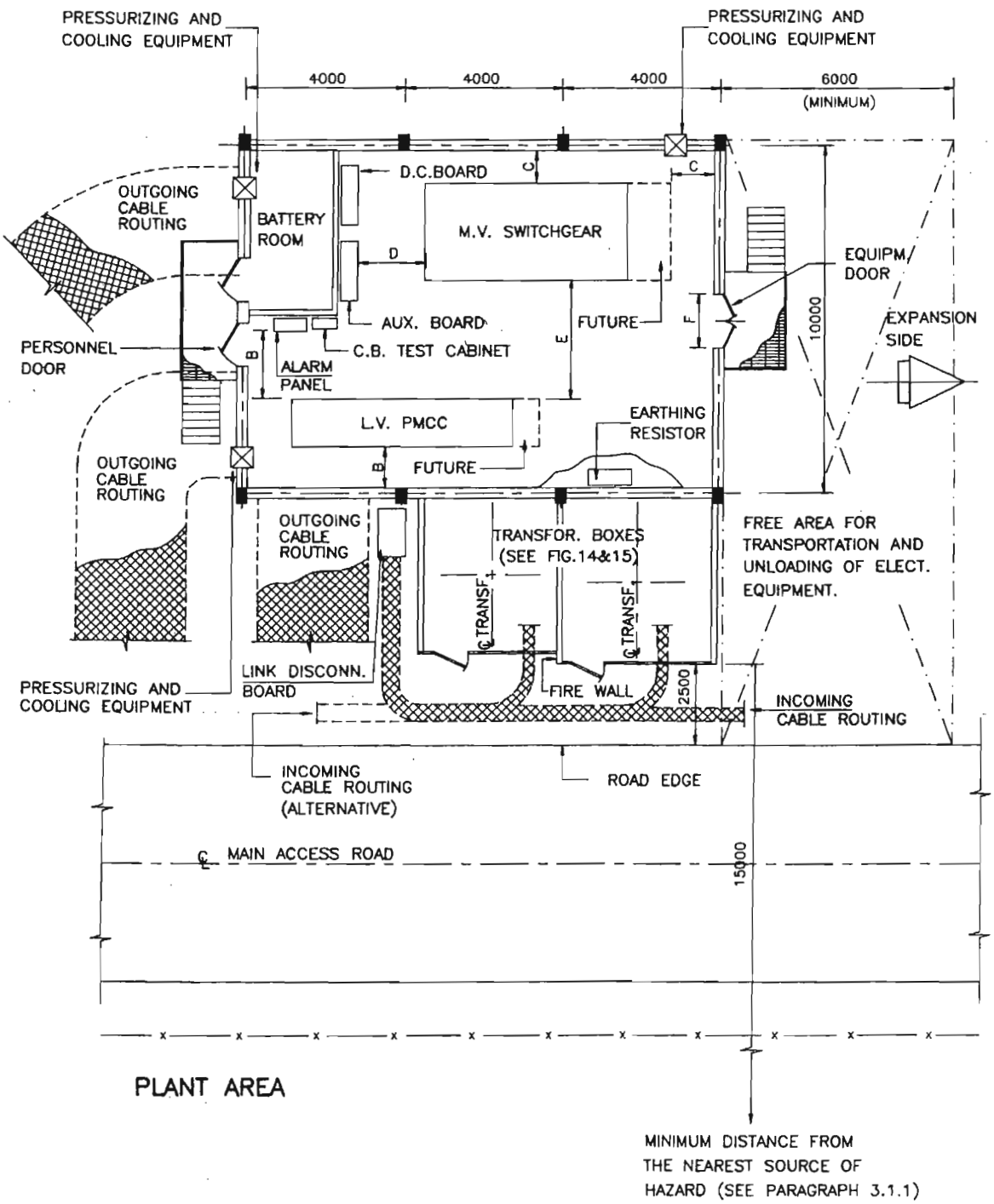


FIGURE 8 – LAYOUT–L.V.& M.V. TAPPED FEEDER SINGLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT OPPOSITE SIDES)

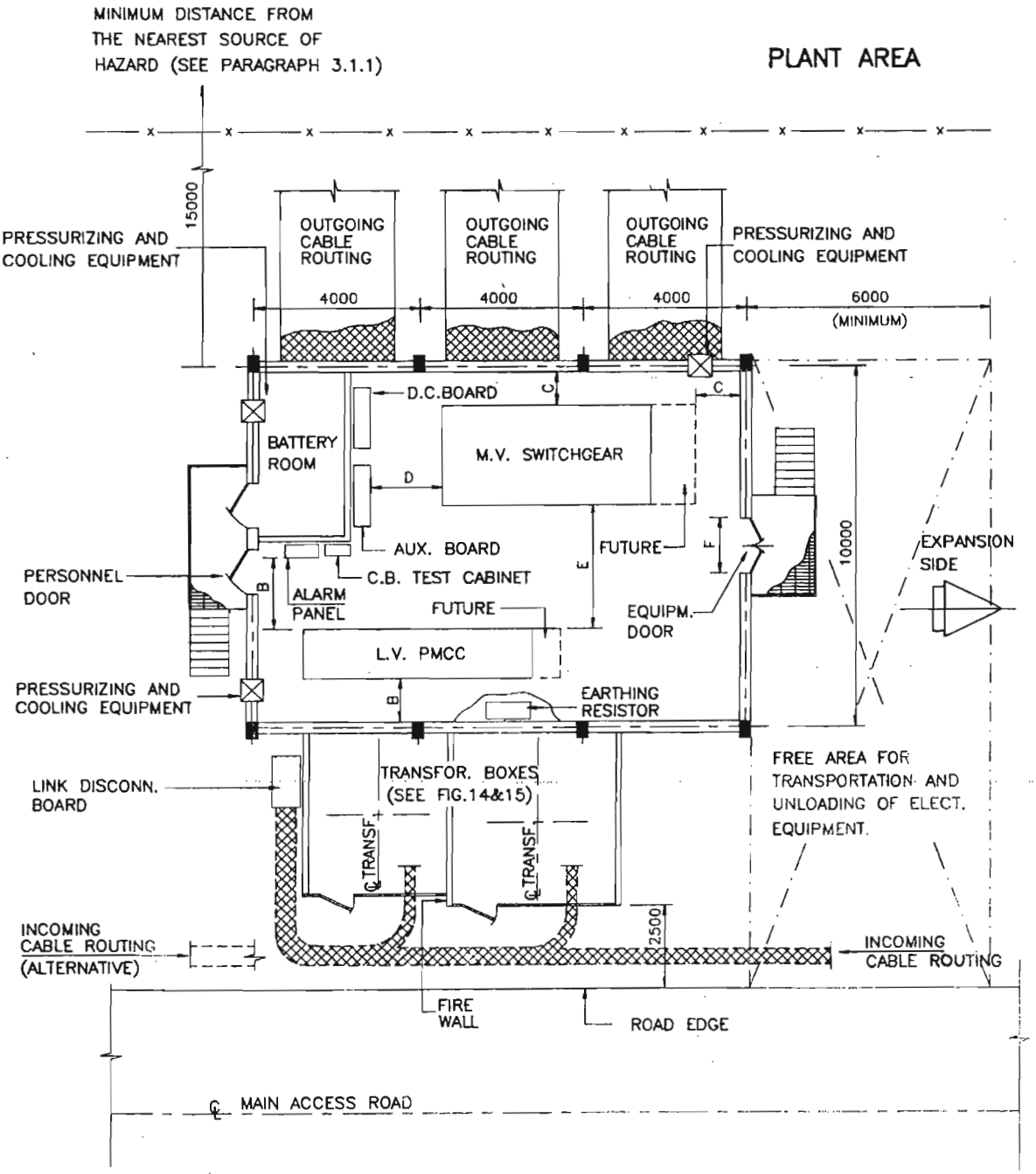


FIGURE 9 – LAYOUT–L.V.& M.V. DOUBLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT SAME SIDE)

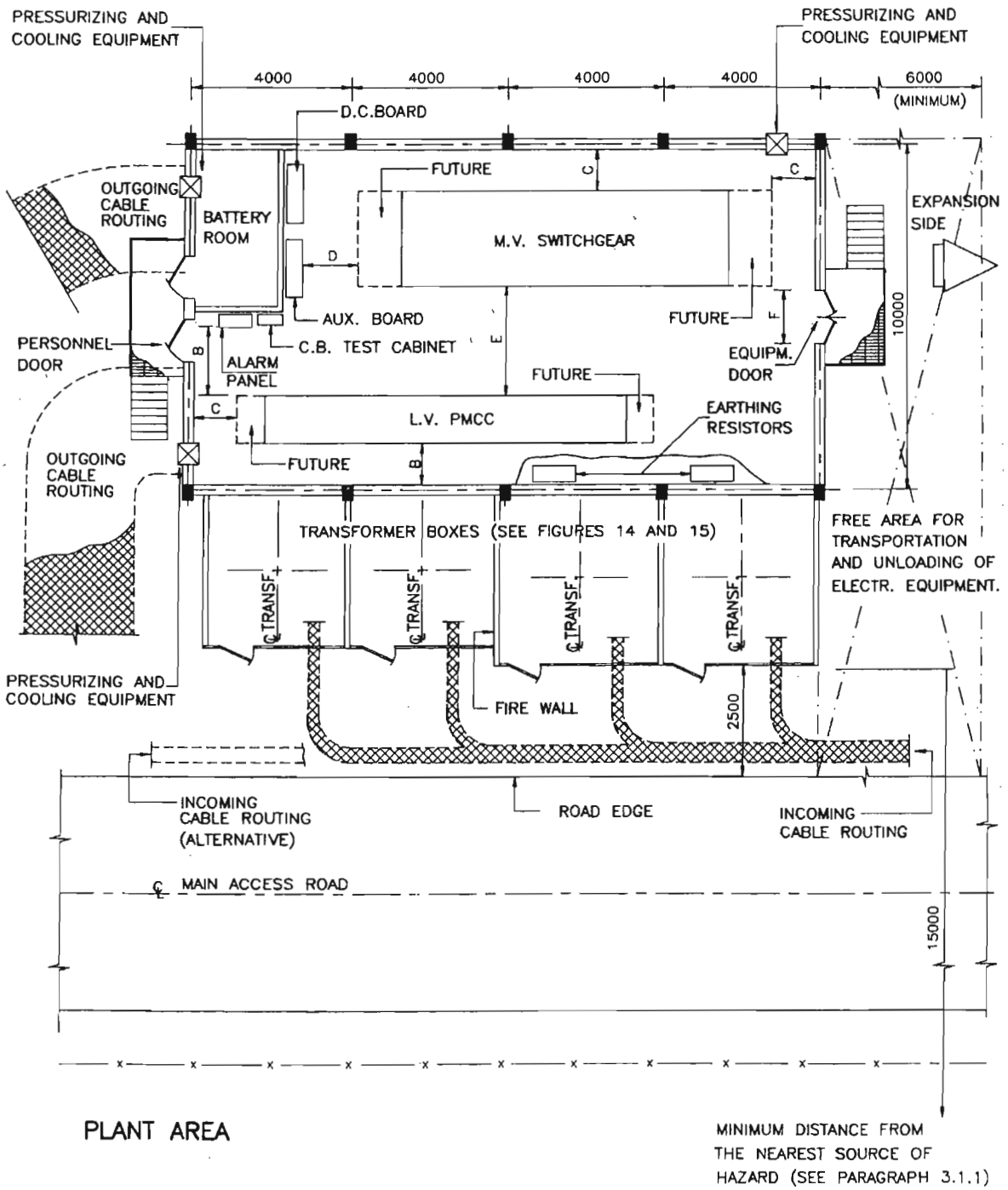


FIGURE 10 – LAYOUT–L.V.& M.V. DOUBLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT OPPOSITE SIDES)

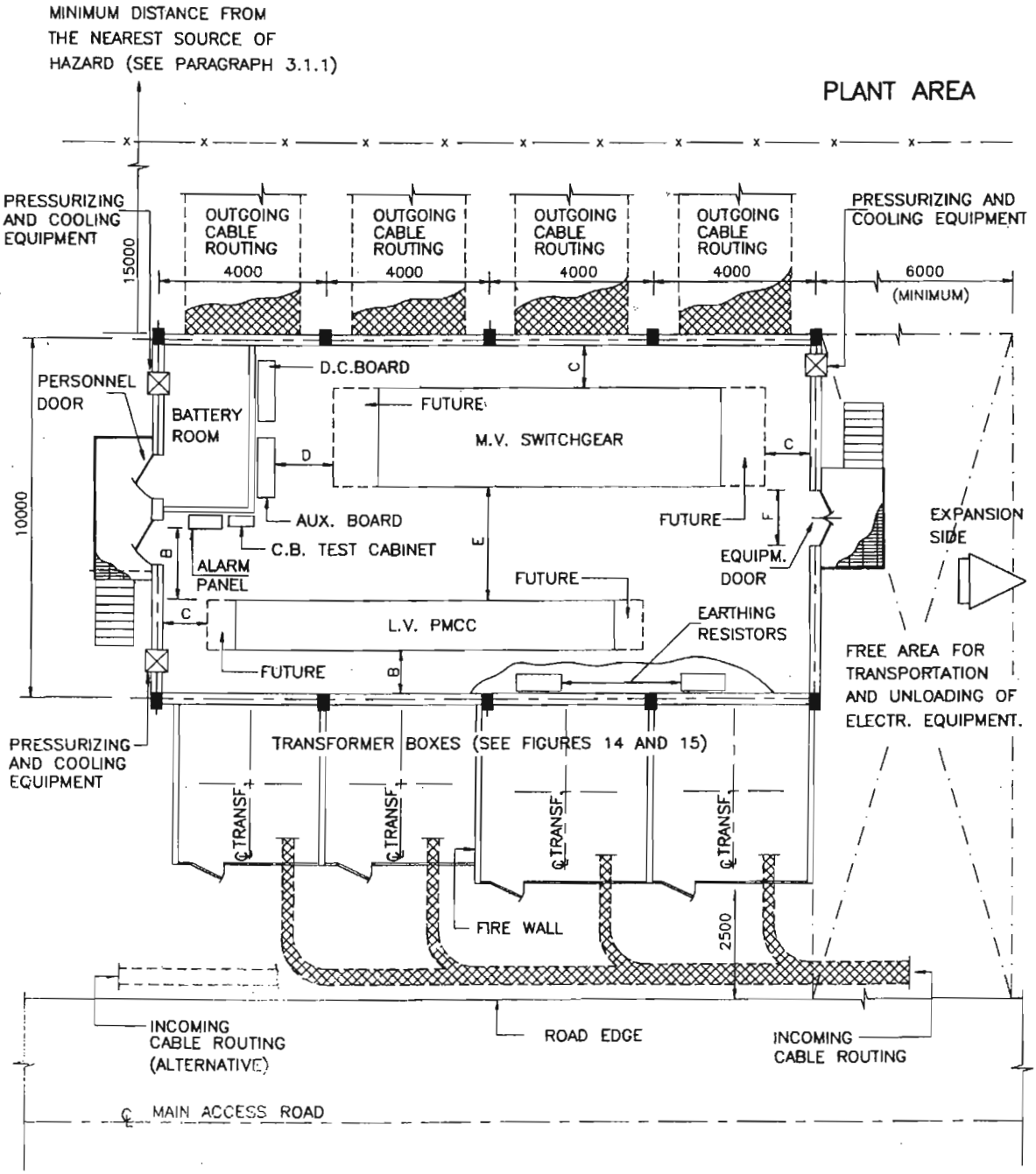


FIGURE 11– LAYOUT–L.V.& M.V. TAPPED FEEDER,DOUBLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT SAME SIDE)

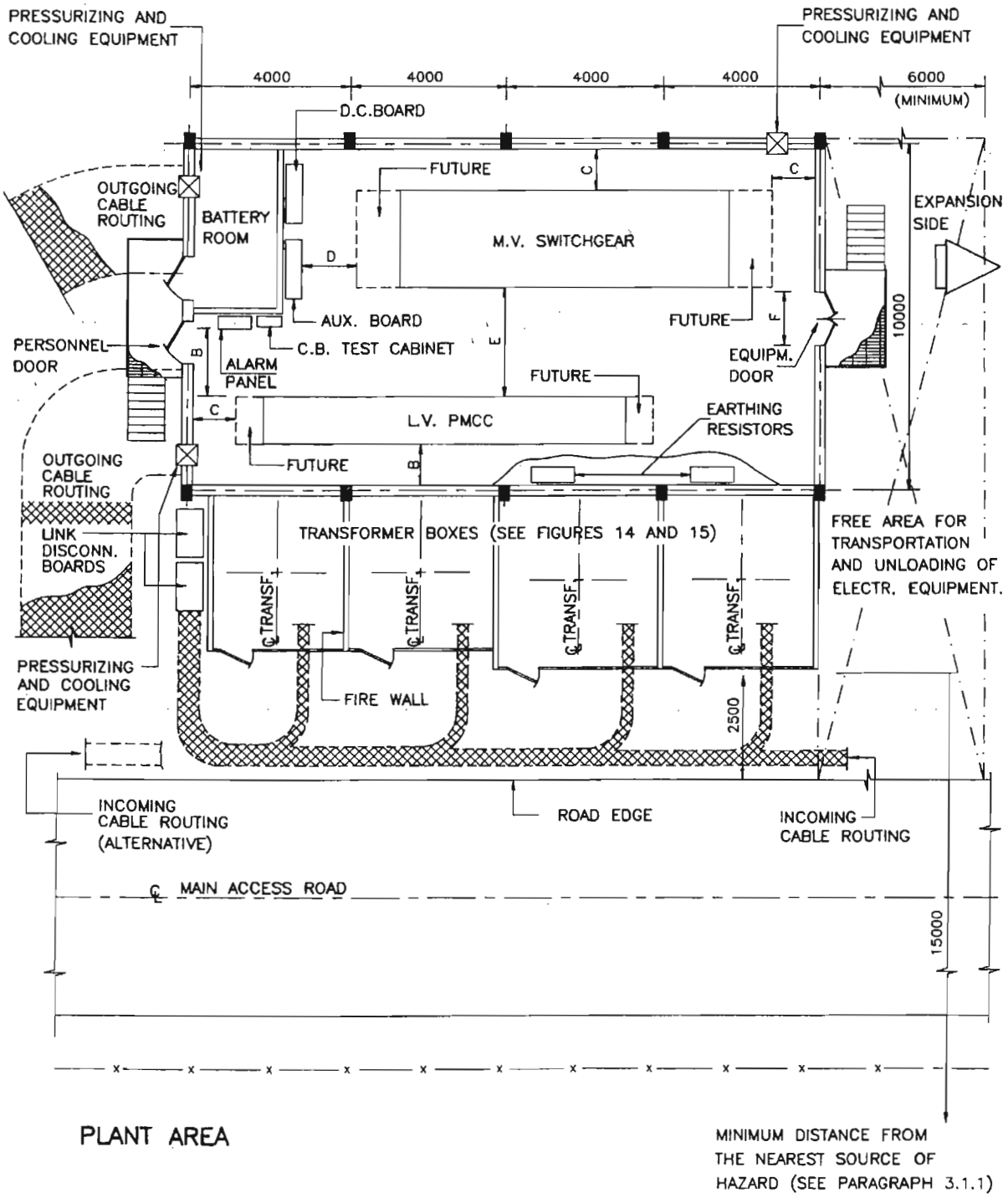


FIGURE 12– LAYOUT–L.V.& M.V. TAPPED FEEDER,DOUBLE ENDED SUBSTATION

(ACCESS ROAD AND PLANT AT OPPOSITE SIDES)

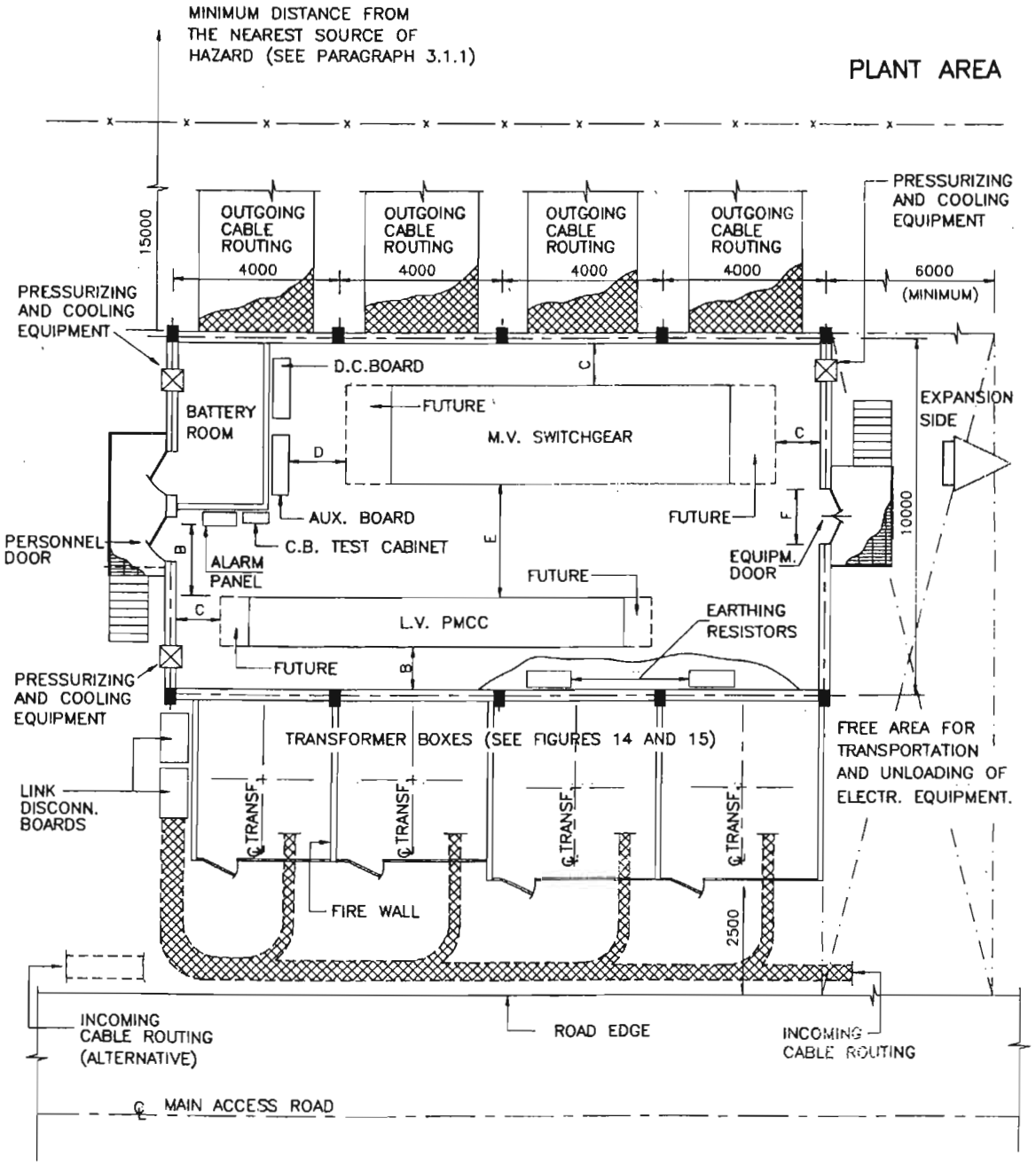
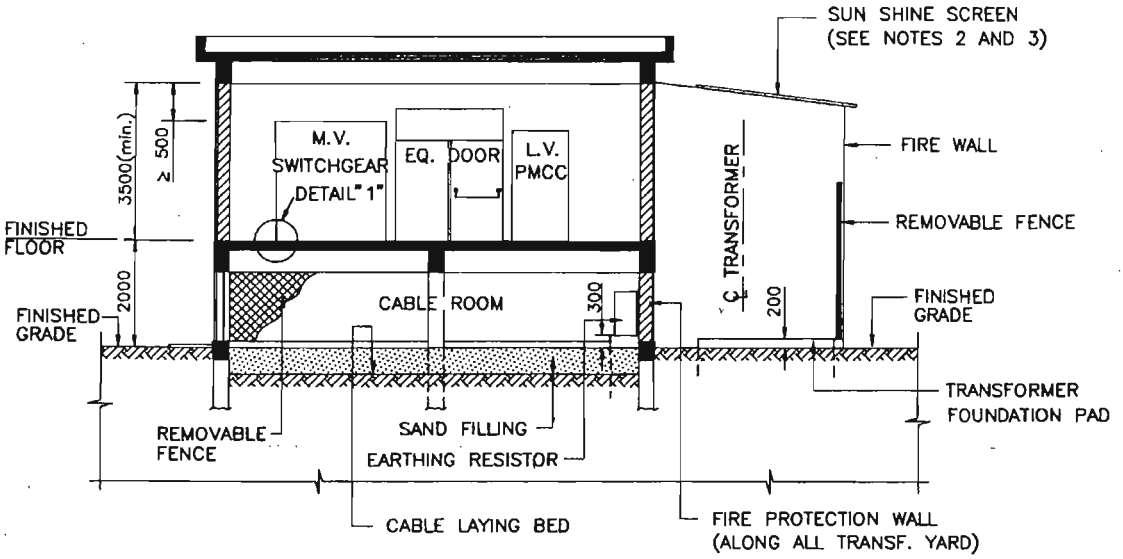
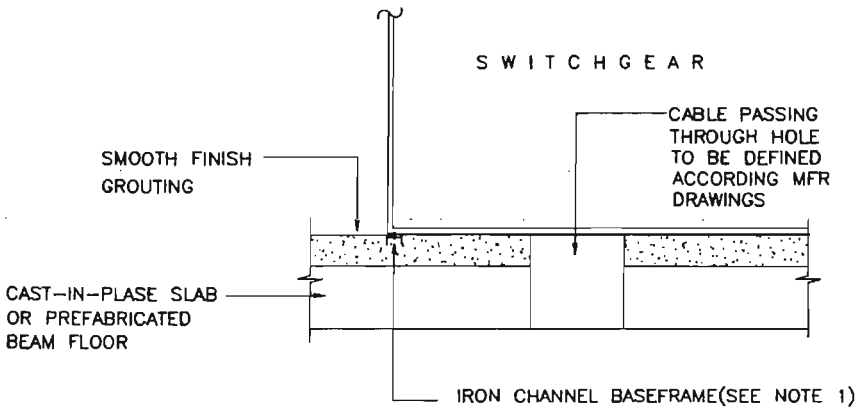


FIGURE 13 – TYPICAL SUBSTATION– SECTION AND DETAIL





D E T A I L "1"

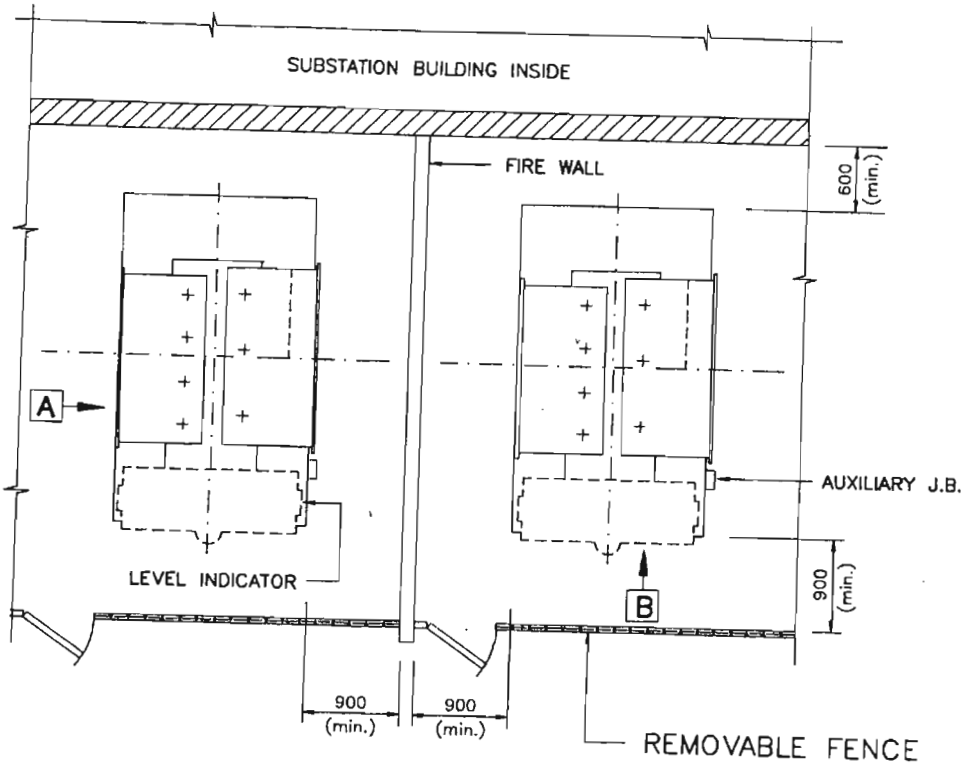
NOTES:

1) THE SWITCHBOARD BASE FRAMES SHALL BE FLUSH FLOOR LEVEL MOUNTING THIS MAY BE POSSIBLE POURING THE FLOOR GROUTING AFTER THE LAYING OF BASEFRAMES.

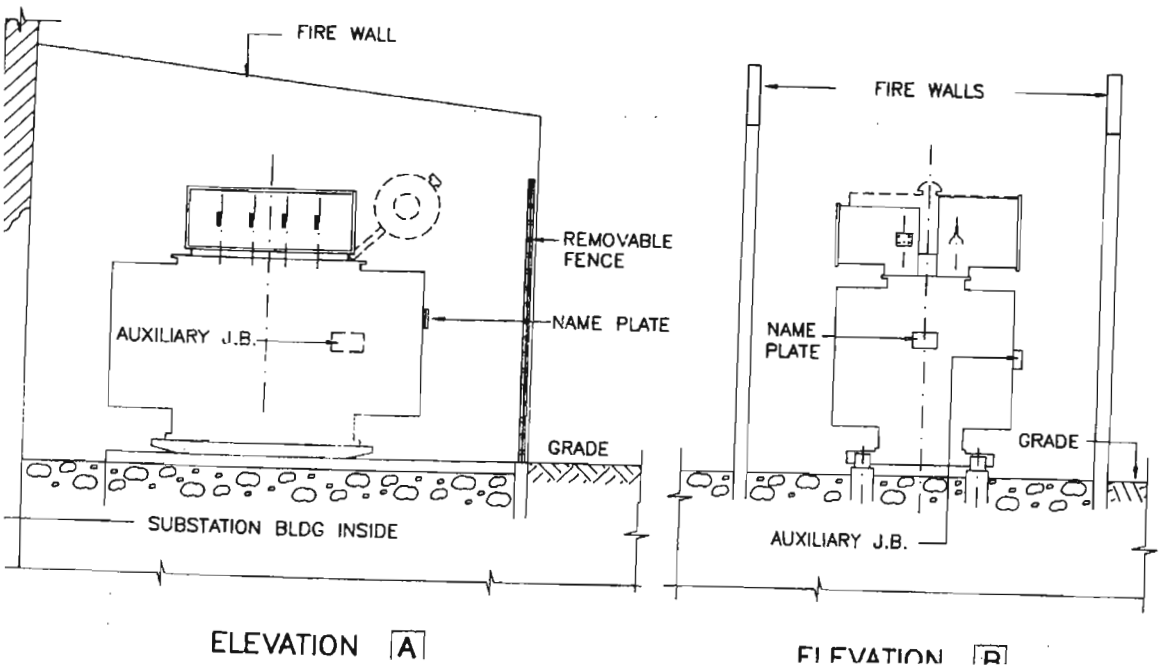
2) THE ELEVATION OF SUN SHINING PROTECTION SCREEN SHALL BE SUCH TO AVOID THE OBSTRUCTION WITH THE BUS BAR DUCTS FROM TRANSFORMER TO SWITCHBOADS.

3) THE SUN SHINING PROTECTION SCREEN SHALL BE REMOVABLE TO ALLOW LIFTING OF SKID MOUNTING TRANSFORMERS BY CRANES.

FIGURE 14 – 630 & 1000 KVA TRANSFORMER BOX



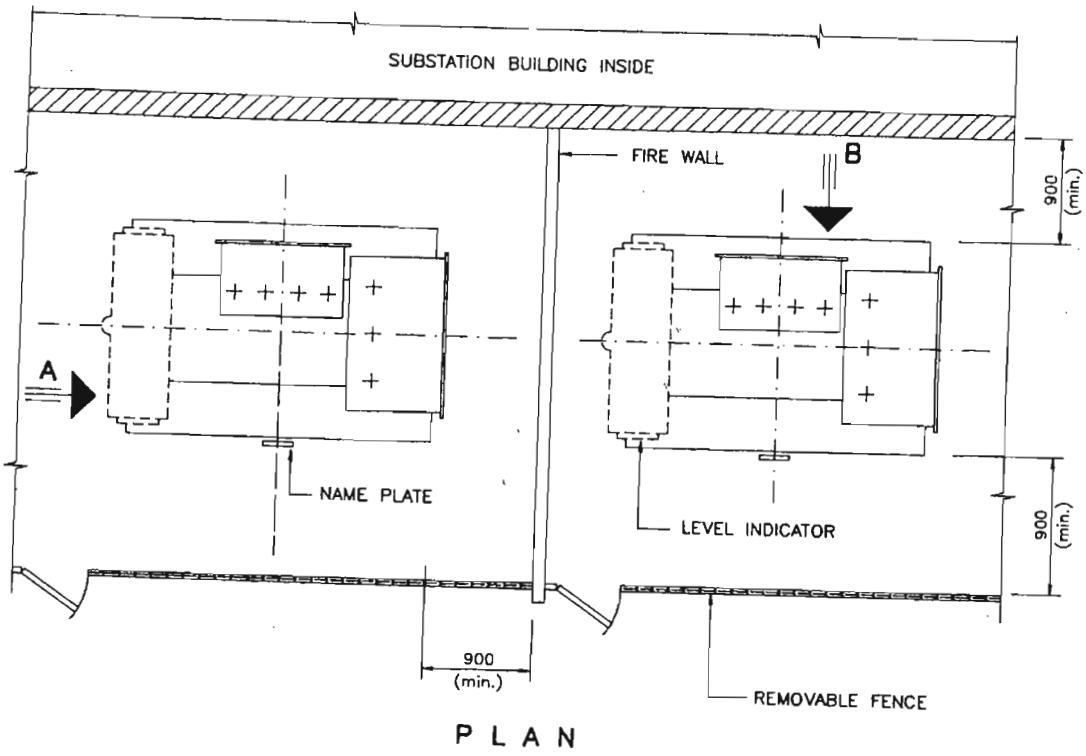
P L A N



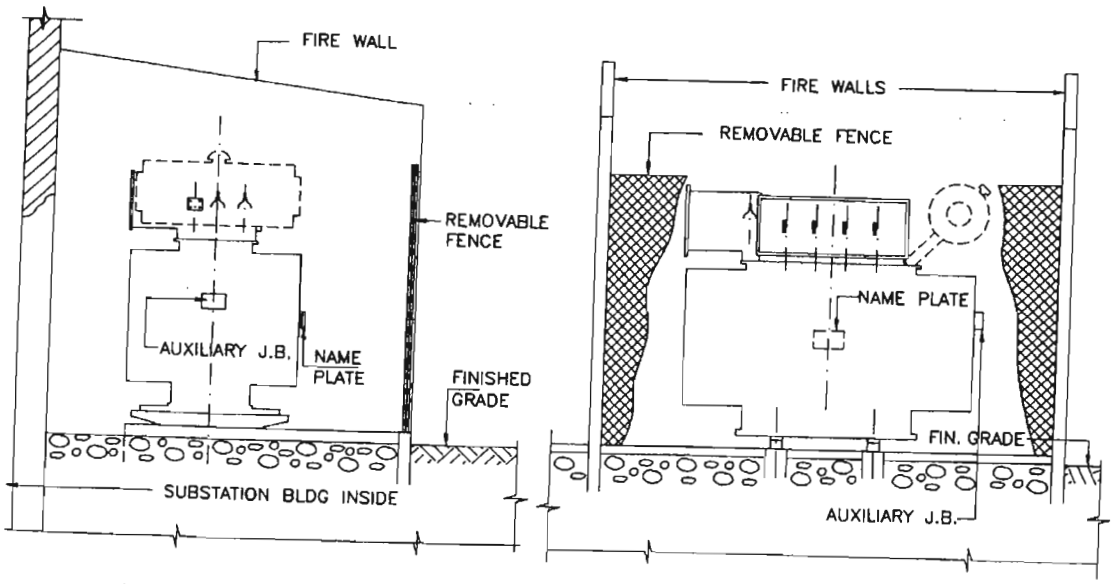
ELEVATION [A]

ELEVATION [B]

FIGURE 15 – 1250 TO 2000 KVA TRANSFORMER BOX



PLAN



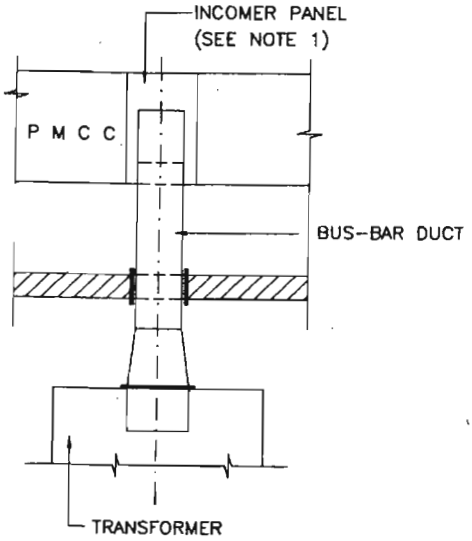
ELEVATION "A"

ELEVATION "B"

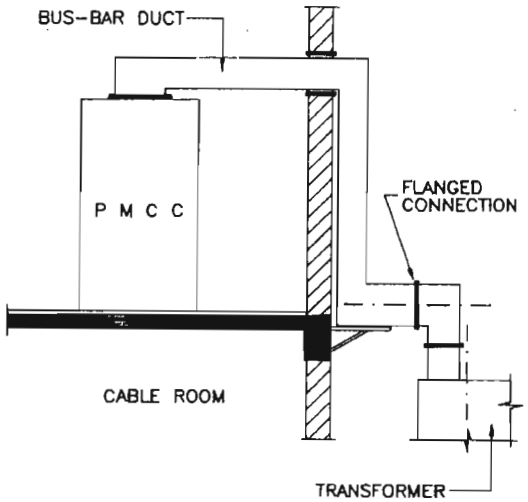
FIGURE 16 – BUS–BAR DUCT DETAILS

(FOR 1250 TO 2000 KVA TRANSFORMERS)

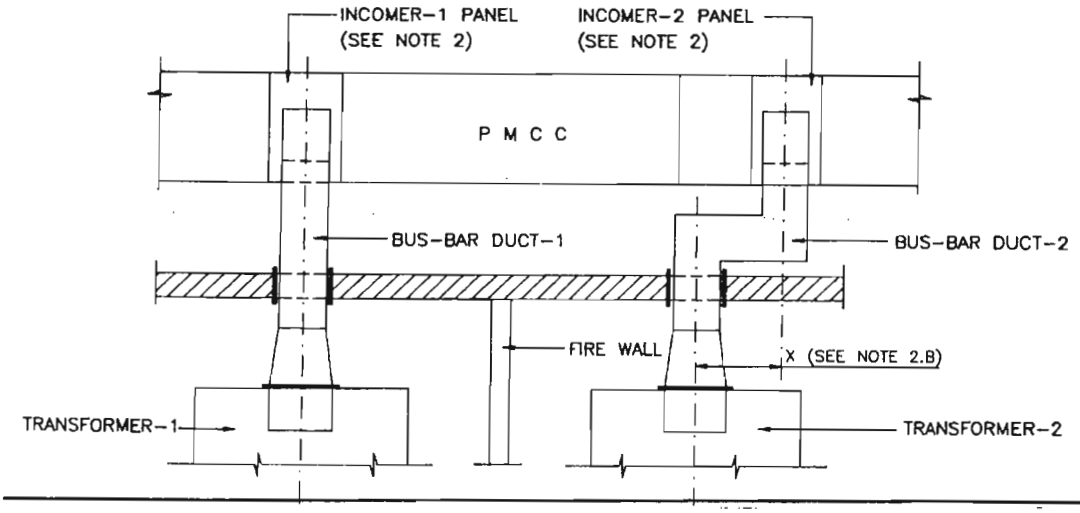
SINGLE ENDED PMCC–PLAN



TYPICAL ELEVATION



DOUBLE ENDED PMCC–PLAN

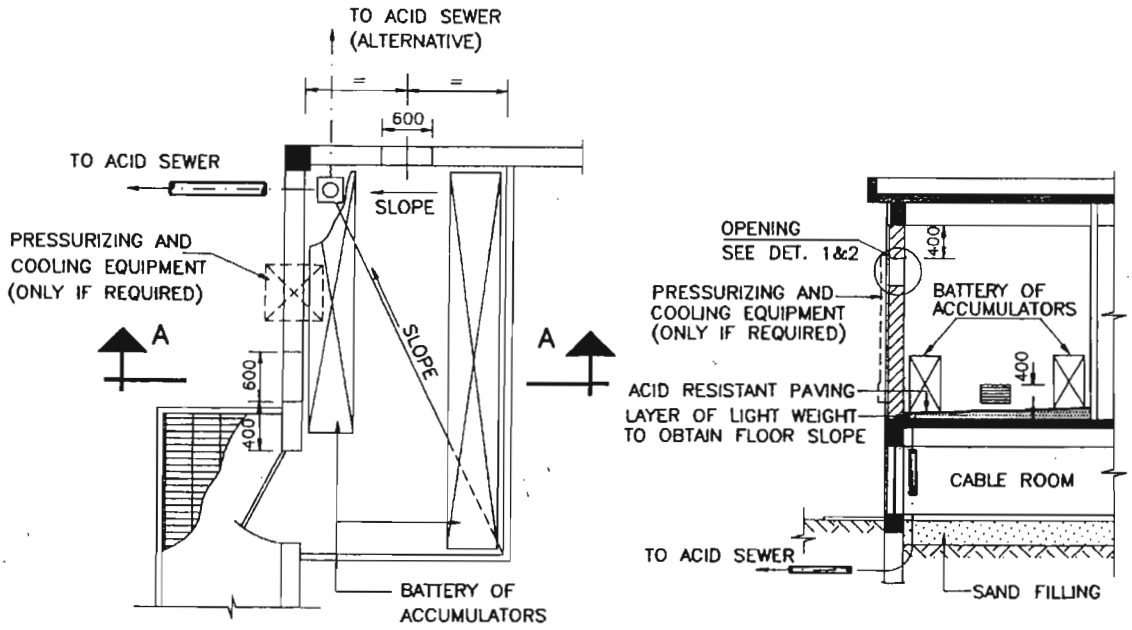


NOTES:

1) THE LOCATION OF INCOMER SHOULD BE SUCH TO ALLOW THE INSTALLATION OF A BUS–BAR DUCT WITHOUT HORIZONTAL DEFLECTION,MAKING ONLY (IF ANY) LITTLE LONGITUDINAL SHIFTING OF PMCC OR TRANSFORMER.

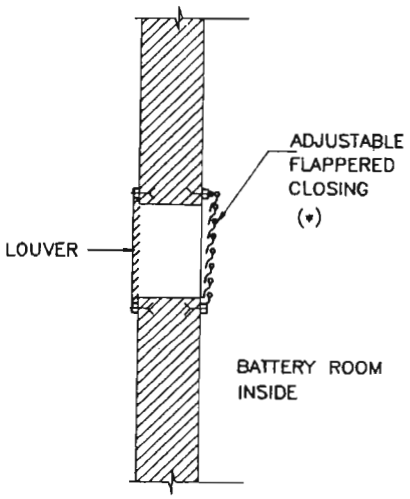
2) THE LOCATION OF INCOMERS SHOULD BE: A) INCOMER 1, SUCH TO ALLOW THE INSTALLATION OF BUS–BAR DUCT 1 WITHOUT HORIZONTAL DEFLECTION, MAKING (IF ANY) LITTLE LONGITUDINAL SIFTING OF PMCC OR TRANSFORMER–1. B) INCOMER 2, AS PER INCOMER 1 (IF POSSIBLE), OR SUCH TO MINIMIZE THE LENGTH OF BUS–BAR DUCT 2 (KEEPING TO MINIMUM THE DIMENSION "X").

FIGURE 17– BATTERY ROOM

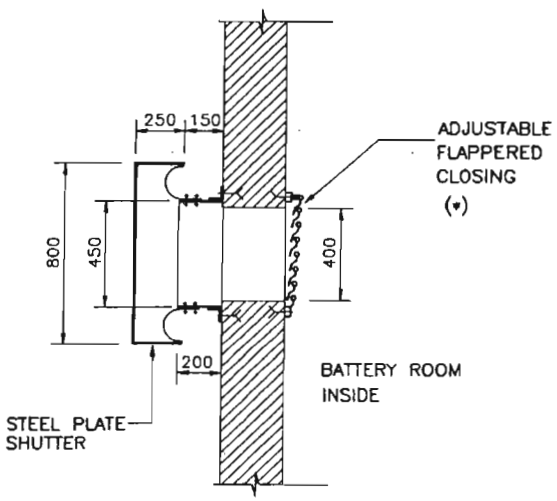


P L A N

SECTION "A–A"



DETAIL–1
OPENING FOR NORMAL SUBSTATION

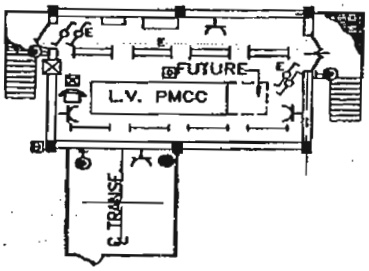


DETAIL–2
OPENING FOR BLAST RESISTANT SUBSTATION

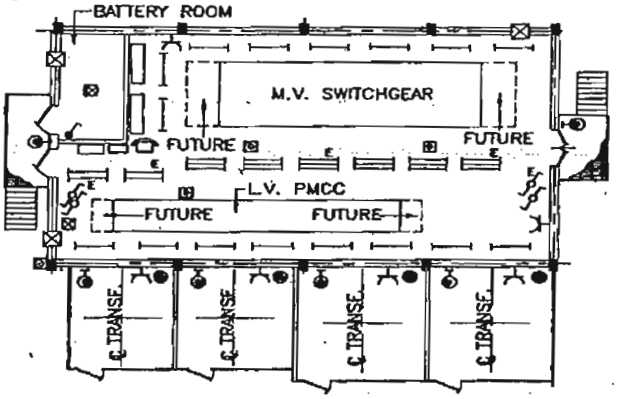
(*) – FOR PRESSURIZED SUBSTATION ONLY.

FIGURE 18 – LIGHTING AND TELECOMMUNICATION LAYOUTS

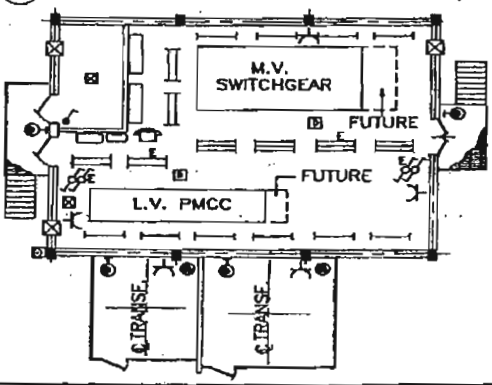
(A) L.V. SINGLE ENDED S/S



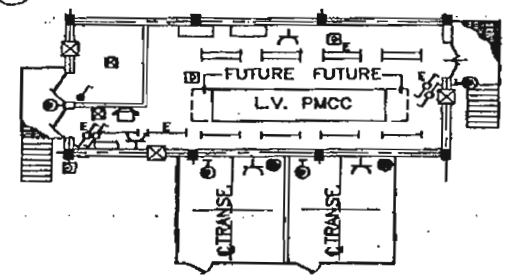
(B) L.V.& M.V. DOUBLE ENDED SUBSTATION



(C) L.V.&M.V. SINGLE ENDED S/S



(D) L.V.DOUBLE ENDED SUBSTATION

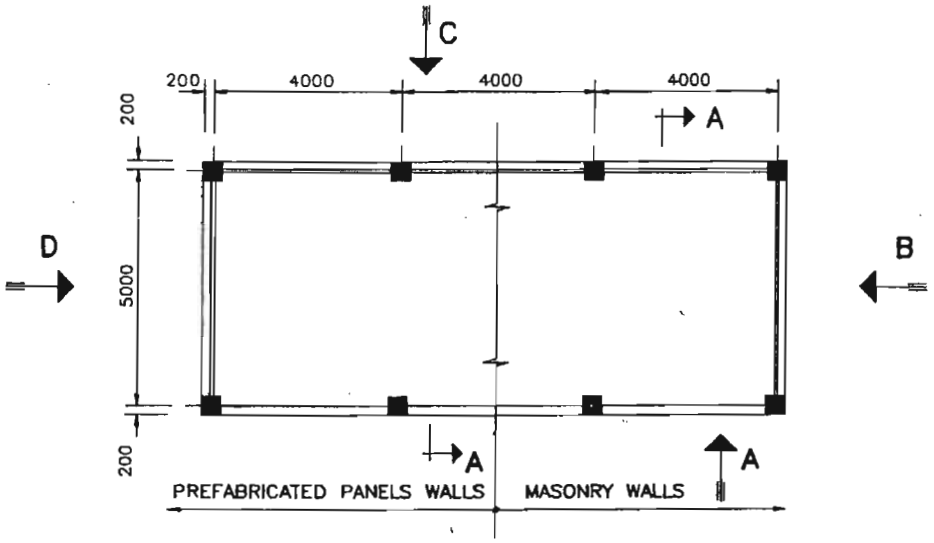


LEGEND

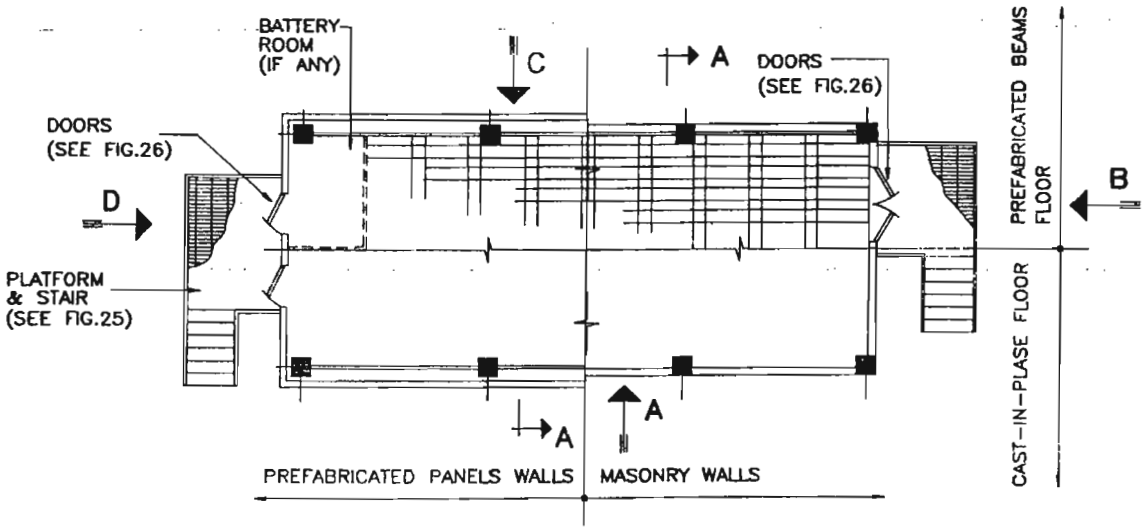
	1X80W MERCURY VAPOR LIGHTING FIXTURE (BRACKET MOUNTING.)		2X20W PORTABLE EMERGENCY LIGHTING FIXTURE (WALL MOUNTING)	E	EMERGENCY CIRCUIT (IF INDICATED ON FLUORESCENT LIGHT. FIXTURE, IT IS REFERED TO ONE TUBE ONLY).
	1X36W FLUORESC.LIGHTING FIXTURE (CEILING MOUNTING.)		3PH+PE,380V,63A POWER SOCKET.		SOUND POWERED TELEPHONE SET.
	2X36W LIGHTING FIXTURE AS ABOVE.		1PH+PE,220V,16A POWER SOCKET.		MANUAL OPERATED FIRE ALARM STATION.
	3X36W LIGHTING FIXTURE AS ABOVE.		CHANGE OVER SWITCH (2WAY)		AUTOMATIC FIRE ALARM DETECTOR.
	EXPL. PROOF(IIB–T3), 1X[illegible]CW INCANDESCENT LIGHTING FIXTURE (CEILING MOUNTING.)		EXPL. PROOF(IIA–T3), SWITCH (IN BATTERY ROOM)		

* NOTE: Lamps as per EU REGULATION 244-2009

FIGURE 19 – 5m WIDE SUBSTATION BUILDING–PLANS



GROUND FLOOR



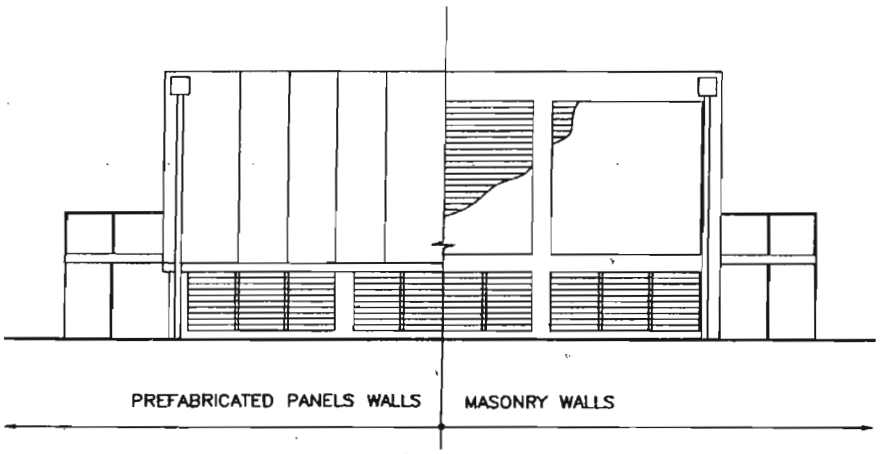
SWITCHROOM FLOOR

NOTES:

1) FOR SECTION "A–A",SEE FIGURES 23 & 24.

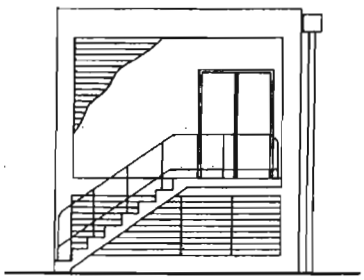
2) SEE ALSO NOTE (1) FOR FIGURE 20.

FIGURE 20 – 5m WIDE SUBSTATION BUILDING–ELEVATIONS



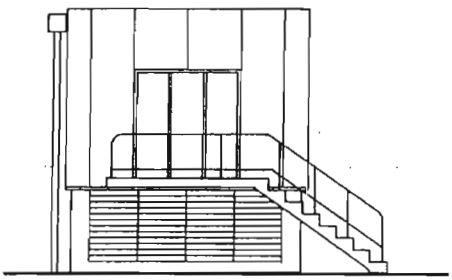
ELEVATION – A

(REFER TO FIG.19)



ELEVATION – B

(REFER TO FIG.19)



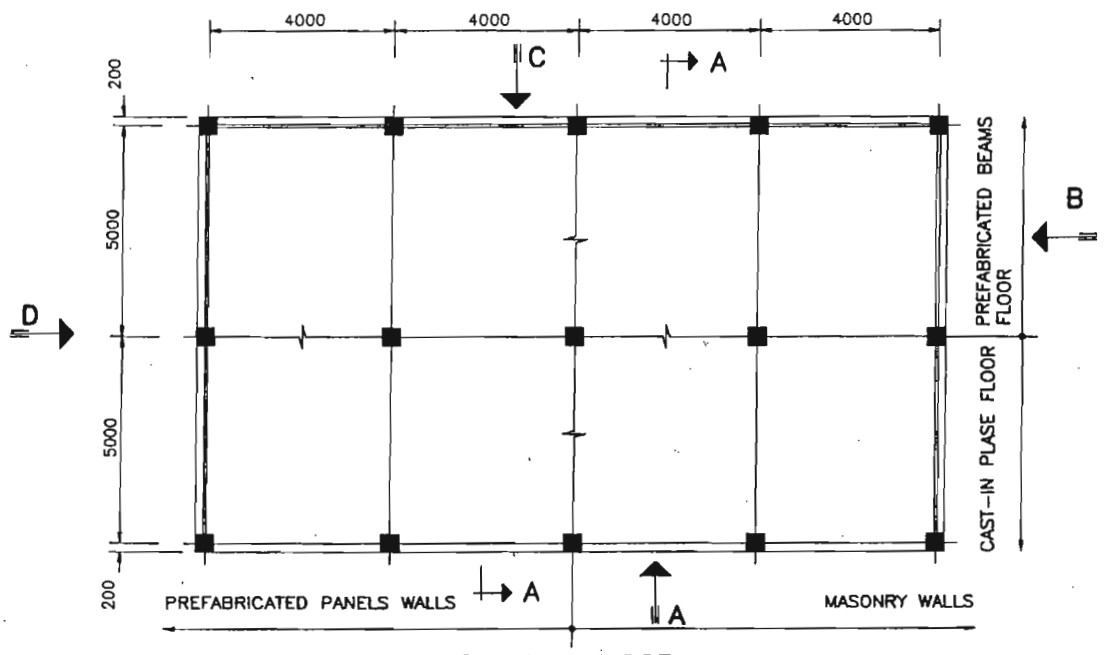
ELEVATION – D

(REFER TO FIG.19)

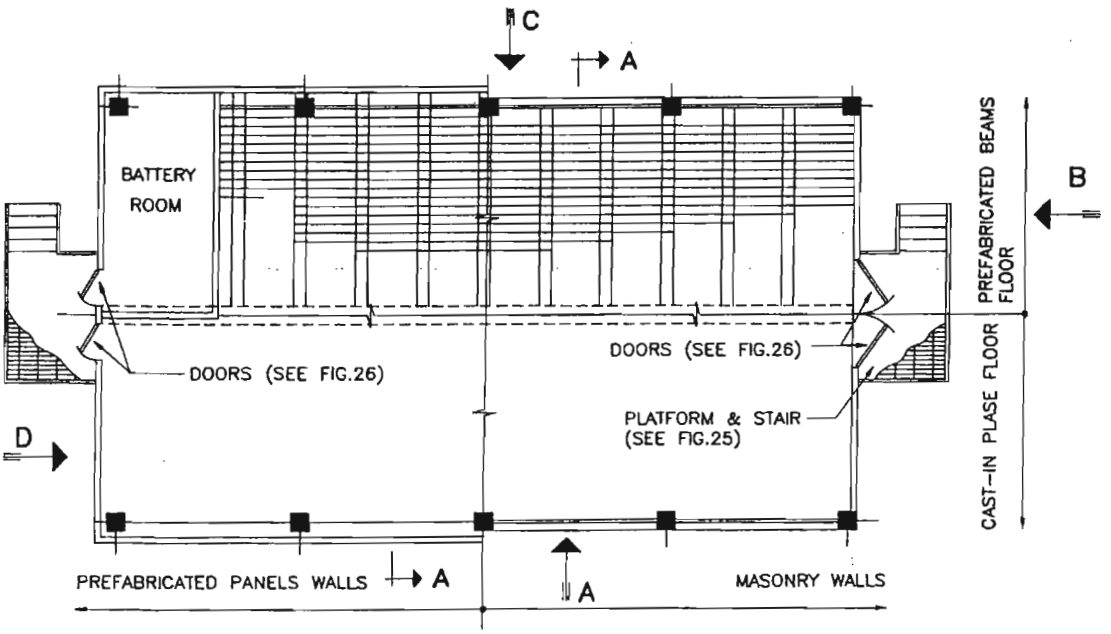
NOTES:

1) ARE NOT SHOWN ON THE WALLS THE OPENINGS (IF ANY) FOR: PRESSURIZING AND COOLING EQUIPMENT, BATTERY ROOM VENTILATION AND BUS BAR DUCT, WHICH WILL BE DEFINED TIME BY TIME.

FIGURE 21 – 10m WIDE SUBSTATION BUILDING–PLANS



GROUND FLOOR

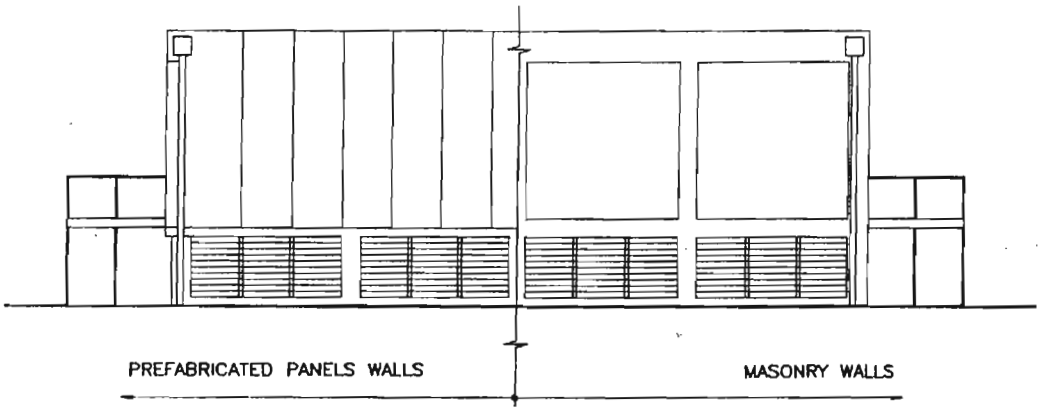


SWITCHROOM FLOOR

NOTES:

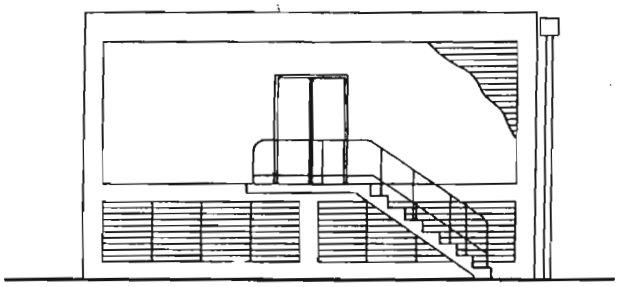
1) FOR SECTION "A–A" SEE FIGURES 23&24.
2) SEE ALSO NOTE "1" FOR FIGURE 20.

FIGURE 22 – 10m WIDE SUBSTATION BUILDING–ELEVATIONS



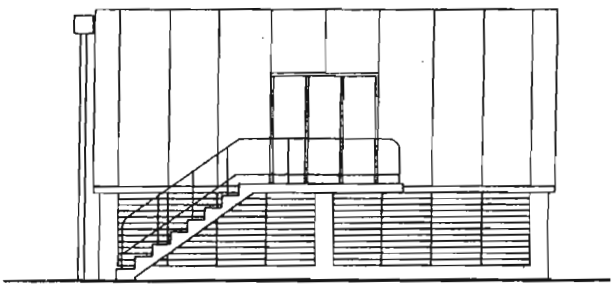
ELEVATION – A

(REFER TO FIG.21)



ELEVATION – B

(REFER TO FIG.21)



ELEVATION – D

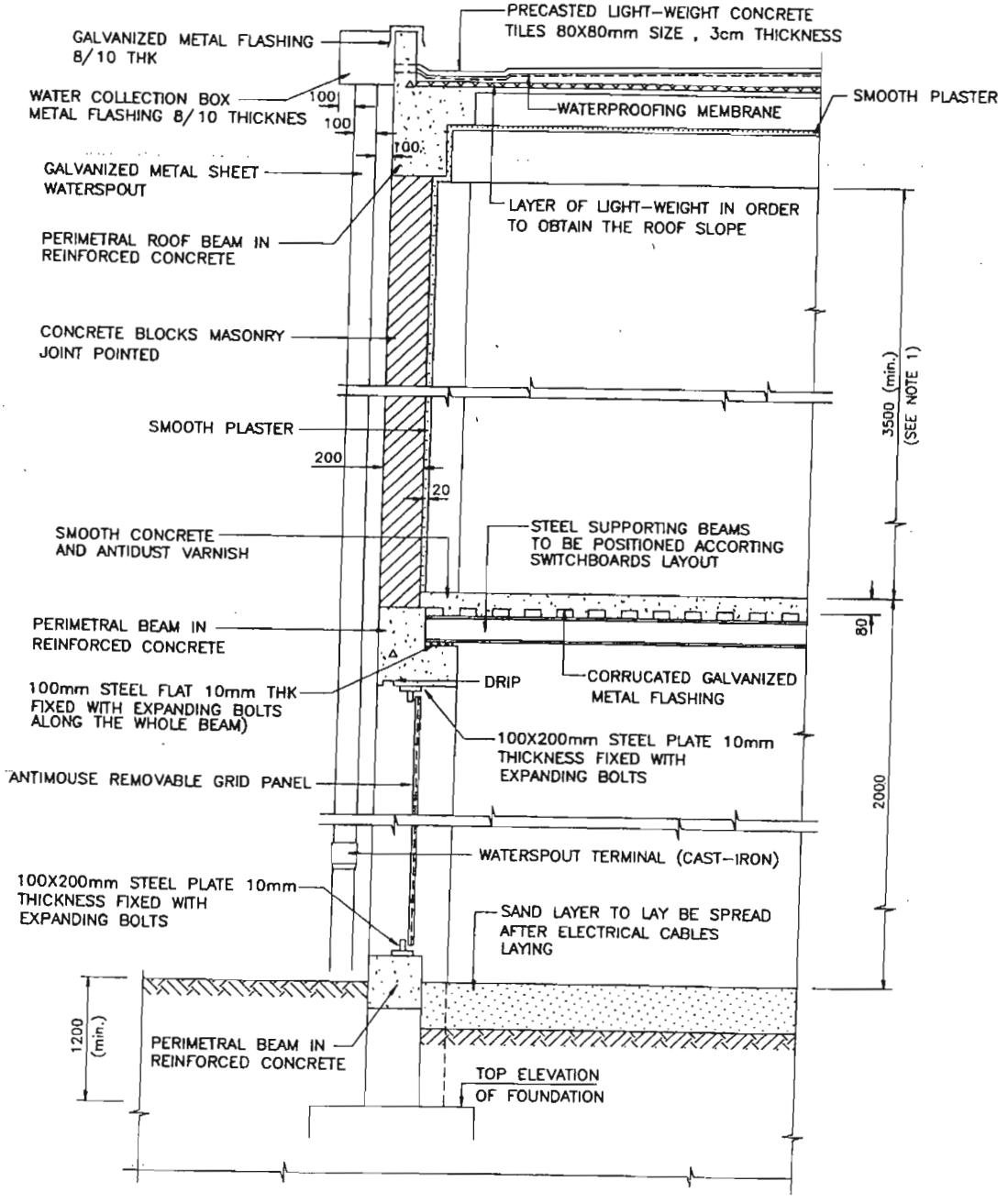
(REFER TO FIG.21)

NOTES:

1) SEE ALSO NOTE 1, FOR FIGURE 20.

FIGURE 23 – SECTION "A–A" (REFER TO FIGURES 19 AND 21)

(TYPICAL SECTION FOR PREFABRICATED BEAM FLOOROWIZED METAL FLASHING

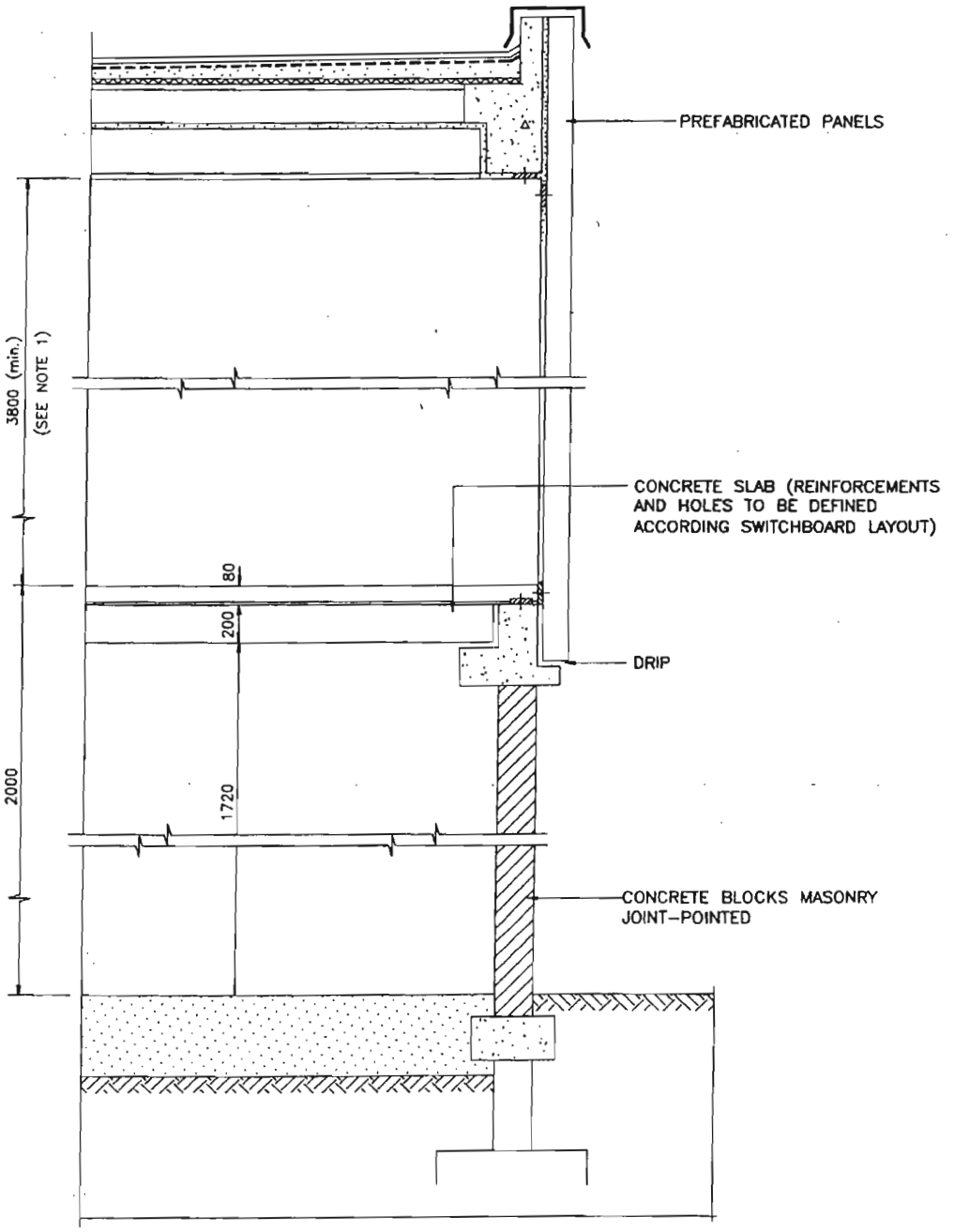


NOTES:

1) SEE FIGURE 13

FIGURE 24 – SECTION "A–A" (REFER TO FIGURES 19 AND 21)

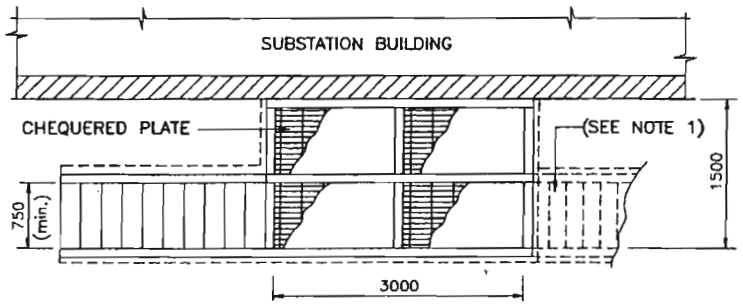
TYPICAL SECTION FOR CAST–IN–PLACE FLOOR)



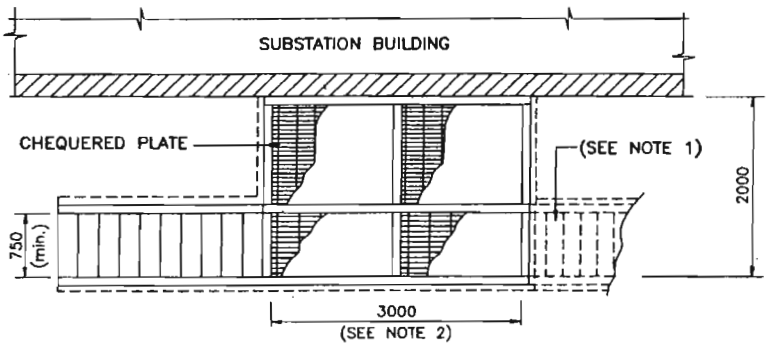
NOTES:

1) SEE FIGURE 13.

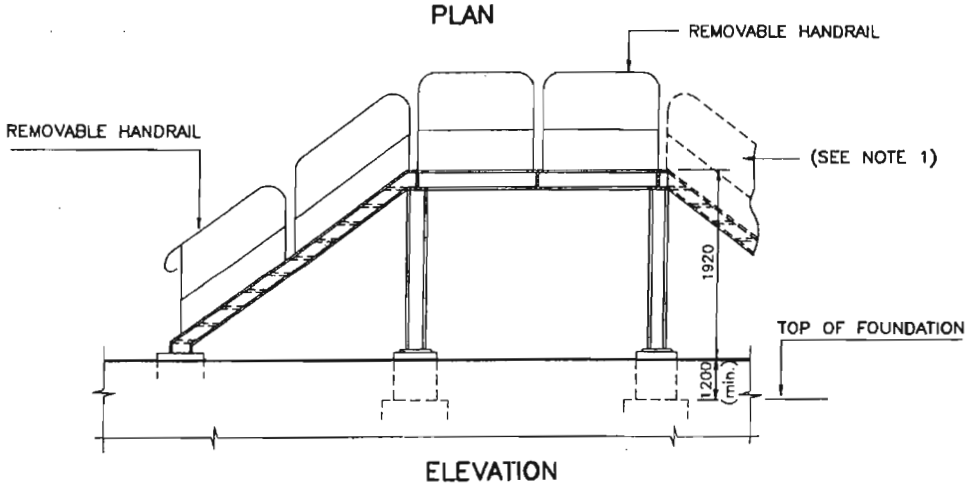
FIGURE 25 – PLATFORMS AND STAIRS



PLATFORM & STAIR AT PERSONNEL DOOR
PLAN



PLATFORM & STAIR AT EQUIPMENT DOOR
PLAN

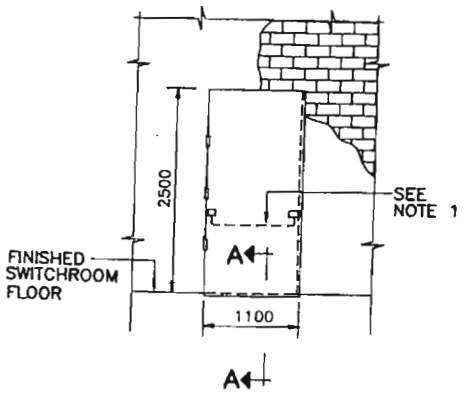


ELEVATION

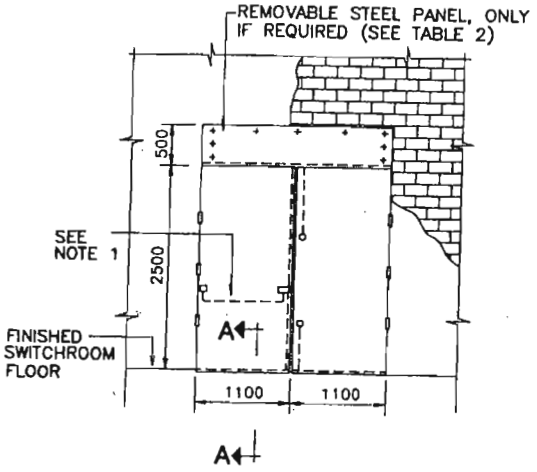
NOTES:

1) ALTERNATIVE POSITION OF STAIRS, SEE SUBSTATION LAYOUT.
2) DIMENSION TO BE INCREASED TO 3800 FOR PLATFORM AT EQUIPMENT DOOR WITH THREE PANEL (TOTAL WIDTH 3300).

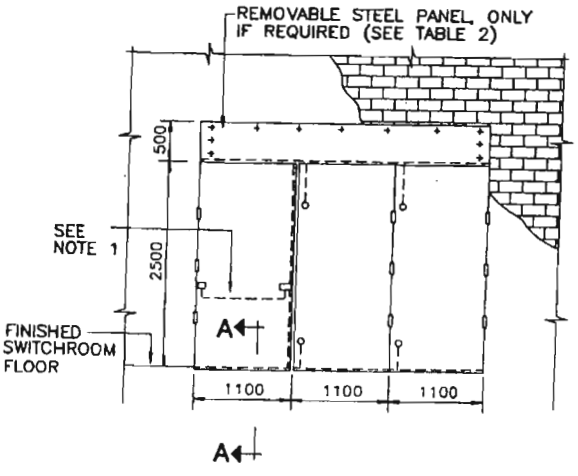
FIGURE 26 – DETAIL OF DOORS



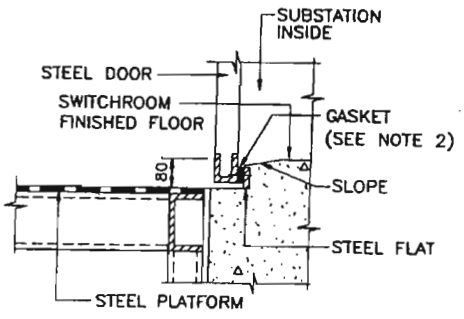
PERSONNEL DOOR



EQUIPMENT DOOR TYPE "A"



EQUIPMENT DOOR TYPE "B"

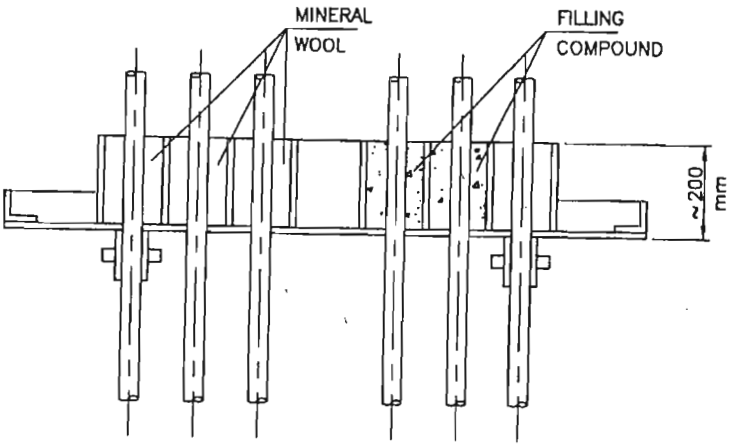


SECTION "A–A"

NOTES:

1) QUICK OPENING LOCK (PANIC HARDWARE)
2) ONLY IF REQUIRED FOR PRESSURIZED SUBSTATIONS.

FIGURE 27 – TRANSIT SEALING
(SOLUTION–N°1)



SECTION "A–A"

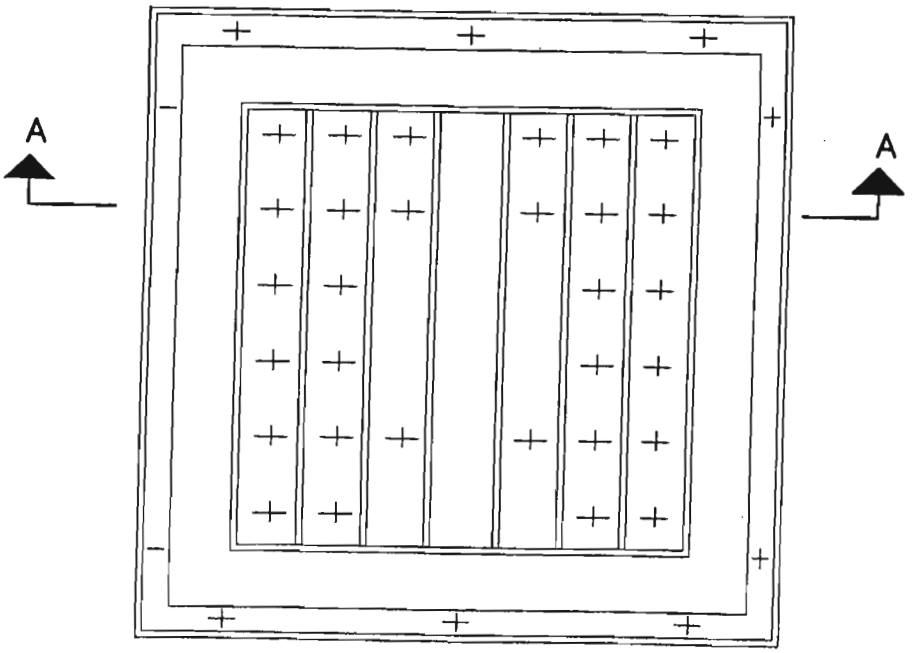
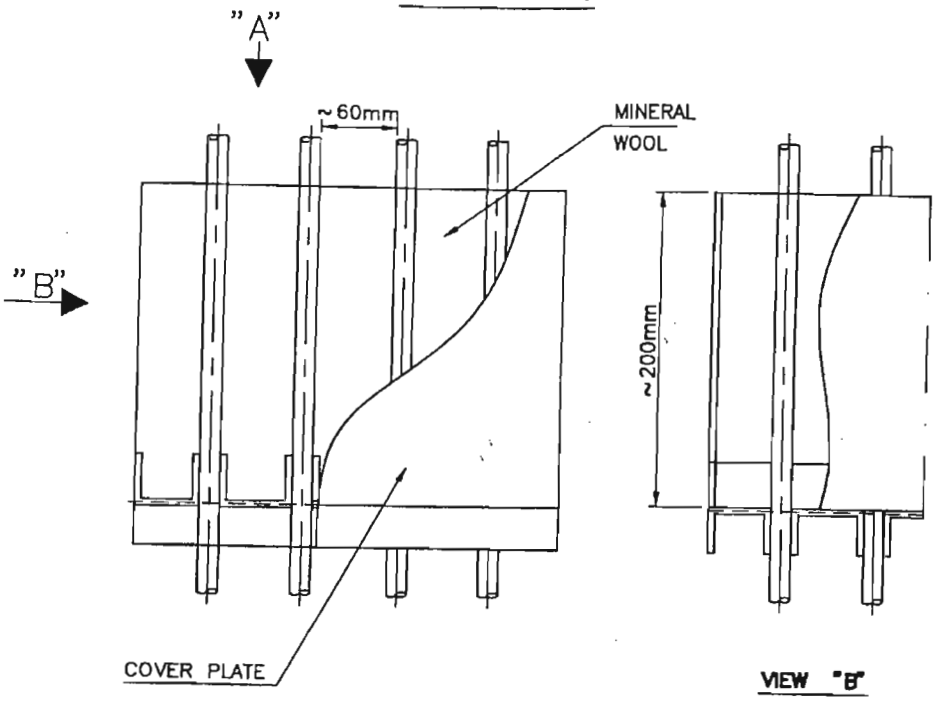
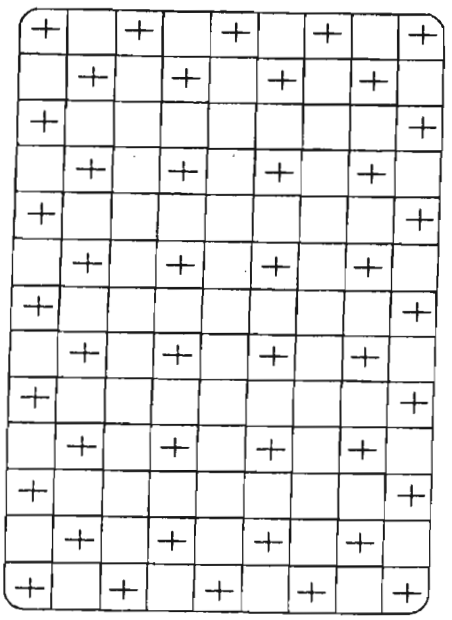


FIGURE 28– CABLE TRANSIT SEALING
(SOLUTION–N°2)



VIEW "B"



VIEW "A"