Palestine Polytechnic University

College of Engineering

Design of lightning and over-voltage protection system for building (B+) at PPU campus

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جامعة بوليتكنك فلسطين
كلية الهندسة
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Design of lightning and over-voltage protection System for building (B+) at PPU campus

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بناءَ على توجيهات المُشرف على المشروع وبِموافقت جميع أعضاء اللجنة المُمتحنة، تَم تقديم هذا المشــروع إلى دائرة الهندســة الكهربائية للوفاء بمتطلبات الدائرة لِدرجت البكالوريوس.

توقيع المشرف

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توقيع اللجنة الممتحنة

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توقيع رئيس الدائرة

....

الملخص :

" تصميم نظام الحماية من الصواعق والجهد الزائد لمبنى (+ B) في حرم جامعة بوليتكنك فلسطين "

يهدف المشروع إلى دراسة اللوائح والقوانين الخاصة بالحماية من الجهد الزائد في فلسطين. وكذلك تصميم نظام الحماية من الجهد الزائد لمبنى +B في الحرم الجامعة بوليتكنك فلسطين الذي يشمل على الأجزاء الخارجية والأجزاء الداخلية. بالإضافة الى كتابة المواصفات الخاصة بنظام الحماية من الصواعق (LPS).

Abstract

The aim of the project is to study the regulations and laws of over-voltage protection in Palestine. Design of over-voltage protection system for building B+ at PPU campus includes the external parts and internal parts. And Write specifications for the designed Lightning Protection System (LPS).

Acknowledgements

We firstly admit all our praise to Allah, thanks for his gracing and giving which enabled us to finish this work as perfect as it is. We also send our pleasing and peace upon his prophet Mohammed the mercy and teacher for the mankind. Out thanks continued to our parents for their effort and care, to our lecturers for their support and instructions, and to friends and all those who helped us to end this work.

Contents

Abstract **iii**

Acknowledgements **iv**

Contents **v**

List of Figures **vii**

List of Tables **ix**

1 Introduction **2**

1.1 Problem Definition 2

1.2 Motivation 3

1.3 Solution 3

1.4 Project Objectives 4

1.5 Economical study 4

2 Lightning protection system **8**

2.1 Damage from Lightning 8

2.2 Lightning Protection Design Process 11

3 Design Process **24**

3.1 Step#1: Characteristics of the Structure to Be Protected 24

3.2 Step#2: Risk Assessment Study 27

3.2.1 Software Method For Performing The Risk Assessment Study . . 27

3.3 Step#3: Selection Of External LPS Type and Material 31

3.4 Step#4: Sizing of Air Termination System Components 32
3.5 Step#5: Design of Down-Conductor System 33
3.6 Step#6: Design of Earth Termination System 35
3.6.1 Grounding Electrode Subsystem (Earth Termination System) . . 35
3.6.2 Functions of Grounding Electrode Subsystem 36
3.6.3 Resistance value for Grounding Electrode Subsystem 36
3.6.4 Earth Termination System Testing 41
3.7 Step#7: Design of Internal LPS System 41
3.7.1 General procedure for SPD selection and installation 43
3.7.2 Minimum cross-sections for lightning 46

4 Conclusion and recommendations 51
4.1 Problems 51
4.2 Solutions of the problems. 52
4.3 Recommendations 52

Bibliography 54

Appendix 56

A IEC 62305 Standards for Lightning Protection 57
A.1 Installation standards 58
A.2 Work Contracts 60
A.3 Product standards 61
A.3.1 Temporary over-voltage (TOV) 63

B Earthing Calculation for (Building B+ at PPU campus) Using Exel Sheet 64

C Design Drawings 74

D Equipment specification of lightning protection system 84

E Prototype model of project 98

List of Figures

2.1 How Lightning Creates Damaging Voltages Inside the Home. The most common source of damage is from strikes to power and communications lines, which then conduct the surges directly into the equipment. Direct strikes to the building, while rare, can damage the structure as well as the contents. 9
2.2 Lighting protection design process 11
2.3 Types of loss and corresponding risks resulting 15
2.4 conductor materials 16
2.5 External lightning protection system, vertical air-termination rod 19
2.6 The General block diagram to design process for lightning protection systems 22

3.1 The building B+ Which we are studying and applying protection 25
3.2 Start Window for RAPAL Software 28
3.3 The Construction Of RAPAL Software 29
3.4 Calculated Risks for Structure Sub-Window 30
3.5 Calculated Risks for Services Sub-Window 31
3.6 The height of the reference plane for vertical air termination rod 33
3.7 The air terminal of the ABB type (PULSAR P3S) 33
3.8 Distribution of down conductor on the building and air termination position 35
3.9 SPDs used in a TT system 42
3.10 Flow chart for identification of surge protection device 44
3.11 TT system (230/400 V); 3+1 circuit 45

3.12 Recommended maximum cable lengths of surge protective devices in the cable branch (IEC 60364-5-53) 47
3.13 SPDs used in a TT system 48

List of Tables

1.1 Project Expected Cost 4
1.2 Prototype Project Cost 6

2.1 Selection of compatible materials 17
2.2 Suitability of air termination forms 18
2.3 Mesh size for mesh method 20

3.1 Distance between down conductors according to IEC 62305-3 (EN 62305-3) 34
3.2 Factors for parallel electrodes arranged in line 38
3.3 Factors for electrodes arranged in a hollow square 39
3.4 Coefficients for strip or round conductor electrodes 40
3.5 Classification of surge protective devices according to IEC 42
3.6 Lightning protection level 46

Preface

Chapter 1

Introduction

Lightning can cause over-voltage through direct strikes or indirect strikes [9], lightning direct stroke can be defined as the lightning stroke that directly hit any part of the electrical network, In most cases in power distribution lines. Indirect lightning stroke can be defined as the lightning stroke that does not directly hit any part of the electrical network, the induced over voltage is generated and travelled over the network, in order to protect against electrical lightning, the protection system must be designed based on two basic parts: external protection system (lighting protection system) and internal protection (surge protection devices (SPD)) [7] to study lightening protections system must be there must be complete knowledge: risk assessment of lightning and its impact on the building determine the building's need for the protection system how the protection system can provide protection for all areas of the building define the requirements to be used to protect buildings against lightning. The requirements for construction of air termination system, down conductors, earthing system, joints and bound, testing joint for external part ,and surge protection devices (SPD), equipotential bonding for internal part [3].

1.1 Problem Definition

In this project, we will design of lightening and over-voltage protection system for building B + at PPU campus. The purpose of choosing on this building is due to several important factors. First: building B+ have high elevations and highest building in the region, which is subject to the damage of this risk a high probability. Second: the building B+ contains large number of expensive equipment in buildings, the sudden rise in the value of the voltage threatens to destroy these devices also leads to significant material losses at the level of institutions and individuals, which protects them from lightning strikes as a major requirement.

1.2 Motivation

The Project aims to design of over-voltage protection system for building B+ at palestine polytechnic university PPU campus. The over-voltage protection laws are neglected by individuals and local government in Palestine additional to mentioned protection measures we want to highlight the over-voltage protection by using a practical protection system. The practical protection system1‘ will include the external part requirements for construction of (air terminals, down conductors, bonding to metal, connectors, and ground electrodes). And the suitable internal part (SPD I, SPD II, and SPD III).

1.3 Solution

The solution to this problem is the risk assessment process for the building, which is one of the most important design steps because it is the point of knowing if there is a need for a lightning protection system for this building and knowing the protection measures required when needed. The next step is to carry out the required protection measures, namely the design of an external protection system or internal protection system or both, according to risk assessment results.

During this project, we will attract attention from the community and official agencies to the importance of protection from lightening and over-voltage protection system through external components and also the internal components of protection systems.

1.4 Project Objectives

1. Design of over-voltage protection system for building B+ at palestine polytechnic university PPU campus.

2. To provide safety for the building B+ and occupants by preventing damage to building structure caused by lightning.

3. We will attract attention from the community and official agencies to the importance of protection from lightening and over-voltage protection system through external components and also the internal components of protection.

1.5 Economical study

The following table shows the project expected cost.

Table 1.1: Project Expected Cost

Item Name	**Number of unit**	**Price ($/unit)**	**Price($)**
$95mm^2$ **soft drawn stranded bare Copper conductor-Ground loop (CB095)**	120 m	8.60	1032
Vertical Earth Rod (RB215) 5/8" ϕ, 1.8m	6	20.47	122.82
Concrete inspection pit (PT006)	7	44.17	309.19
Green/yellow PVC insulated $70mm^2$ **stranded earthing conductor (CC070)**	40 m	7.72	308.8
Fourteen way earth bar length - 925 mm (LK243-14)	1	140.92	140.92
Stranded bare copper conductor $70mm^2$ **down conductor (CB070)**	200 m	6.40 per meter	1280

Item Name	**Number of unit**	**Price ($/unit)**	**Price($)**
Air termination base flat saddle (SD160)	1	28.31	28.31
Air termination PULSAR P3S (2CTH030007R0000)	1	940	940
Cable to cable Square clamp (CR815)	6	15.50	309.19
One hole cable clip Spacing $70mm^2$ **(CP915)**	140	11.60	1624
Disconnecting Link (Text point) (LK205)	6	35.13	210.78
Green/yellow PVC insulated $16mm^2$ **2 stranded earthing conductor**	100m	4.35	435
$95mm^2$ **conductor to 5/8** ϕ **rod furse weld joint (CR2-4-14295 0)**	6	5.62	33.72
$95mm^2$ **conductor conductor furse weld joint (CC2 -4-9595)**	50	3.40	170
PVC protection down conductor guard (GC225)	6	12.94	77.64
Underground Warning & Location Tape (TP120-FU)	3	43.57	130.71
SPD Type 1 (OVR 3N 15 275) (2CTB813913R0400)	1	406.03	406.03
SPD Type 2 (OVR T1 3N 25 255) (2CTB815101R1600)	9	300.35	2703.15
Other	-	-	120
Total			10382.26

Table 1.2: Prototype Project Cost

Item Name	**Number of unit**	**Price ($/unit)**	**Price($)**
Piece of wood	180 m^2	66.98	66.98
Plastic panel	2	7.50	15
Molded Case Circuit Breaker	1	13.07	13.07
Residual Current Device	1	20.43	20.43
Fuse	9	8.04	72.36
1/2 automatic 16 A	1	5.23	7.23
SPD Type 1	1	16.07	16.07
SPD Type 2	1	16.07	16.07
SPD Type 3	1	8.04	8.04
Wire's and Cable	**-**	5	5
Total			240.25

Lightning protection system

Chapter 2

Lightning protection system

2.1 Damage from Lightning

People generally think of lightning damage as what happens at the point where a cloud-ground stroke terminates on a tree, structure, or elevated wiring. This is generally called a lightning strike. Unless the struck items are protected from lightning, the results of the strike are often visible and lasting. But the lightning current pulse continues into conductive parts of the structure, cables, and even underground wiring and pipes. Because the initial lightning impulse is so strong, equipment connected to cables a mile (1.6 km) or more from the site of the strike can be damaged [9].

Figure 2.1 shows four ways in which a lightning strike can damage residential equipment, in order of decreasing frequency of occurrence. The most common damage mode shown in Figure 2.1 (mode 1) arises from a lightning strike to the network of power, phone and cable television (CATV) wiring. This network, especially if it is elevated, is an effective collector of the lightning surges. The wiring then conducts the surges directly into the residence, and then to the connected equipment. While not shown in Figure 2.1, lightning can also travel through the ground (soil), reaching underground cables or pipes. This is another route for lightning to come into a building, and can also damage the cables.

The second most common (mode 2) shown in Figure 2.1 results from strikes to, or near, the external wiring network common to most suburban and rural houses. Air conditioners, satellite dishes, exterior lights, gate control systems, pool support equipment, patios and cabanas, phone extensions, electronic dog fences, and security systems can all be struck by lightning, and the lightning surges will then be carried inside the house by the wiring.

As shown in Figure 2.1, lightning may strike nearby objects (trees, flagpoles, signs) that are close to, but not directly connected to the house (mode 3). In this situation, the lightning strike radiates a strong electromagnetic field, which can be picked up by wiring in the house, producing large voltages that can damage equipment.

Finally, Figure 2.1 shows (mode 4) a direct lightning strike to the structure. It can severely damage a structure without a lightning protection system (LPS), and will generally damage most electronic equipment in the house [10]. The structure damage can normally be prevented by a properly installed LPS of Faraday rods and down conductors, but the LPS alone provides little protection for the electronic equipment in the house.

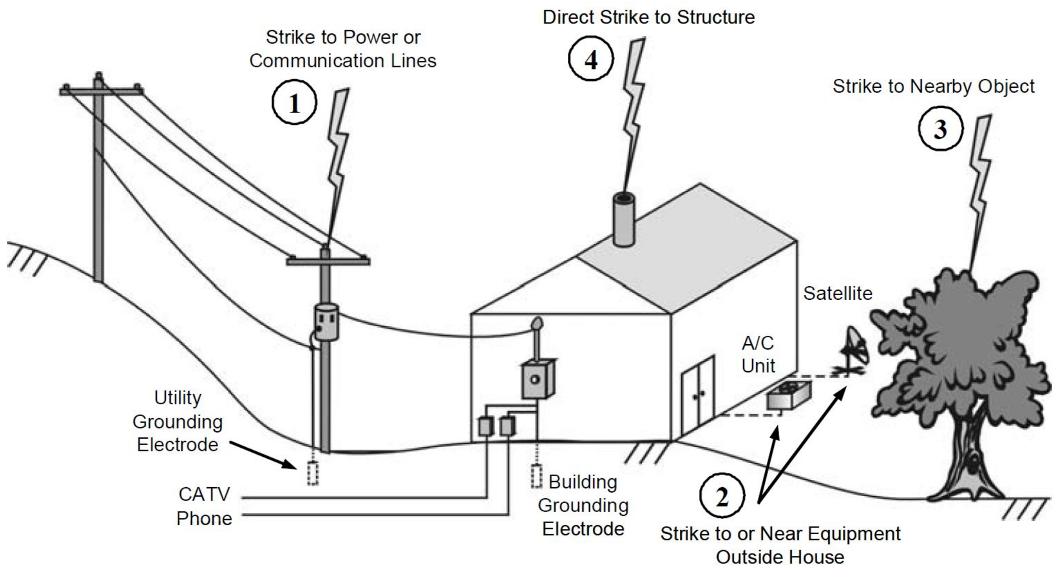


Figure 2.1: How Lightning Creates Damaging Voltages Inside the Home. The most common source of damage is from strikes to power and communications lines, which then conduct the surges directly into the equipment. Direct strikes to the building, while rare, can damage the structure as well as the contents.

There are several factors that cause instantaneous rise in voltage and moments that do not exceed 100 microseconds. These include:

- Tern on and off in electric networks that contain large motors (large inductive load) or capacitors. The high-voltage pulse in this case continues between micro-seconds and 50 milliseconds (5μ - 50ms).
- Inductive effect of electric current generated by air lightning. The high voltage pulse in this case continues from 50 ns to 1 mS (50ns -1ms).

The peak of the high voltage pulse may reach tens of times the nominal voltage of the electrical devices. Therefore, protection methods must be provided to ensure that the electrical voltage of the electrical system is determined at a certain limit.

The hazards caused by lightning can be divided into two types:

- Direct hazards, including fires caused by the lightning current when struck in a place. As well as the destruction of houses and facilities due to the explosive effect of the rapid evaporation of liquids contained in the house or facility such as water tanks and even liquids containing concrete, wood, etc., caused by the great impact of lightning.
- Indirect risks, including the destruction and burning of electrical equipment in the facility because of high voltage due to the electrical impact of the electrical current caused by the lightning. Induction induction of the lightning current may reach the homes and facilities very far from the place hit by lightning and enter the electrical system through electrical wiring [7]. Therefore, any lightning protection system to be integrated must contain an external protection system that is required to protect against direct shock hazards and an internal protection system to protect against indirect impact.

The design process of lightning protection systems is commonly broken into discrete phases, allowing the lightning protection designer to present an integrated design package. These phases can be listed as follows, a quality assurance is required in each phase. Planning phase. Consultation phase. Detailed Design phase.

2.2 Lightning Protection Design Process

The Lightning Protection Design Process involves a number of design steps as in figure 2.2 [8], we will use these steps to design the protection system for building B+ .

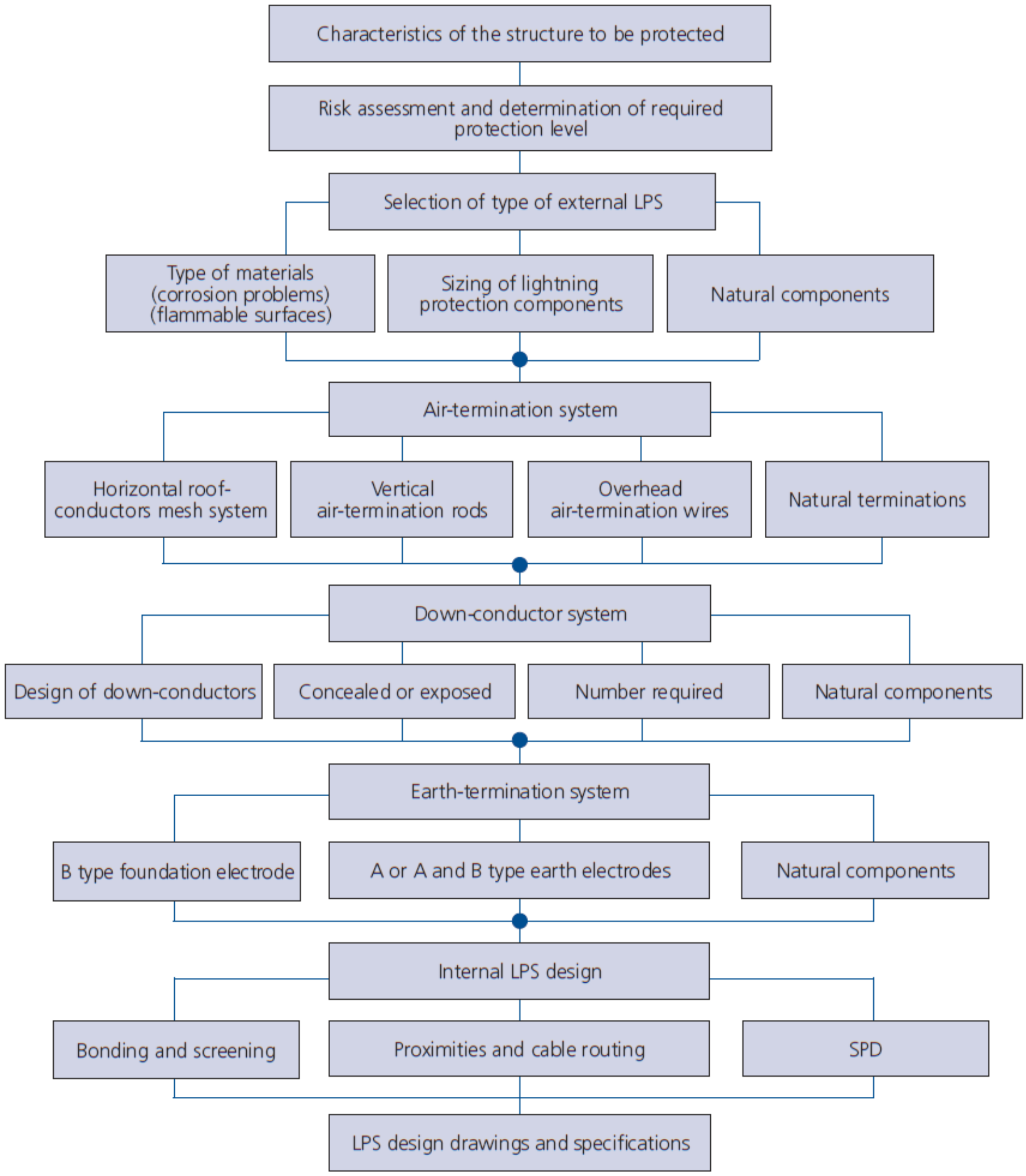


Figure 2.2: Lighting protection design process

Step#1: Characteristics of the Structure to Be Protected

When Lightning strikes affecting a structure, the Characteristics of the structure will determine the damage level to the structure itself and to its occupants and contents, including failure of internal systems. The damages and failures may also extend to the surroundings of the structure and even involve the local environment. The Characteristics of the structure include:

- The design of the building.
- The environment around the building.
- The material in the building.
- The number of lightning strikes to earth in the area of the building.
- The value of the building and its contents.
- Sensitive electronics in the building.
- Loss of revenue In the event of breakdown.
- Escape facilities and number of staff in the building.
- Fire protection in the building.
- The historical and cultural value of the building.
- The social function of the building.
- Cable laying up to the building.
- Conductivity of the ground in the area of the building.
- The risk to the surroundings.

Step#2: Risk Assessment Study

The benefits from performing the risk assessment study are to: It provides the basis on which decisions can be made in order to limit the risks for a given structure. It makes clear which risks should be covered by insurance. It is used to Objectify and quantify the risk to buildings and structures, and their contents, as a result of direct and indirect lightning strikes. Determine if lightning protection is required or not. if required, to select the appropriate lightning class which determines the minimum lightning protection level (LPL) that is used within the lightning protection design.

The decision to provide lightning protection may be taken regardless of the outcome of risk assessment where there is a desire that there be no avoidable risk. Lightning protection can be installed even when the risk management process may indicate that it is not required. A greater level of protection than that required may also be selected. Local regulations requirements, if any, may be applicable and have to be taken into account.

- Manual Method (equations and tables method),which will be explained as per: IEC 62305-2.

Procedure For Performing The Risk Assessment Study By Manual Method

Procedure for performing the risk assessment study includes three parts as follows:
Part#1: evaluating Need for lightning protection.
Part#2: Determination of Required Protection Level.
Part#3: evaluating the cost-effectiveness of protection measures.

To evaluate the need of lightning protection, the following steps need to be carried out a follows: **Step#2-1-1**: Identify the structure to be protected.
Step#2-1-2: Identify the types of loss relevant to the structure to be protected Rn, where:

R1 risk of loss of human life.

R2 risk of loss of services to the public.

R3 risk of loss of cultural heritage.

Step#2-3: For each loss to be considered, identify the tolerable level of risk RT (tolerable means still acceptable).

Step#2-1-4: For each type of loss to be considered , identify and calculate the risk components Rx that make up risk Rn which are: RA, RB, RC, RM, RU, RV, RW, RZ (Risk Components related to Source and Type of Damage).

Step#2-1-5: Calculate Rn = Σ Rx

Step#2-1-6: Comparing the calculated actual risk Rn of each loss to a tolerable level of risk (RT), then we have two cases: Case#1: If the calculated risk Rn is equal or less than the respective tolerable risk RT i.e. Rn ? RT , then Structure is adequately protected for this type of loss and no lightning protection is required for this type of loss, Case#2: If the calculated risk Rn is higher than the tolerable risk RT i.e. Rn ¿ RT, then Install lightning protection measures in order to reduce Rn.

Step#2-1-7: go back to **step#2-1-4** and make a series of trial and error calculations until the risk Rn is reduced below that of RT (Rn ? RT). Each primary risk Rn (R1 to 3) is composed of several risk components Rx. Each risk component Rx relates to a different relationship between source of damage (S1, S2 and S3) and type of damage (D1, D2 and D3) as shown in figure 2.3.

Step#3: Selection Of External LPS Type and Material

The correct choice of material, configuration and dimensions of the lightning protection components is essential when linking the various elements of an LPS together. The designer/user needs to know that the components, conductors, earth electrodes etc will meet the highest levels when it comes to durability, long term exposure to the environmental elements and perhaps most importantly of all, the ability to dissipate the lightning current safely and harmlessly to earth. Various standards series have been compiled with this very much in mind. At present these standards in appendix A.3.

Material Requirements for Conductors and Air Terminations. All lightning protection materials should conform to EN 50164-1 and EN 50164-2 Lightning Protection

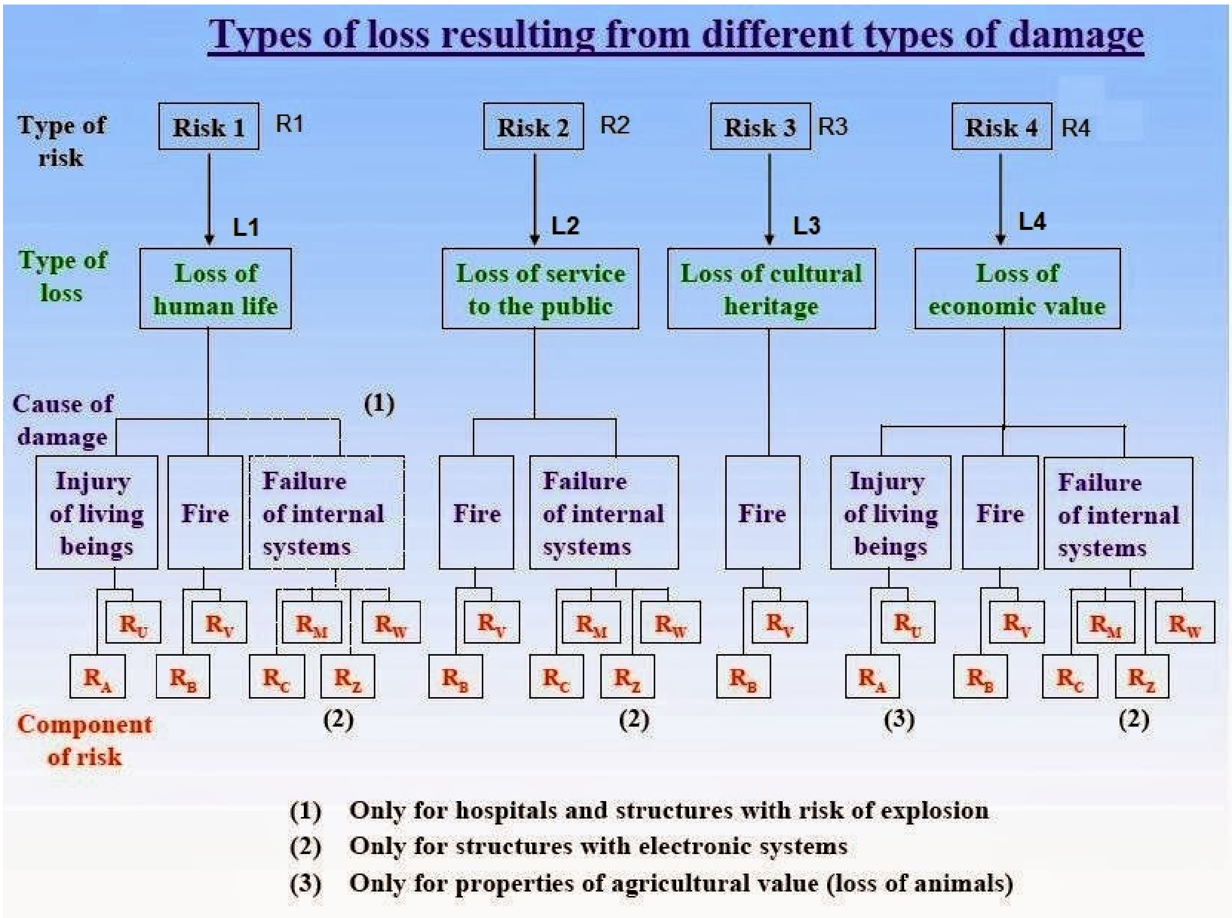


Figure 2.3: Types of loss and corresponding risks resulting

Components requirements. The exceptions to these requirements are non-current carrying devices such as down-conductor fixings (clips), anti-vandal guards and mechanical supports. The IEC standards prescribe the minimum material requirements as summarized in the figure 2.4.

Material	Arrangement	Minimum cross section (mm^2)	Notes
Copper & tin plated copper	Tape	50	2 mm minimum thick
	Solid round (1)	50	8 mm diameter
	Stranded	50	1.7 mm minimum diameter of each strand
	Solid round air-terminal (2)	200	16 mm diameter
Aluminum & Aluminum alloy	Tape (3)	70	3 mm minimum thickness
	Solid round	50	8 mm diameter
	Stranded	50	1.7 mm minimum diameter of each strand
	Solid round air-terminal (2)	200	
Galvanized & stainless steel	Refer to standard		
Natural components	Refer to ***Section 8***		

Notes:

(1) 50 mm^2 (8 mm diameter) may be reduced to 28 mm^2 (6 mm diameter) where mechanical strength is not an essential requirement

(2) For air-terminals of 1 m or less, 10 mm diameter may be used

(3) 50 mm^2 with a minimum 2.5 mm thickness may be used with aluminum alloy

(4) Materials may be covered with PVC for aesthetic purposes

*(5) Refer to **Section 21** for review of differences in requirements between EN 50164-2 and IEC 62305-3*

Figure 2.4: conductor materials

Use of Dissimilar Metals, Galvanic corrosion occurs when two dissimilar metals are in contact with each other in the presence of an electrolyte. In this situation, one metal becomes the anode and the other the cathode. The anode will tend to go into solution and therefore corrode. The electrolyte can be water with impurities from the air, other surfaces or from the metal itself. The following Table 2.1 shows the material of structure and its LPS compatible material:

Table 2.1: Selection of compatible materials

Structure meterial	**Most suitable LPS material**
Aluminium	Aluminium
cost iron	Aluminium or tin plated copper
copper	copper
Gunmetal, bronz,ets	copper
Steel (galvanized)	Aluminium
Steel (stainless)	Aluminium or tin plated copper
Steel	Aluminium
Tin	Aluminium or copper
Zinc	Aluminium

use natural conductive components can be used as an integral part of the lightning protection system. Natural components are typically metallic structural items that will not be modified during the life of the structure, such as reinforcing steel, metal framework and roofing/cladding. Natural components must meet minimum material requirements and be electrically continuous with secure interconnections between sections such as brazing, welding, clamping, seaming, screwing or bolts.

The following parts of a structure can be used as (natural components) of the lightning protection system: metal Installations, facade elements, mounting Channels and the metal substructures of facades, metal downpipes,rebar in Reinforced Concrete, rebar in precast Concrete, reebar in prestressed concrete.

Step#4: Sizing of Air Termination System Components

The different design methods can be applied to different regions of a single lightning protection system, provided the zones afforded by each method overlap to protect the entire structure. I.e. we can use the three methods together in designing one complete LPS for given structure. Generally most of the standards consider the three methods as equivalent, although there are limits on the application of the protection angle and mesh methods as in table 2.2 [5]

Table 2.2: Suitability of air termination forms

The Rolling Sphere Method (RSM)	The rolling sphere method is recommended as the most universal and most effective method. The rolling sphere method generally provides the most optimized design and the vertical air-terminal is far more effective at capturing lightning flashes than mesh conductors installed upon, or just above structure surface.
The Protection Angle Method (PAM)	The protection angle method can only be used with limited vertical distances (limited height).
The Mesh Method	The mesh method is more suitable for the protection of flat/plane surfaces.

Meshed conductors used as air-terminations should not be confused with the mesh method. While the mesh method requires the use of surface mounted meshed conductors (a grid) to protect flat surfaces, the rolling sphere and protection angle method can also be used to determine protection provided by elevated meshed conductors to protect a variety of compound surfaces.

The protection angle method is most commonly used to supplement the mesh method, providing protection to items protruding from the plane surface (roof mounted structures like antennas, ventilation pipes). Where the protection angle method alone is employed, multiple rods are generally required for most structures.The protection angle method can be used on : simple shaped buildings with flat surfaces, simple shaped buildings with inclined surfaces, where the height of the rod is the vertical height, but the protection angle is referenced from a perpendicular line from the surface to the tip of the rod.

If air-termination rods are installed on the surface of the roof to protect structures mounted thereon, the protective angle ? can be different. In figure 2.5 the roof surface is the reference plane for protective angle ?1. The ground is the reference plane for the protective angle ?2. Therefore the angle ?2 according to Figure is less than ?1.

Mesh Method used for protection of plane (flat) roof structures and should not be

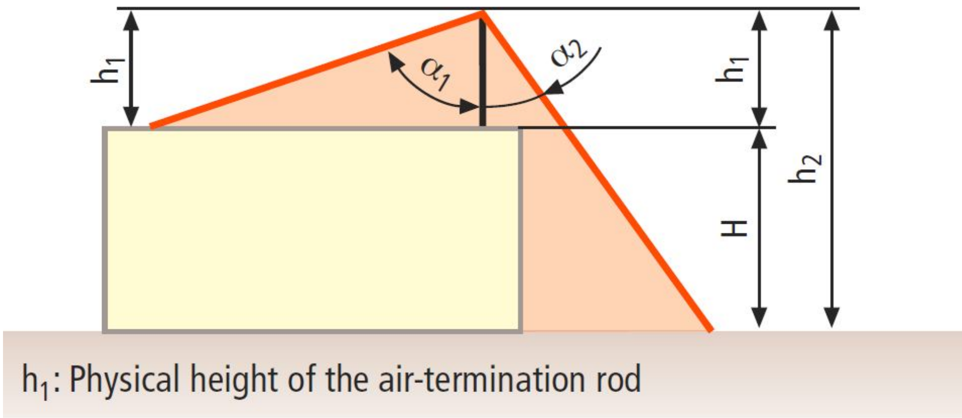


Figure 2.5: External lightning protection system, vertical air-termination rod

used on curved surfaces. so, it can be used on the following surfaces regardless of the height of the structure , horizontal flat-roof structure, sloped-roof structure, compound flat roof structure, compound shed roof structure such as industrial roofs, Vertical sides of tall buildings for protection against flashes to the side.

Conditions for Application of Mesh Method Protection. The mesh method is considered to protect the whole bound surface if the following five conditions are verified:
Condition#1: Air-termination conductors are positioned on:

- Roof edge lines.
- Roof overhangs.
- Roof ridge lines, if the slope of the roof exceeds 1/10 (5.7).

Condition#2: The mesh size of the air-termination network is in accordance with.

Condition#3: No metallic structures protrude outside the volume protected by air-termination systems.

Condition#4: From each point, at least two separate paths exist to ground/earth termination system (i.e. no dead ends), and these paths follow the most direct routes. Larger number of down-conductors results in reduction of the separation distance and

Table 2.3: Mesh size for mesh method

LPL	Mesh size
I	5 m x 5 m
II	10 m x 10 m
III	15 m x 15 m
IV	20 m x 20 m

reduces the electromagnetic field within the building.

Condition#5: The air-termination conductors follow, as far as possible, the shortest and most direct route.

Step#5: Design of Down-Conductor System

This Step was explained before in section **??**according to IEC 62305-3, the number of down conductors depends on the perimeter of the external edges of the roof (perimeter of the projection on the ground surface).(but at least two down-conductors should be used on a structure).

The down conductors must be arranged to ensure that, starting at the exposed corners of the structure, they are distributed as uniformly as possible to the perimeter. (Note: a down-conductor should be installed at each exposed corner of the structure, where this is possible). However an exposed corner does not need a down conductor if the distance between this exposed corner to the nearest down-conductors.

Step#6: Design of Earth Termination System

- Grounding Electrode Subsystem (Earth Termination System)
- Functions of Grounding Electrode Subsystem
- Resistance value for Grounding Electrode Subsystem
- Earth Termination System Testing

Step#7: Design of Internal LPS System

- Function of Internal Lightning Protection System
- Components Of The Internal Lightning Protection System
- Components Of Equipotential Bonding Subsystem
- Equipotential bonding conductors

Step#8: LPS Design Drawings and Specifications

after we complete designing , we drawing submitted all design as following using Auto-Cad Software.

- Location of all grounding.
- Location of all roof conductors.
- Location of all through-roof / through-wall assemblies.
- Location of all down conductors.
- Location of all air terminals.
- details of all bonding bars .
- details of all welding points to Rebars.
- details of all Roof Top Equipments.o
- Details for installation of different materials and equipments.
- Details for internal protection device .

The following picture 2.6 shows the general block diagram for project

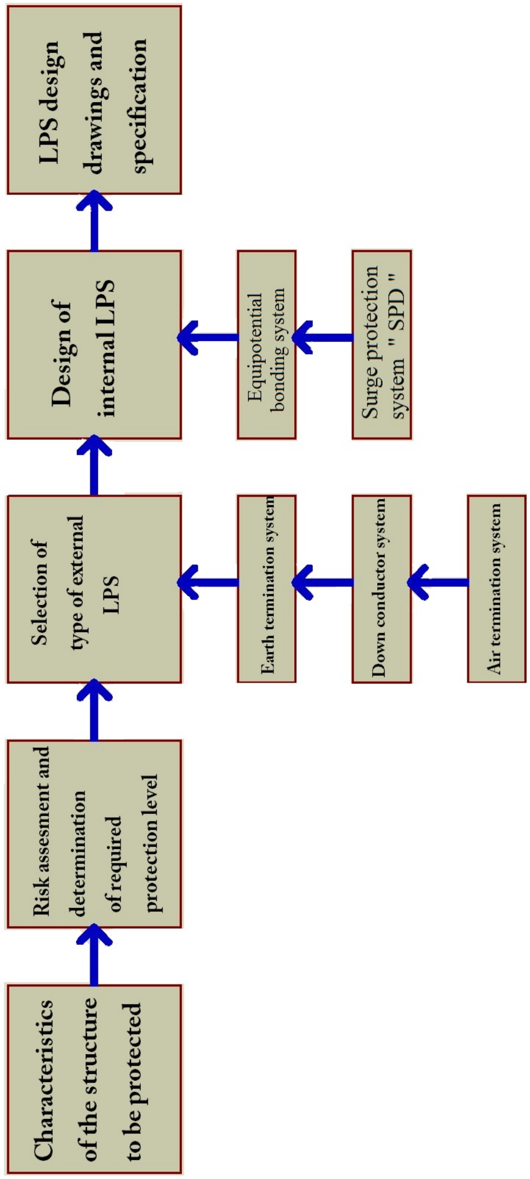


Figure 2.6: The General block diagram to design process for lightning protection systems

Design Process

Chapter 3

Design Process

As we said the lightning protection design process involves a number of design steps as in figure 2.2, we will use these steps to design the protection system for building B+ .

3.1 Step#1: Characteristics of the Structure to Be Protected

- **The Design Of The Building:** A building that is tall and has a large footprint has a greater likelihood of being struck by lightning. IEC Technical Report No 61662 "Assessment of the Risk of Damage due to Lightning" contains a method for calculating how often a building may be expected to be struck by lightning.
- **The Environment Around The Building:** The environment affects the probability that the building will be struck by lightning. If there are nearby buildings or if the buildings situated in a hollow, the risk of the building being struck is reduced. The method in IEC Technical Report No 61661 'Assessment of the Risk of Damage due to Lighting" can take into consideration these factors and the way they influence the likelihood of the building being struck by lightning.
- **The Material In The Building:** Ira material used in the building has an effect on the seriousness of the consequences of a lightning strike. If the material on the outside is electrically conductive, e.g. sheeting or reinforced concrete, there is

a certain natural lightning protection. These buildings tolerate a lightning strike better than buildings comprising non-conductive material such as timber or brick. A non-conductive material can be blown apart by the lightning strike.

Figure 3.1: The building B+ Which we are studying and applying protection

- **The Value Of The Building And Its Contents:** If lightning protection is to be installed merely to protect property, the cost of the lightning protection must be compared with the value of the building's content. Consideration must also be given to how unique these are Also the contents of the building must be reviewed to proive the adequate protection measure, if any, like for presence of combustible or noncombustible materials and presence explosive or non-explosive

- **Escape Facilities And The Number Of Persons In The Building:** For the safety of persons it is important to consider how many persons are regularly present in the building and if they have limited freedom of movement or reduced physical mobility. Statistically speaking, it is relatively improbable to be killed by lightning. This does not, however; mean that lightning cannot strike a place of assembly, in which case the consequences can be very serious.

- **The Social Function Of The Building:** If the building has an important social function, e.g. hospital, nuclear plant water, gas or electricity installation, major telecommunications installation and radio stations, alarm and surveillance centers, important installations for the police, military, rescue services and traffic control, a lightning protection may be needed. Other social functions of the building are dwelling house, office, farm, theatre, hotel, school, church, prison, department store, bank, factory, industry plant and sports area, a lightning protection should be determined by risk assessment. An assessment should be made of the consequences for the pubic if the installation is knocked out by lightning. It should also be assessed whether the function which these buildings have are especially important during thundery weather Or whether a breakdown then can be accepted.

- **Cable Laying Up To The Building:** If electric and telecommunications cables are completely laid in the ground, the risk that lightning current will be led into the building is less than if the cables are placed wholly or partly above ground. ”Assessment of the Risk of Damage due to Lightning” contains a method for calculating how often a building will be exposed to over-voltages.
- **The Risk To The Surroundings:** The risk to the surroundings should be considered if lightning protection is to be installed. This mainly applies to industries. For installations which must conduct a hazard analysis, lightning and also the effect of Lightning on the security system must be included as a hazard. The risk to the surroundings should be considered also for connected lines to the building (power lines, telecommunication lines, pipelines).

Effects Of Lightning On A Structure

Lightning affecting a structure can cause damage to the structure itself and to its occupants and contents, including failure of internal systems. The damages and failures may also extend to the surroundings of the structure and even involve the local environment. The scale of this extension depends on the characteristics of the structure and on the characteristics of the lightning flash [11].

3.2 Step#2: Risk Assessment Study

The benefits from performing the risk assessment study are to: It provides the basis on which decisions can be made in order to limit the risks for a given structure. And it makes clear which risks should be covered by insurance. And it is used to Objectify and quantify the risk to buildings and structures, and their contents, as a result of direct and indirect lightning strikes. Determine if lightning protection is required or not. If required, to select the appropriate lightning class which determines the minimum lightning protection level (LPL) that is used within the lightning protection design.

Important Notes: The decision to provide lightning protection may be taken regardless of the outcome of risk assessment where there is a desire that there be no avoidable risk. Lightning protection can be installed even when the risk management process may indicate that it is not required. A greater level of protection than that required may also be selected. Local regulations requirements, if any, may be applicable and have to be taken into account.

The risk assessment study can be done by (4) different methods as follows:

1. Manual Method (equations and tables method), this method is time-consuming and not always easy to apply the procedures and data given.
2. Software Method , we are using this method to calculate the risk assessment study on the B+ building .
3. Excel Sheets Method.
4. Online Calculators Method.

3.2.1 Software Method For Performing The Risk Assessment Study

The RAPAL is one of the most useful software programs, using risk analysis in accordance with IEC 62305-2:2006, for the evaluation of the necessity for lightning protection of structures and connected services. The software (RAPAL), developed in Visual Basic, runs as a Microsoft Windows application and features a user-friendly graphics interface. The application software is a useful tool for engineers and can also be used for educational purposes in high voltage engineering courses.

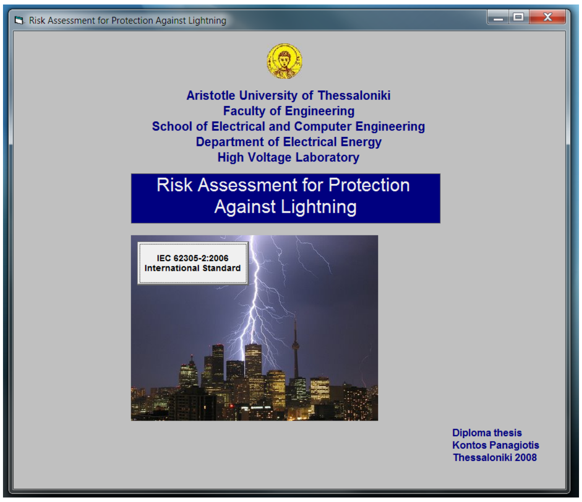


Figure 3.2: Start Window for RAPAL Software

The authority that produces this software: Faculty of Engineering- Aristotle University of Thessaloniki - Greece, the followed international standard: IEC 62305-2:2006. This program consists of (7) main windows which are:

1. Structure's Dimensions.
2. Structure's Attributes.
3. Environmental Influences.
4. Conductive Electric Service Lines.
5. Protection Measures.
6. Type Of Loss.
7. Results.

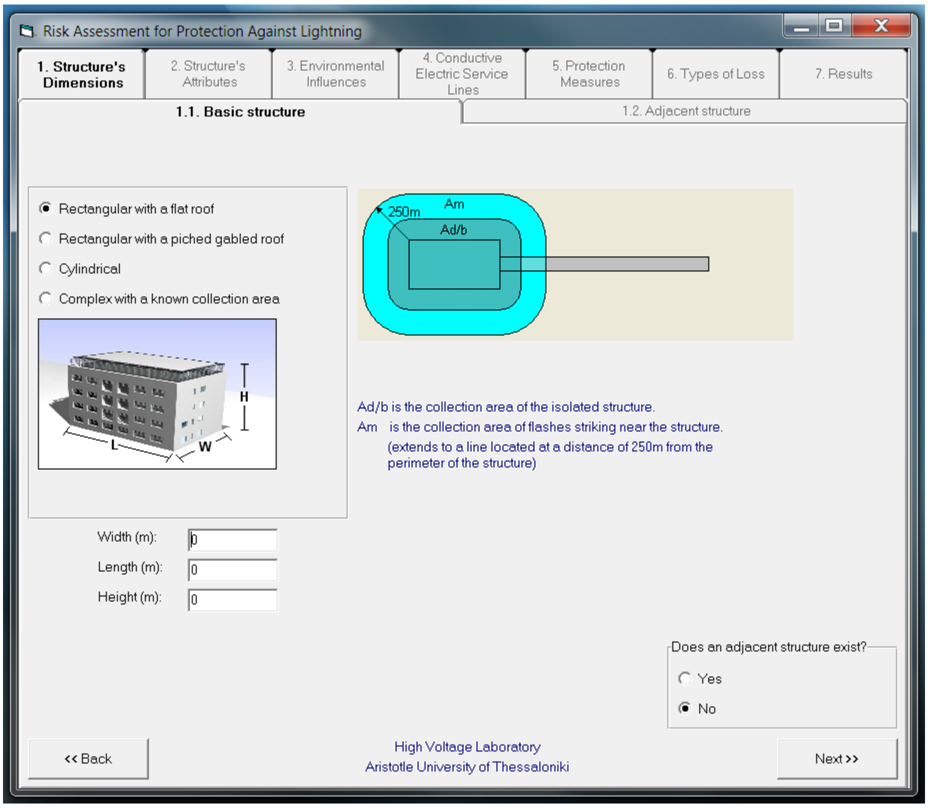


Figure 3.3: The Construction Of RAPAL Software

Notes: Each one of these main windows includes some sub-windows. Each main and sub-main window includes some boxes for data selection/entry.

After filling the boxes with the required data, the dimensions of the building and surrounding environment, also the service lines supplied with the building (consisting of power lines and communication lines), the types of losses that may be caused to the building and the equipment in the door, we obtained the following data.

The tolerable risk values are indicated beside each calculated risk value for comparison. If the value of the calculated risks is indicated in red color in Fig 3.4 and Fig 3.5, so this value exceed the limit of tolerable risk and more protection measures are required by clicking "back to protection measures" button. While the green color means that the value of the calculated risk is within limit of tolerable risk and no more protection measures are required .

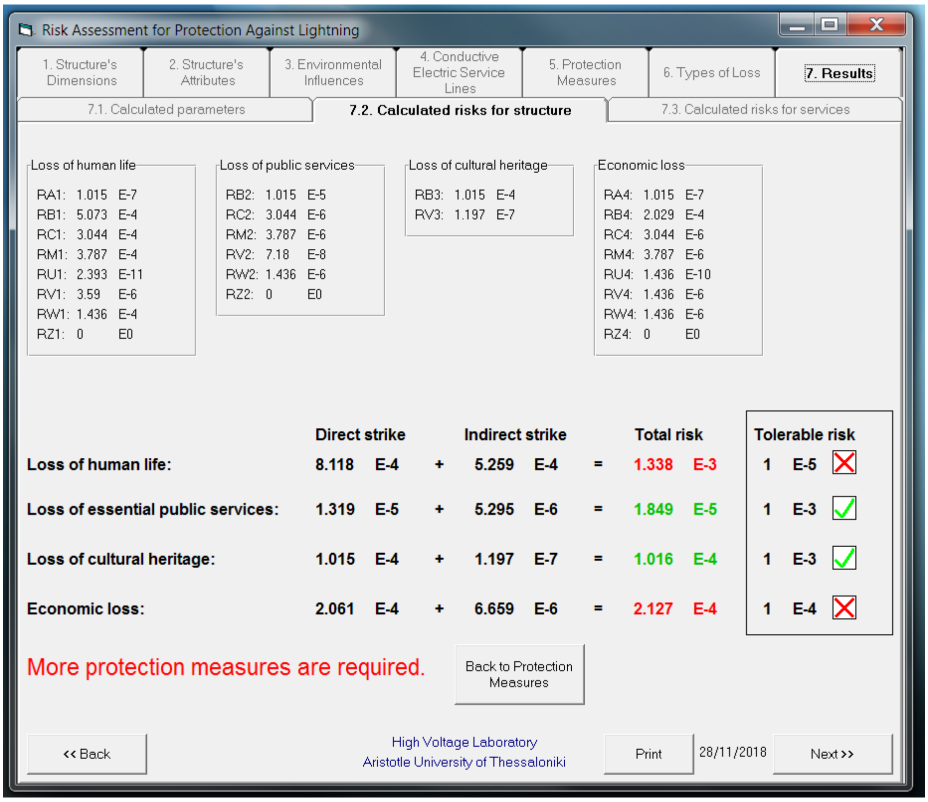


Figure 3.4: Calculated Risks for Structure Sub-Window

So here we need an extra protection system to protect the building and ensure safety for people working inside and outside the building, and also keep the sensitive equipment from damage. This is the subject of this thesis "Design of lightning and over-voltage protection System for building (B+) at PPU campus ".

After we received data indicating that the building needs additional protection, we begin to take the measures required for that. Design of the external protection of (Air termination, down Conductor, grounding), which in turn protects the building and human from the risk of direct electrical shock. Internal protection consisting of (Equipotential Bonding, surge protection system) that protects the internal organs of the building from damage.

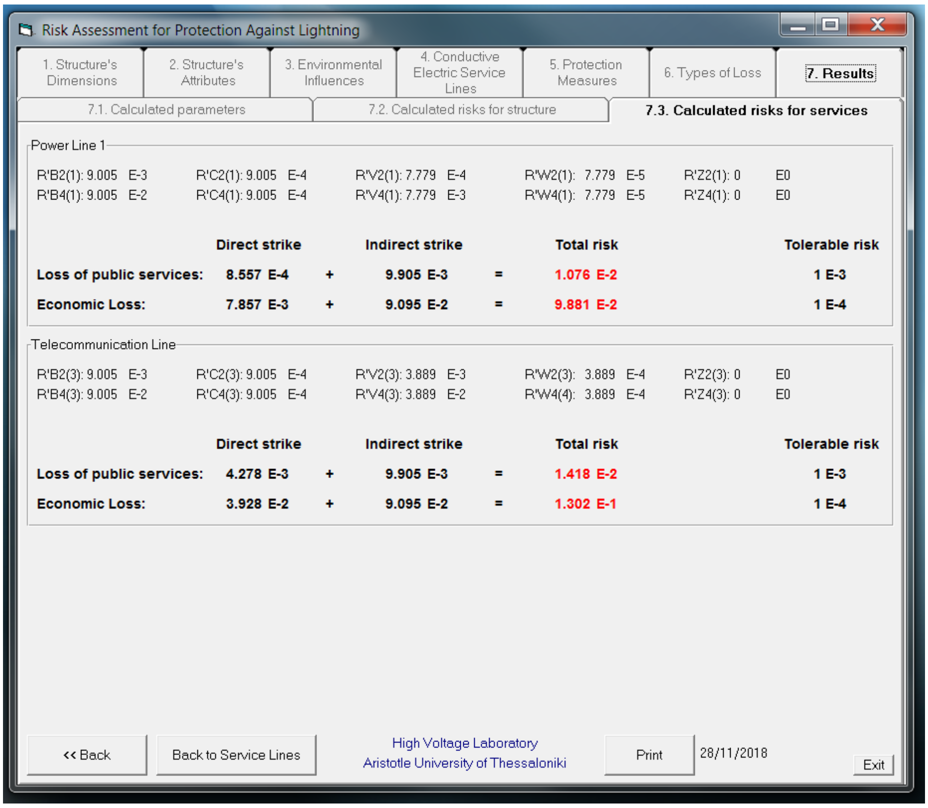


Figure 3.5: Calculated Risks for Services Sub-Window

3.3 Step#3: Selection Of External LPS Type and Material

The Correct Choice Of Lightning Protection Components (LPC). The correct choice of material, configuration and dimensions of the lightning protection components is essential when linking the various elements of an LPS together. The designer/user needs to know that the components, conductors, earth electrodes etc will meet the highest levels when it comes to durability, long term exposure to the environmental elements and perhaps most importantly of all, the ability to dissipate the lightning current safely and harmlessly to earth.

A conductor material should be chosen that is compatible with the surface it is to be located upon and that which it is to connect to. As a typical lightning protection system requires frequent bonds to nearby metallic items, compatibility with this should also be assessed. And most lightning protection systems are entirely copper or utilize an upper aluminium portion connecting to a copper earth termination system.

Use of Dissimilar Metals Galvanic corrosion occurs when two dissimilar metals are in contact with each other in the presence of an electrolyte. In this situation, one metal becomes the anode and the other the cathode. The anode will tend to go into solution and therefore corrode. The electrolyte can be water with impurities from the air, other surfaces or from the metal itself. Combinations of metals with potential differences above 0.5 V should be rejected to avoid excessive corrosion. see Appendix D to know all details about material and size.

3.4 Step#4: Sizing of Air Termination System Components

The function of the air-termination systems of a lightning protection system is to prevent direct lightning strikes from damaging the building to be protected. They must be designed to prevent uncontrolled lightning strikes to the structure to be protected. By correct dimensioning of the air-termination systems, the eicts of a lightning strike to a structure can be reduced in a controlled way. Air termination systems can consist of the following components and can be combined with each other as required: Rods, Spanned wires and cables, Inter meshed conductors.

The protection angle method is used to protect the surface. It is the most commonly used to complement the grid method, providing protection to the salient elements of the plane surface (ceiling structures such as antennas and ventilation pipes)Represented as follows fig3.6. The surface of the elevator was chosen to put the air termination on it, which is located in the middle of the building almost and forms the maximum height see **??** for more details.

The air terminal of the ABB type (PULSAR P3S)[] is placed at a height of 6 meters from the surface of the elevator Fig 3.8, to form a total height 10 meters from the roof of the building as shown in Fig 3.6. And at an angle of protection of 45 degree.

This gives us 95% of the surface area being protected from lightning. The remaining space is on the corners of the building and is protected by a connector ring on a surface.

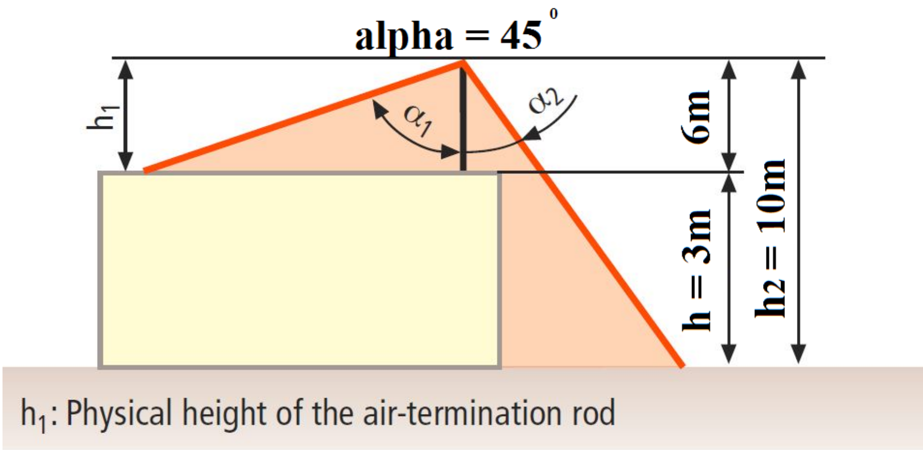


Figure 3.6: The height of the reference plane for vertical air termination rod

Figure 3.7: The air terminal of the ABB type (PULSAR P3S)

3.5 Step#5: Design of Down-Conductor System

The number of down conductors depends on the perimeter of the external edges of the roof (perimeter of the projection on the ground surface).(but at least two down-conductors should be used on a structure). The down conductors must be arranged to ensure that, starting at the exposed corners of the structure, they are distributed as uniformly as possible to the perimeter. (Note: A down-conductor should be installed at each exposed corner of the structure, where this is possible).

However an exposed corner does not need a down conductor if the distance between this exposed corner to the nearest down-conductors complies with the following conditions: the distance to both adjacent down-conductors is the distance according to Table 3.1 or smaller.

Table 3.1: Distance between down conductors according to IEC 62305-3 (EN 62305-3)

Class of LPS	Typical Distance between down conductors
I	10 m
II	10 m
III	15 m
IV	20 m

Note: If down-conductors cannot be spaced symmetrically, a variation of ± 20 % of the distance requirements of Table 3.1 is permitted, provided the mean spacing of down-conductors conforms to the values shown.

During our design for this part we calculated the distance to be installed down conductor. It is not possible to install on the faades only the eastern and western buildings. However, the north direction contains the front faade of the building, which leads to a distortion of the general appearance of the building. The southern direction is a single building. With refer to the dimensions of the building we obtained a total distance of 64.15 meters. By using Class I or II and Typical distance between the conductors 10 m . Dividing the distance on the class we get 6.4 connector. This number indicates the number of wires to be used as down conductor.

We used 6 wires(Bare stranded copper cable with 70mm section area D). and we distributed it on the sides of the building from the corner, taking into account the windows and openings on the eastern and western faade. The down conductor were assembled with a loop of wire that extended along the perimeter of the building and air termination as well, Fig 3.8. All details are attached to the CAD diagram C.

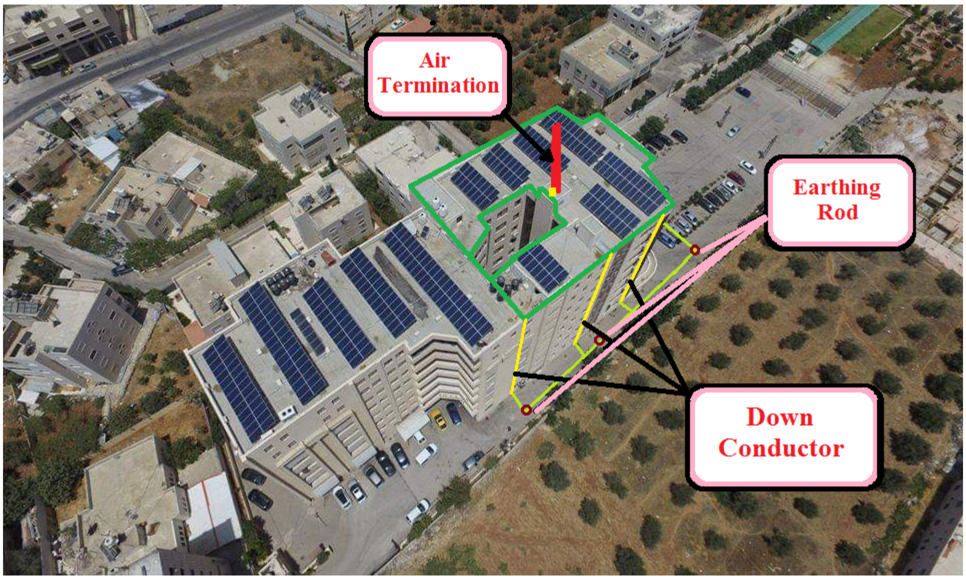


Figure 3.8: Distribution of down conductor on the building and air termination position

3.6 Step#6: Design of Earth Termination System

The correct choice of material, configuration and dimensions of the lightning protection components is essential when linking the various elements of an LPS together. The designer/user needs to know that the components, conductors, earth electrodes etc will meet the highest levels when it comes to durability, long term exposure to the environmental elements and perhaps most importantly of all, the ability to dissipate the lightning current safely and harmlessly to earth.

3.6.1 Grounding Electrode Subsystem (Earth Termination System)

The reliable performance of the entire lightning protection system is dependent upon an effective earthing system. The grounding electrode subsystem to be effective, it must has, Low electrical resistance between the electrode and the earth, The lower the earth electrode resistance the more likely the lightning current will choose to flow down that path in preference to any other, allowing the current to be conducted safely to and dissipated in the earth. Materials with Long term performance (Good corrosion resistance for example): The choice of material for the earth electrode and its connections is of vital importance. It will be buried in soil for many years so has to be totally dependable.

3.6.2 Functions of Grounding Electrode Subsystem

Dispersion of the lightning current safely and effectively from the conductor subsystem (air termination and down conductor) to ground. Clamp the electrical potential of the system (touch and step potential) as close to zero volts, or ground potential, as possible, to minimize the risk of injury to personnel or damage to equipment.

3.6.3 Resistance value for Grounding Electrode Subsystem

The Grounding System Design Calculations by using the Equations Method from BS 7430 issued in 1998. The safety criteria of IEC 479-1 and IEEE Std 80 Comparison of IEC 479-1 and IEEE Std 80 , have been compared, and their differences have been quantified. There are cases in which IEEE Std 80 is more conservative than IEC 479-1 and vice versa. The IEC 479-1 safety criteria are rather complex while the safety criteria of IEEE Std 80 are simplified. The opinion of the authors is that simplicity is important. Given the fact that the safety criteria include comfortable safety margins, one can conclude that the simplicity of IEEE Std 80 does not compromise safety in grounding system design. Another major difference is that IEC 479-1 does not address all relevant computational issues while IEEE Std 80 provides approximate equations and formulas which are useful to a designer. In conclusion, IEEE Std 80 provides useful procedures for grounding system safety assessment [4].

We used the following equations and tables to calculate the resistance of the vertical rods (earthing electrode) and the horizontal strip connector. Insert the equations on the Excel sheet to facilitate calculation, and the equations are as follows:

The resistance to earth of a rod electrode R, in ohms (Ω), is given by the following equation:

$$R_v = \frac{\rho}{2\pi L}[Log(\frac{8L}{d} - 1] \tag{3.1}$$

where :

L is the length of the electrode, in metres (m)

d is the diameter, in metres (m).

ρ is the resistivity of the soil, in ohm metres (Ω m) (assumed uniform).

The combined resistance of rod electrodes in parallel Rn, expressed in ohms (Ω), can be obtained from the following equation:

$$R_n = R\left(\frac{1 + \lambda a}{n}\right) \tag{3.2}$$

in which

$$a = \frac{\rho}{2\pi Rs}$$

where :

R is the resistance of one rod in isolation, in Ω.

s is the distance between adjacent rods, in m.

ρ is the resistivity of soil, Ω m.

λ is a factor given in Table 2 or Table 3.

n is the number of electrodes (as given in Table 2 and Table 3).

The above equations assume that rod electrodes can be represented approximately by hemispherical electrodes, having the same earthing resistance, located in the soil surface. This assumption is satisfactory provided that the spacing between the rods is not less than their length. If the rods are equally spaced in a straight line an appropriate value of λ may be taken from Table (2) according to BS 7430:1998 stander 3.4.

For electrodes equally spaced around a hollow square, e.g. around the perimeter of a building, the equations given above are used with a value of taken from Table (3).

The reduction in combined earth resistance provided by additional electrodes inside the square is small, but such electrodes will reduce the potential gradient over the soil

Table 3.2: Factors for parallel electrodes arranged in line

Number of electrodes (n)	**Factor λ**
2	1.00
3	1.66
4	12.15
5	2.54
6	2.87
7	3.15
8	3.39
9	3.61
10	3.81

surface inside the square. A practical example of this is the use of strip electrodes forming an earth grid within the square.

Table 3.3: Factors for electrodes arranged in a hollow square

Number of electrodes (n) along each side of the square	**Factor λ**
2	2.71
3	4.51
4	5.48
5	6.14
6	6.63
7	7.03
8	7.36
9	7.65
10	7.90
12	8.32
14	8.67
16	8.96
18	9.22
20	9.40
NOTE The total number of electrodes around the square is 4(n 1).	

Horizontal strip or round conductor electrodes have special advantages where high resistivity soil underlies shallow surface layers of low resistivity. They are frequently in the form of untinned copper strip of not less than 25 mm by 3 mm section, but may be of bare copper conductor as used for overhead lines. The minimum size should conform to the value given in Table 4.

For a strip or round conductor electrode the resistance R_h, in ohms (Ω) is given by the following equation:

$$R_h = \frac{\rho}{P\pi L} * \left[log_e \left(\frac{2L^2}{\omega h} \right) + Q \right] \tag{3.3}$$

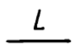
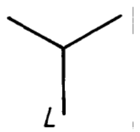
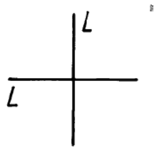
where :

L is the length of the strip or conductor, in metres (m). h is the depth of electrode, in metres (m).

ω is the width of strip or diameter of conductor, in metres (m).

ρ is the resistivity of soil, in ohm metres (Ω m). P and Q are coefficients given in Table 5 for different arrangements of electrode.

Table 3.4: Coefficients for strip or round conductor electrodes

Electrode arrangement	Coefficient		
	P	Q	
		Strip	Round
Single length[a] 	2	– 1	– 1.3
Two lengths at 90° 	4	0.5	0.9
Three lengths at 120° 	6	1.8	2.2
Four lengths at 90° 	8	3.6	4.1

[a] Where two or more straight lengths, each of length L in metres (m) and of separation s in metres (m), are laid parallel to each other and connected together the combined resistance can be calculated from the following equation:

$$R_n = FR_1$$

where

R_n is the resistance of n straight conductors in parallel, in Ω;

R_1 is the resistance of one straight conductor in isolation calculated from the equation and coefficients given above, in Ω.

F has the following value:

for two lengths, $F = 0.5 + 0.078(s/L)^{-0.307}$

for three lengths, $F = 0.33 + 0.071(s/L)^{-0.408}$

for four lengths, $F = 0.25 + 0.067(s/L)^{-0.451}$ provided that $0.02 \leq (s/L) \leq 0.3$.

3.6.4 Earth Termination System Testing

Although lightning current discharges are a high frequency event, at present most measurements taken of the earthing system are carried out using low frequency proprietary instruments. A test joint (or Measuring point) and Concrete inspection pit should be fitted on every down conductor that connects with the earth termination. This is usually on the vertical surface of the structure with long 3m above ground serfec , sufficiently high to minimize any unwanted third party damage/interference.

3.7 Step#7: Design of Internal LPS System

The installation of a lightning and surge protection system for electrical installations represents the latest state of the art and is an indispensable infrastructural condition for the trouble-free operation of complex electrical and electronic systems without consequential damage. The requirements on SPDs which are necessary for the installation of such a lightning and surge protection system as part of the lightning protection zone concept according to IEC (62305-4).

SPDs used as part of the fixed building installation are classified into type 1, 2 and 3 surge protective devices according to the requirements and stress on the places of installation and are tested to IEC (61643-11).

The Type 1 surge arrester, fitted in the installation's main incoming electrical switchboard, is capable of deviating the energy of a direct lightning strike. This is the first stage of the electrical network's protection. The behaviour of the cables, subjected to a transient signal, limits the effectiveness of a surge arrester to 10 m. It is therefore necessary to use one or more surge arresters in the installation in order to obtain the required level of protection for the equipment.

The Type 2 surge arrester should be used in coordination with the incoming surge arrester Type I. This is the second stage of the protection. Finally, if there is a risk of over-voltage on the electrical network, this risk also exists for the auxiliary wiring network. The appropriate protection is a surge arrester designed to protect telephone or data transmission lines. This is fitted in chain on the local network.

The last link in the lightning and surge protection system for power supply systems is the protection of terminal devices . The main function of a type 3 surge protective device installed at this point is to protect against overvoltages arising between the conductors of an electrical system, in particular switching overvoltages.

A summary of the different functions, arrangements and requirements on arresters is given in Table 3.5. The following Figure 3.9 places the installation of each device in the electrical system (TT - system)inside the facility.

Table 3.5: Classification of surge protective devices according to IEC

Type / designation	**Standard IEC 61643 -11:2011**
Lightning current arrester / combined arrester	Type 1 SPD
Surge arrester for distribution boards, sub-distribution boards, fixed installations	Type 2 SPD
Surge arrester for socket outlets / terminal devices	Type 3 SPD

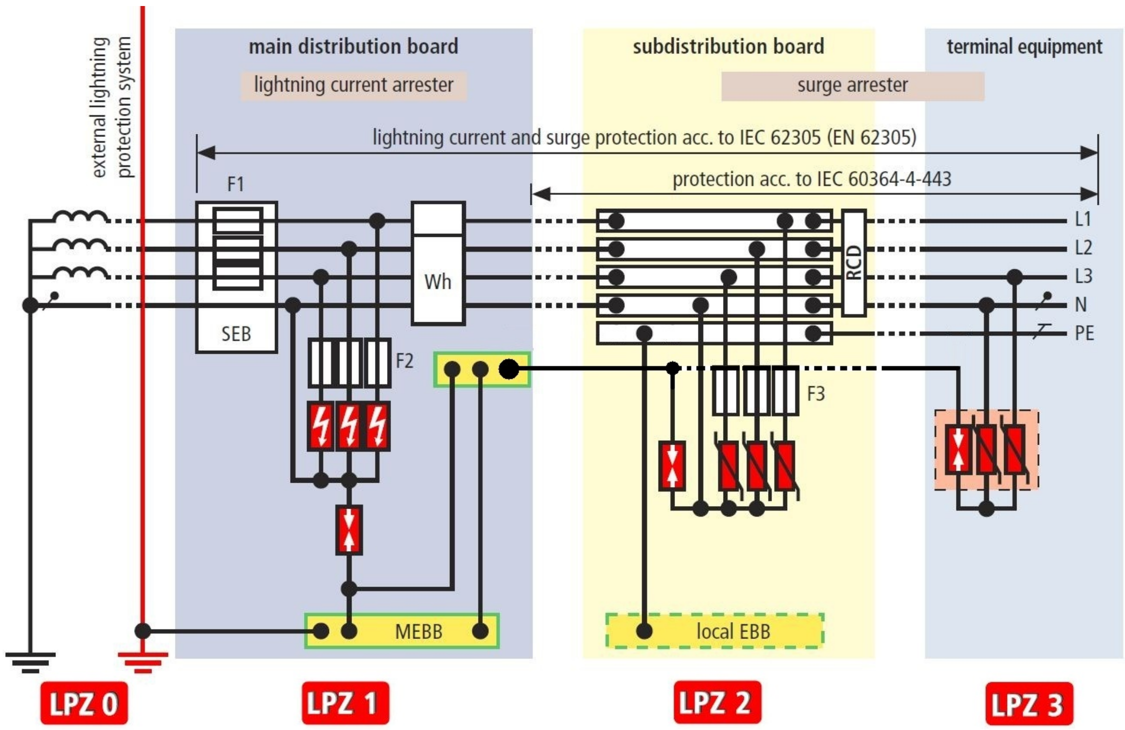


Figure 3.9: SPDs used in a TT system

3.7.1 General procedure for SPD selection and installation

The selection and installation of the SPD must consider the main SPD roles:

- Providing equipotential bonding to the services, reducing the risk of flash overs to/within the services when current from the LPS is injected into the ground and a portion of this current may flow out the service to remote ground points
- Reducing transient energy entering into the facility from a direct or indirect flash to the service
- Protecting internal electrical and electronic equipment

For service entrance (role 1), a lightning current SPD is required at the service entrance (i.e. SPD meeting class I tests). This SPD is mandatory for structures with a LPS.

For protection against lightning to the service (role 2), SPDs are also required at the service entrance, but if a LPS is not fitted to the structure, then the SPDs can be used meeting either class I or class II tests.

For internal equipment protection (role 3), in most cases additional SPDs need to be located in sub distribution panels or closer to, or within, the equipment. These SPDs are considered to be secondary protectors, and their operation needs to be coordinated with the service entrance protection. SPDs meeting the either class II or class III tests are suitable.

While it is stated that SPDs should be located at the service entrance , this is generally not the exact physical location. For practical and safety considerations the SPDs are installed within the main electrical distribution panel, after the main disconnect/over-current device. This allows the power to be isolated to the SPDs if maintenance is required. On large facilities the SPDs may be fed by an isolator device, allowing SPDs to be serviced without the need to remove power from the entire panel/site, The following Figure 3.10 shows principle of selection of protection devices : Determine number of secondary SPDs, locations), surge ratings, voltage ratings, back-up over-current (fuse) requirements, etc .

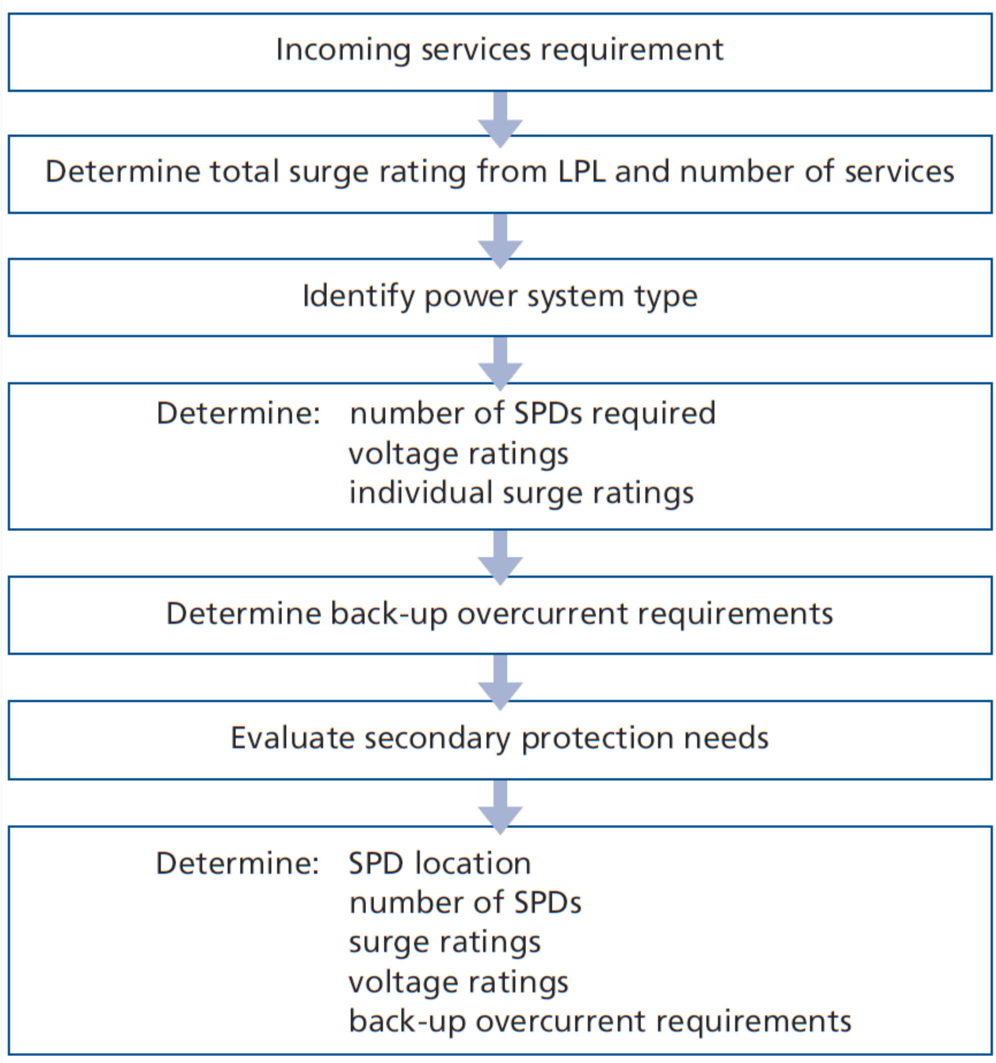


Figure 3.10: Flow chart for identification of surge protection device

In TT systems, over-current protective devices, residual current protective devices (RCDs) and, in special cases, fault voltage - operated protective devices can be used for protection against electric shock under fault conditions . For the installation of lightning current and surge arresters in TT systems, this means that they may only be arranged downstream of the protective devices described above to ensure protection against electric shock under fault conditions in the event of a faulty SPD. If type 1 or type 2 SPDs are installed downstream of an RCD, it has to be expected that the RCD interprets this discharge process as residual current due to the impulse current discharged to PE and the RCD interrupts the circuit . If type 1 SPDs are used, Therefore, in TT systems type 1 and type 2 SPDs must always be installed upstream of the residual current protective device and must be arranged in such a way that the conditions for the use of over-current protective devices for protection against electric shock under fault conditions are met.

These so-called N-PE arresters must meet special requirements since in this case the sum of the partial discharge currents from L1, L2, L3 and N must be conducted and they must be capable of extinguishing follow currents of 100 Arms due to a possible shifting of the neutral point.Moreover, an N-PE arrester must fulfil increased Temporary over-voltage (TOV)[A.3.1] requirements. According to IEC 60364-5-53, a withstand capability of 1200 V for 200 ms must be proven. The maximum continuous operating voltages shown in Figure 3.11 must be observed when using SPDs in TT systems between L and N.

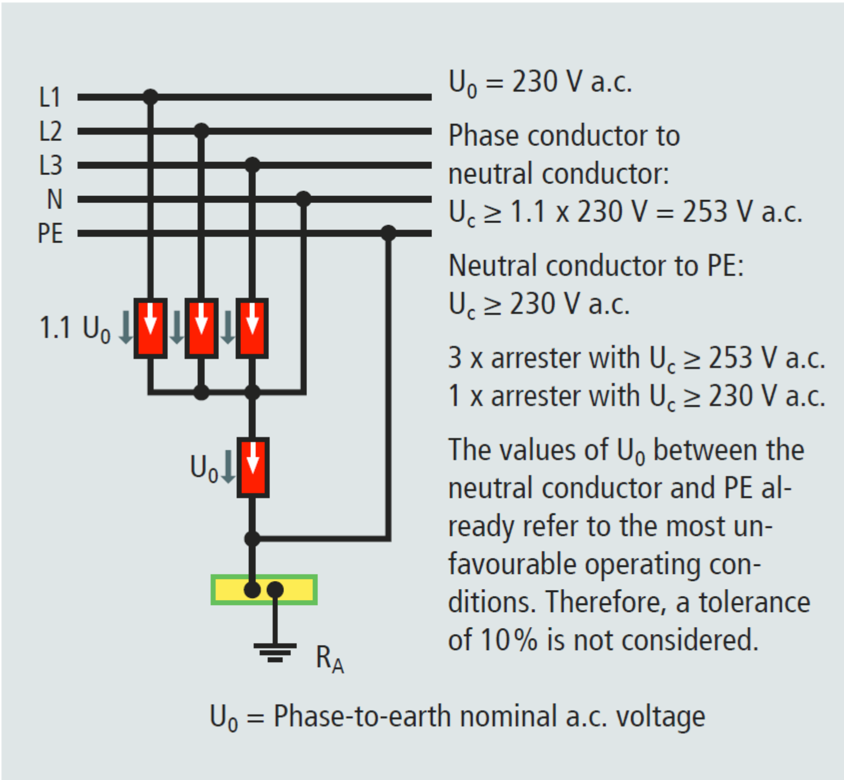


Figure 3.11: TT system (230/400 V); 3+1 circuit

The lightning current carrying capability of the type 1 SPDs is rated to conform to lightning protection levels I, II, III / IV as per IEC 62305-1 . The following values must be complied with to ensure the lightning current carrying capability of SPDs between N and PE as show in table 3.6.

Table 3.6: Lightning protection level

I	$I_(imp) \geq 100$ kA (10/350 μs)
II	$I_(imp) \geq 75$ kA (10/350 μs)
III/IV	$I_(imp) \geq 50$ kA (10/350 μs)

The type 2 SPDs are also connected between L and N and between N and PE. Type 2 SPDs between N and PE must have a discharge capacity of at least In $\geq$ 20 kA (8/20 s) for threephase systems and In 10 kA (8/20 s) for a.c. systems. Since coordination is always based on the worst-case conditions (10/350 s wave form), type 2 N-PE arresters of the Red/Line series have a value of 12 kA (10/350 s). Figures 3.9 , 3.11 , show examples of how to connect SPDs in TT systems. Generally, the impulse current discharged by this SPD is so low that the RCD does not identify this process as residual current. Nevertheless, an impulse current proof RCD should also be used in this case.

3.7.2 Minimum cross-sections for lightning

protection equipotential bonding The length of the connection cable for surge protection devices is a significant aspect of the installation standard IEC 60364-5-53 . To ensure adequate protection of systems and devices, the maximum surge voltage that can occur must be smaller than or equal to the surge voltage resistance of the devices to be protected. The sum of the protection level of the surge protection devices and the voltage drop on the supply lines must remain below the voltage resistance.

When the surge protective device in the cable branch operates, the discharge current flows through further elements (conductors, fuses), causing additional dynamic voltage drops across these impedances. In this case, the ohmic component is negligible compared to the inductive component. Considering the relation [2]

$$U_(dyn) = i.R + \left(\frac{di}{dt}L\right) \approx \left(\frac{di}{dt}\right) L \tag{3.4}$$

thereand the rate of current change (di/dt) for transient processes of some 10 kA/ μ s, the dynamic voltage drop Udyn mainly depends on the inductive component. In order to keep this dynamic voltage drop low, the electrician carrying out the work must keep the inductance of the connecting cable and thus its length as low as possible. Therefore, IEC 60364-5-53 recommends that the total cable length of surge protective devices in cable branches should not exceed 0.5 m (Figure 3.12). According to IEC 60364-5-53 , it is mandatory to maintain a maximum cable length of 1 m.

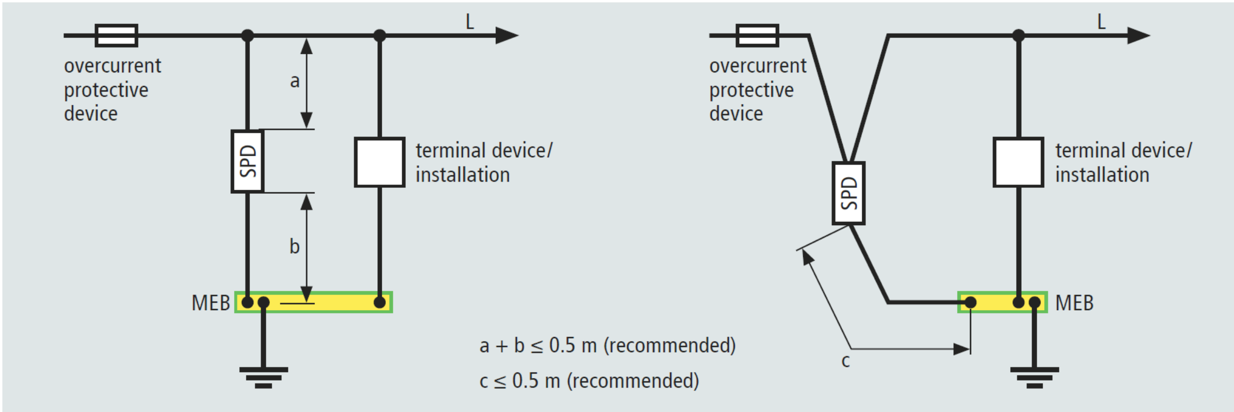


Figure 3.12: Recommended maximum cable lengths of surge protective devices in the cable branch (IEC 60364-5-53)

According to IEC 60364-5-53 , type 1 or 1+2 lightning arresters with a cross-section of at least 16 mm^2 of copper capable of carrying lightning current are required. Type 2 surge protection devices with a minimum cross-section of 4 mm^2 copper, or the standard commercial minimum connection cross-section of 6 mm^2, must be connected. Account must additionally be taken of the maximum short-circuit currents occurring at the place of installation.

Back-up fuse To provide protection in case of short circuits in surge protection devices, a back-up fuse (F2) is used. OBO specifies a maximum fuse rating for all devices. If an upstream fuse (F1) has a smaller or equal value than the maximum fuse current, a separate fuse/back-up fuse (F2) is however not needed before the surge protection device. If the rating of the system fuse (F1) is higher than the maximum fuse current, a fuse corresponding to the specified maximum fuse current must be fitted before the protection device. The rating of the fuse (F2) before the protection device should be as high as possible. The pulse resistance of a higher-rated fuse is greater than that of a lower- rated one.

Figures 3.13 show examples of how to connect SPDs in TT systems. Type 3 surge protective devices are installed downstream of the RCD, as close as possible to load.

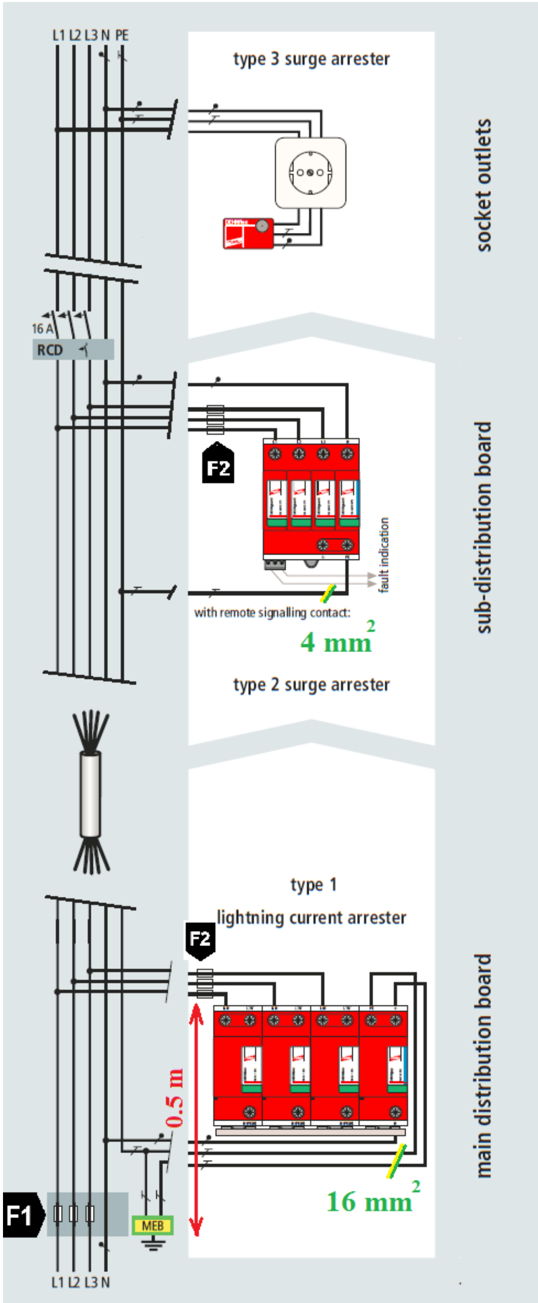


Figure 3.13: SPDs used in a TT system

In addition to power supply lines, telecommunication lines are the most important lines. Permanently functioning interfaces to the outside world are vital for the highly technical processes in today industrial plants and offices. Telecommunication line networks frequently extend over some km^2. Therefore, it is quite likely that surges are injected into such widespread networks. The safest solution to protect a structure from the negative consequences of lightning effects is to install a complete lightning protection system.

Copper cables with a low shielding effect are used as connecting cables to the local exchange and in a building internal cabling system. High potential differences can occur between the building installation and the incoming lines since the incoming lines extend beyond several buildings. Potential rise of the cores caused by galvanic and inductive coupling must be expected. If high-power and low-power lines are routed in parallel, switching over-voltages in the power system can also cause failure which interferes with the low-power lines.

Conclusion and recommendations

Chapter 4

Conclusion and recommendations

This chapter divided in to two main part, the first part summering main problem and solution for lightening and over-voltage protection system for building B + at PPU campus. it's also contain the expected results after applying the project.
The other part is our recommendation for attract attention from the community and official agencies to the importance of protection from lightening and over-voltage protection system , Which our institutions lack .

4.1 Problems

The most important aspect of understanding in lightning protection is that - not only a direct lightning strike act as a potential threat to the structure- but also more frequently, electronic equipment are damaged by surges caused by remote lightning discharges or switching operations in larger electrical systems. During thunderstorms too, high volume of energy is released during very short time.

The most neglected part in many structures / buildings are protection against lightning. Since the post impact of lightning is too severe and disastrous care .should be given at every level to ensure lightning protection is not provided for seeking statutory approvals.

Last but not the least, human safety from lightning will only be possible by creating awareness, use of warning guidance boards in required location and using suitable protective devices.

4.2 Solutions of the problems.

The basic interest of this project is to discuss and insist on the importance of protection devices / system and to regulation the overall process including selection.

Not limiting to the orientation of the product technicality or specification, the most important thing that is left out off-late is the Good Practices to be maintained in implementing and maintaining the same. Many installations across the world for lightning protection device just confirm to the requirement criterion of merely having a terminal on top and further completion of system are not followed.

This project will help in understanding the issues of various installation procedures and fool proof method of recommending and implementing Lighting Protection System, Earthing , Surge Protection System , and Surge protection Device (SPD). This project also will define about, how a selection of lightning protection device is to be done, the basis of installation and utilization of component.

4.3 Recommendations

The installation should not be a vendor driven , is only based on regulations as insisted by National /International standards and code.

All maintenance procedures shall be scheduled and carried out meeting the standard requirements in periodic intervals.

The following points are the minimum requirement of design guideline as recommended in various IEC standards:

- Connection to the air terminal and down conductors should be checked properly and the connection need to be done with proper tested clamps as insisted by IEC 62561-1
- Establishing connection for equipotential bonding with nearby metallic components need to be taken care of.
- At least two down conductors are mandatory immaterial of how small is the installation is.

- Proper monitoring and value measuring option to be provided for earth pits and should be protected with proper cover and maintained.
- Proper SPDs need to be employed at every entry point of a service in to the building.
- Proper SPDs need to be employed at every entry point of a service in to the building.
- Use proper signage boards mentioning lightning protection down conductor, earth pits etc., for people to easily identify.

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Appendix

Appendix A

IEC 62305 Standards for Lightning Protection

Since its foundation in 1980, the IEC TC 81 (Lightning Protection) of the International Electrotechnical Commission (IEC) has drawn up diverse standards for the protection of buildings from lightning, for the protection of electronic systems, for risk analysis and for the simulation of the effects of lightning. These standards were compiled one after the other as they were required, and published under different numbers with no recognisable system. The standards work therefore became more and more unsystematic to the user. In September 2000, the IEC TC 81 therefore decided to introduce a new, clearly arranged structure for lightning protection standards (series: IEC 62305). Revised and new standards will be integrated into this new structure.

The new International Lightning Protection Standards IEC 62305 (Parts 1 to 4) were published at the beginning of 2006. Almost at the same time they came into force as new European Lightning Protection Standards EN 62305-1 to 4. The standards IEC 62305 and EN 62305 provide compact information as required for the protection of electrical and electronic systems in buildings and structures. So, this complex protection successfully has been subdivided into a number of concrete individual protective measures which the designer and installer can compose to an overall system adjusted and specific to the respective target of protection.

When signing new contracts on designing and installation of lightning protection systems, in future the contractor has to follow the series of standards IEC 62305 or EN

62305 to work in compliance with the State of the Art. For this to be possible, the contractor must familiarise himself with the contents of the new lightning protection standards. We would like to support as the specialists in this field, regardless of whether you are involved in design or executing, in becoming familiar with the new series of lightning protection standards. [6]

A.1 Installation standards

At the beginning of 2006, the new IEC standards on lightning protection, Parts 1 to 4 of the series IEC 62305 were published. Almost at the same time they became effective as new European Lightning Protection Standards EN 62305-1 to 4. The new standards of the series EN 62305 specify the state of the art in the field of lightning protection on a uniform and up-to-date European basis. The actual protection standards (EN 62305-3 and -4) are preceded by two generally valid standard parts (EN 62305-1 and -2) (Table A.1).

Classification	**Title**
IEC 62305-1: 2006-01 **(EN 62305-1)**	Protection against lightning Part 1: General principles
IEC 62305-2: 2006-01 **(EN 62305-2)**	Protection against lightning Part 2: Risk management
IEC 62305-3: 2006-01 **(EN 62305-3)**	Protection against lightning Part 3: Physical damage to structures and life hazard
IEC 62305-4: 2006-01 **(EN 62305-4)**	Protection against lightning Part 4: Electrical and electronic systems within structures

IEC 62305-1 (EN 62305-1): General principles

This section contains information about the risk posed by lightning, lightning characteristics, and the parameters derived therefrom for the simulation of the effects of lightning. In addition, an overall view of the IEC 62305 (EN 62305) series of standards is given. Procedures and protection principles which form the basis of the following sections are explained.

IEC 62305-2 (EN 62305-2): Risk management

Risk management in accordance with IEC 62305-2 (EN 62305-2) uses risk analysis to first establish the necessity for lightning protection. The optimum protective measure from a technical and economic point of view is then determined. Finally, the remaining residual risk is ascertained. Starting with the unprotected state of the building, the remaining risk is reduced and reduced until it is below the tolerable risk. This method can be used both for a simple determination of the class of lightning protection system in accordance with IEC 62305-3 (EN 62305-3), and also to establish a complex protection system against lightning electromagnetic impulse (LEMP) in accordance with EN 62305-4.

IEC 62305-3 (EN 62305-3): Physical damage to structures and life hazard

This section deals with the protection of buildings and structures and persons from material damage and life-threatening situations caused by the effect of lightning current or by dangerous sparking, especially in the event of direct lightning strikes. A lightning protection system comprising external lightning protection (air-termination system, down-conductor system and earth-termination system) and internal lightning protection (lightning equipotential bonding and separation distance) serves as a protective measure. The lightning protection system is defined by its class, Class I being more effective than Class IV. The class required is determined with the help of a risk analysis carried out in accordance with IEC 62305-2 (EN 62305-2), unless otherwise laid down in regulations (e.g. building regulations).

IEC 62305-4 (EN 62305-4): Electrical and electronic systems within structures

This section deals with the protection of buildings and structures with electrical and electronic systems against the effects of the lightning electromagnetic impulse. Based on the protective measures according to IEC 62305-3 (EN 62305-3), this standard also takes into consideration the effects of electrical and magnetic fields, and induced voltages and currents, caused by direct and indirect lightning strikes. Importance and necessity of this standard derives from the increasing use of diverse electrical and electronic systems which are grouped together under the heading information systems. For the protection of information systems, the building or structure is divided up into lightning protection zones (LPZ). This allows local differences in the number, type and sensitivity of the electrical and electronic devices to be taken into consideration when choosing the protective measures.For each lightning protection zone, a risk analysis in accordance with IEC 62305-2 (EN 62305- 2) is used to select those protective measures which provide optimum protection at minimum cost. These standards can be applied to the design, installation, inspection and maintenance of lightning protection systems for buildings and structures, their installations, their contents and the persons within[1].

A.2 Work Contracts

A work contractor is fundamentally liable for ensuring that his service is free of deficiencies. Compliance with the recognised engineering rules is the decisive starting point for work and service free of deficiencies. Relevant national standards are used here in order to fill the factual characteristic of the (recognised engineering rules) with life. If the relevant standards are complied with, it is presumed that the work and service is free from deficiencies. The practical significance of such a prima facie evidence lies in the fact that a customer who lodges a complaint of non-conform service by the work contractor (for example for the installation of a lightning protection system) has basically little chance of success if the work contractor can show that he complied with the relevant technical standards. As far as this effect is concerned, standards and pre-standards carry equal weight. The effect of the presumption of technical standards is removed, however, if either the standards are withdrawn , or it is proven that the actual standards no longer represent the state of the art.

Standards cannot statically lay down the state of the recognised engineering rules in tablets of stone, as technical requirements and possibilities are continually changing. So, if standards are withdrawn and replaced with new standards or prestandards, then it is primarily the new standards which then correspond to the state of the art.

Contractors and those placing an order for work regularly agree that the work must conform to the general state of the art without the need to make specific mention of this. If the work shows a negative deviation from this general state of the art, it is faulty. This can result in a claim being made against the contractor for material defect liability. The material defect liability only exists, however, if the work was already faulty at the time of acceptance! Circumstances occurring subsequently such as a further development of the state of the art do not belatedly make the previously accepted, defect-free work faulty

For the question of the deficiency of work and service, the state of the recognised engineering rules at the time of the acceptance is the sole deciding factor.

Since, in future, only the new lightning protection standards will be relevant at the time of completion and acceptance of lightning protection systems, they have to be installed in accordance with these standards. It is not sufficient that the service conformed to the engineering rules at the time it was provided, if, between completion of a contract, service provision and acceptance of the construction work, the technical knowledge and hence the engineering rules have changed.

Hence works which have been previously installed and already accepted under the old standards do not become defective because, as a result of the updating of the standards, a higher technical standard is demanded.

With the exception of lightning protection systems for nuclear facilities, lightning protection systems have only to conform to the state of the art at the time they are installed, i.e. they do not have to be updated to the latest state of the art. Existing systems are inspected in the course of maintenance tests according to the standards in force at the time they were installed.

A.3 Product standards

Materials, components and units for lightning protection systems must be designed and tested for the electrical, mechanical and chemical stresses which have to be expected during their use. This affects both the components of the external lightning protection as well as units of the internal lightning protection system.

- Clamps .
- Connectors .
- Terminal components .
- Bridging components .
- Expansion pieces .
- Measuring points

EN 50164-2: Requirements for conductors and earth electrodes

This standard specifies the requirements on conductors, air-termination rods, lead-in components and earthing electrodes.

EN 61643-11: Surge protective devices connected to low voltage systems

Since 1 December 2002, the requirements on, and inspections of, surge protective devices in low voltage systems have been governed by EN 61643-11. This product standard is the result of international standardisation as part of IEC and CENELEC.

EN 61643-21: Surge protective devices connected to telecommunications and signalling networks

This standard describes the performance requirements and testing methods for surge protective devices used for the protection of telecommunications and signal processing networks including e.g.

- data networks .
- voice transmission networks .
- alarm systems .
- automation systems.

CLC/TS 61643-22 (IEC 61643-22:2004, modified): 2006-04; Low-voltage surge protective devices, Part 22:

Surge protective devices connected to telecommunications and signalling networks - Selection and application principles .

EN 61663-1

Lightning protection - Telecommunication lines - Fibre optic installations.

EN 61663-2

Lightning protection - Telecommunication lines - Lines using metallic conductors

A.3.1 Temporary over-voltage (TOV)

Temporary over-voltage may be present at the surge protective device for a short period of time due to a fault in the high voltage system. This must be clearly distinguished from a transient caused by a lightning strike or a switching operation, which last no longer than about 1 ms. The amplitude UT and the duration of this temporary over-voltage are specified in EN 61643-11 (200 ms, 5 s or 120 min.) and are individually tested for the relevant SPDs according to the system configuration (TN, TT, etc.). The SPD can either a) reliably fail (TOV safety) or b) be TOV-resistant (TOV withstand), meaning that it is completely operational during and following temporary over-voltages.

Appendix B

Earthing Calculation for
(Building B+ at PPU campus)
Using Exel Sheet

Earthing Calculation for (Building (B+) at PPU campus)

Using Exel Sheet

Content

1 **Presentation**

2 **Grid Current**

→ **Basis**

→ **Calculation**

3 **horizontal strip or round Ground conductor Sizing.**

4 **Ground Resistance**

→ **Formulas**

→ **Calculation**

Green cells I/P
Blue cells O/P

1 Presentation

→ **horizontal strip or round Ground conductor Sizing.**

Calculations are done according to BS 7430 Guide for safety in substation grounding .

→ **Ground Resistance Calculation**

Calculations are done according to BS 7430 Earthing.

2 Maximum values of lightning current

Fault Current **100** **KA**

(This is the highest fault current in Lighting phenomenon)

Calculation

The calculation of fault current form single line diagram

3 horizontal strip or round Ground conductor Sizing.

A - GENERAL DESIGN DATA

1	**Soil Resistivity,** ρ		**500**	Ohm-M
2	**Gravel Resistivity,** ρ_s		**500**	Ohm-M
3	**Symmetrical Short Circuit Curr**	**:**	**100000**	A
4	**Duration of Earth Fault Curren**	**:**	**0.07**	Sec
5	**Maximum Allowable Conductor**	**:**	**120**	° C
5	**Design Ambient Temperature**	**:**	**40**	° C
6	**Thickness of Crushed Gravel,**	**:** hs	**0.102**	mtr.
7	**Depth of Earth Grid, *h***	**:**	**0.5**	mtr.
9	**Reference depth of the Grid, *ho***		**1**	mtr.

STANDARDS USED

IEEE Gude for Safety in AC Substation Grounding	IEEE - 80	2000

B - SIZE OF EARTHING CONDUCTOR :

$$Amm^2 = \frac{I}{\sqrt{\left(\frac{TCAP \times 10^{-4}}{t_c \alpha_r \rho_r}\right) \ln\left(\frac{K_0 + T_m}{K_0 + T_a}\right)}}$$

ge : 43
0 - 2000

Where

Material Proposed

Copper annealed soft - drawn

α_r	= Resistivity of Conductor Material	0.003930	Ohm - M
ρ_r	= Thermal co-efficient of resistivity at reference temperature Tr in 1/°C	1.72	
Tm	= Max. allowable temperature in °C	1083.00	°C
Ta	= Ambient temperature in °C	40.00	°C
Ko	= 1/a0 or 1/ar - Tr in °C	234.00	
Iefs	= rms current in Ka	100.00	KA
tc	= Duration of Current in s	0.07	Sec.
TCAP	= thermal capacity per unit volume from Table 1	3.42	J/(cm³°C)
Amm²	= Conductor cross section in mm²	93.87	mm²

A_{kcmil} = **185.31** kcmil

Amm² = **93.87** mm²

THE SIZE OF CONDUCTOR SELECTED	=	**95.0**	mm²
length of the Horizontal Grid Conductor , L_H	=	**120**	**m**

Description		Material Conductivity (%)		αr factor at 20°C		*K0* at (0°C)		Fusing Temperature *Tm (°C)*		ρr 20°C(μΩ.cm)		TCAP Thermal Capacity [J/(cm³.°C]
Copper annealed soft - drawn	1	100	1	0.00393	1	234	1	1083	1	1.72	1	3.42
Copper, commercial hard - drawn	2	97	2	0.00381	2	242	2	1084	2	1.78	2	3.42
Copper-clad steel wire	3	40	3	0.00378	3	245	3	1084	3	4.4	3	3.85
Copper-clad steel wire	4	30	4	0.00378	4	245	4	700	4	5.86	4	3.85
Copper-clad steel rod	5	20	5	0.00378	5	245	5	1084	5	8.62	5	3.85
Aluminium EC Grade	6	61	6	0.00403	6	228	6	657	6	2.86	6	2.56
Aluminium 5005 alloy	7	53.5	7	0.00353	7	263	7	652	7	3.22	7	2.6
Aluminium 6201 alloy	8	52.5	8	0.00347	8	268	8	654	8	3.28	8	2.6
Aluminium-clad steel wire	9	20.3	9	0.0036	9	258	9	657	9	8.48	9	3.58
Steel, 1020	10	10.8	10	0.0016	10	605	10	1510	10	15.9	10	3.28
Stainless - clad steel rod	11	9.8	11	0.0016	11	605	11	1400	11	17.5	11	4.44
Zinc-coated steel rod	12	8.6	12	0.0032	12	293	12	419	12	20.1	12	3.93
Stanless steel, 304	13	2.4	13	0.0013	13	749	13	1400	13	72	13	4.03

Table 2—Material constants

Material	Conductivity (%)	T_m [a] (°C)	K_f
Copper, annealed soft-drawn	100.0	1083	7.00
Copper, commercial hard-drawn	97.0	1084	7.06
Copper, commercial hard-drawn	97.0	250	11.78
Copper-clad steel wire	40.0	1084	10.45
Copper-clad steel wire	30.0	1084	12.06
Copper-clad steel rod	20.0	1084	14.64
Aluminum EC Grade	61.0	657	12.12
Aluminum 5005 Alloy	53.5	652	12.41
Aluminum 6201 Alloy	52.5	654	12.47
Aluminum-clad steel wire	20.3	657	17.20
Steel 1020	10.8	1510	15.95
Stainless clad steel rod	9.8	1400	14.72
Zinc-coated steel rod	8.6	419	28.96
Stainless steel 304	2.4	1400	30.05

[a]See 11.3.3 for comments concerning material selection.

A = 95 mm2

ONE run of 95 mm² bare copper conductor will be used for earthing.

4 *Ground Resistance- R_g* *AS per BS 7430*

The resistance of a system consisting of the combination of horizontal grid and vertical electrode is as follows

$$R_g = \frac{R_h * Rn}{R_h + Rn}$$

Rh= The resistance of horizontal strip or round conductor.

Rn= The resistance of all ground rods

R_h & Rn can be find out from the following formulas

$$R = \frac{\rho}{2\pi L}\left[\ln\frac{8L}{d} - 1\right]$$

(10.2 Rods or pipes) OHMs 257.00

L	is the length of rod, in metres (m);	1.8
d	is the diameter of rod or pipe, in metres (m);	0.015875
r	is the soil resistivity in ohm metres (OHM·m).	500

A.1.2 *Multiple electrodes*

$$R_n = R\left(\frac{1+\lambda a}{n}\right)$$

R	is the resistance of one rod in isolation, in ohms .	
S	is the distance between rods, in metres (m).	2
ρ	is the soil resistivity, in ohm metres (OHMs.m) .	500
n	is the number of electrod (Table 2 and 3).	7
⋋	is the factor from Table 2.	3.81

The spacing between the rods is not less than their length.

If the rods are equally spaced in a straight line an appropriate value of λ may be taken from Table 2.

Table 2 — Factors for parallel electrodes arranged in line

Number of electrodes (n)	Factor λ
2	1.00
3	1.66
4	2.15
5	2.54
6	2.87
7	3.15
8	3.39
9	3.61
10	3.81

$$a = \frac{\rho}{2\pi RS}$$

0.1721

A.1.2 *Multiple electrodes*

Put S=L

$$R_n = R\left(\frac{1+\lambda a}{n}\right)$$

OHMs 60.79

(10 Resistance of common types of earth electrodes)

2- Horizontal strip or round conductor electrodes

For a horizontal strip or round conductor electrode the resistance Rh, in ohms is given by the following equation:

$$R_h = \frac{\rho}{P\pi L}\left[\log_e\left(\frac{2L^2}{wh}\right) + Q\right]$$

(10.3 Horizontal strip or round conductor electrodes)

L	**is the length of conductor, in metres (m).**	120
h	**is the depth of strip, in metres (m).**	0.5
w	**is the width of strip,or diameter of round conductor in metres (m).**	0.01575
r	**is the soil resistivity, in ohm metres.**	500
P	**are the coefficients given in Table 5.**	2
Q	**are the coefficients given in Table 5.**	-1.3

Table 5 — Coefficients for strip or round conductor electrodes

Electrode arrangement	Coefficient		
	P	Q	
		Strip	Round
Single length[a]	2	−1	−1.3
Two lengths at 90°	4	0.5	0.9
Three lengths at 120°	6	1.8	2.2
Four lengths at 90°	8	3.6	4.1

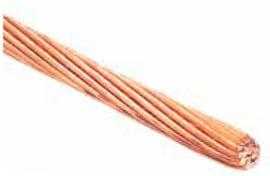
OHMs **9.1641**

$$R_g = \frac{R_h * Rn}{R_h + Rn}$$

OHMs **7.9636**

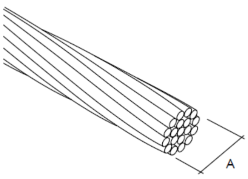
ONE run as above zise bare copper conductor will be used for earthing.
soft drawn bare copper conductor. This value From design drawings .

The design is justified as the effective resistance is below 5 ohm in each separate building As per Specs



Standards

BS EN 60228 (soft drawn)
BS EN 7884 (hard drawn)

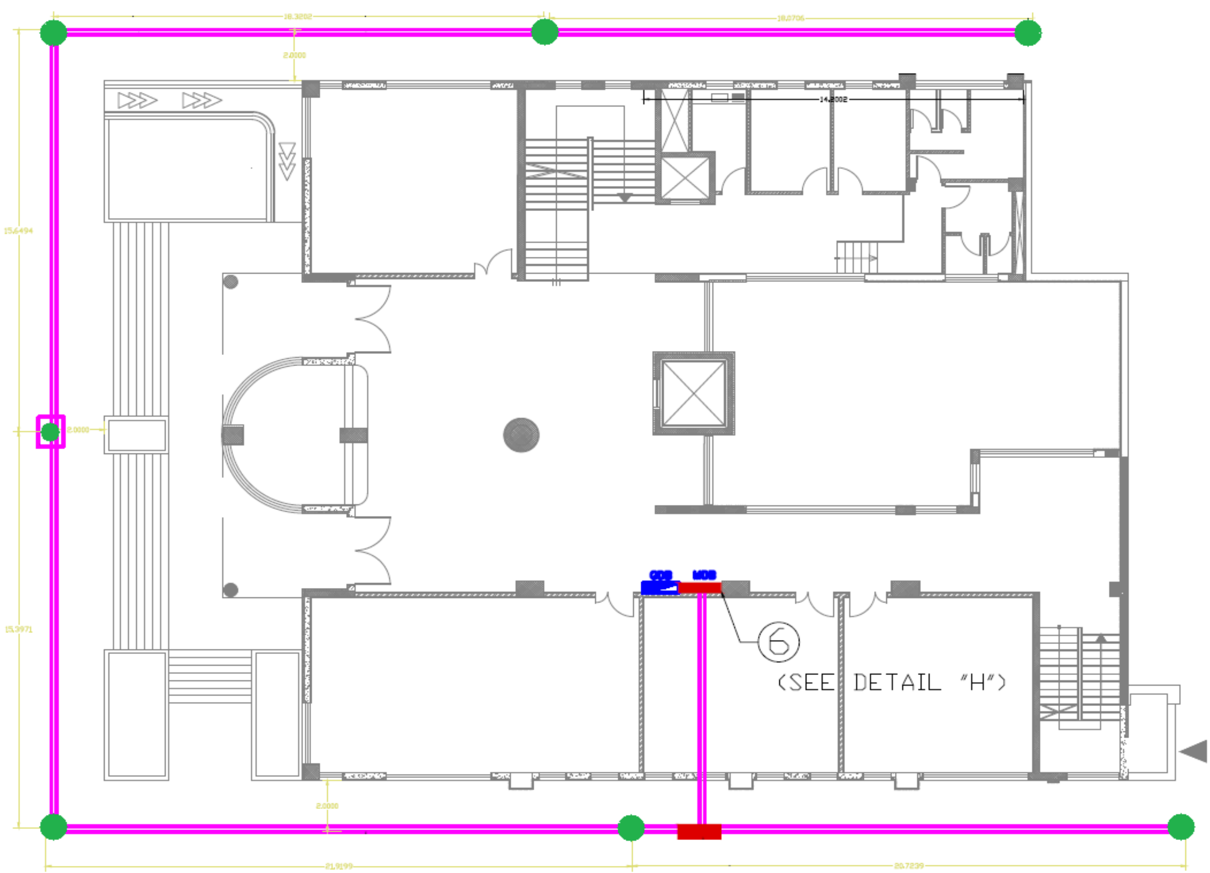


Bare stranded copper cable

Part no.	Cross-sectional area (mm²)	Stranding no. / mm ø	Nominal diameter (A) (mm)	Weight per metre (kg)
Soft drawn stranded copper cable				
CB006	6	7/1.04	Ø 3.12	0.05
CB016	16	7/1.70	Ø 5.10	0.15
CB025	25	7/2.14	Ø 6.42	0.23
CB035	35	7/2.52	Ø 7.56	0.32
CB050-FU	50	19/1.78	Ø 8.90	0.43
CB070	70	19/2.14	Ø 10.70	0.62
CB095	95	19/2.52	Ø 12.60	0.86
CB120	120	37/2.03	Ø 14.21	1.09
CB150-FU	150	37/2.25	Ø 15.75	1.33
CB185	185	37/2.52	Ø 17.64	1.67
CB240	240	61/2.25	Ø 20.25	2.20
CB300-FU	300	61/2.52	Ø 22.68	2.76
CB400-FU	400	61/2.85	Ø 25.65	3.53
Tinned soft drawn stranded copper cable				
CB070-T*	70	19/2.14	Ø 10.70	0.62
Hard drawn stranded copper cable				
CB071*	70	7/3.55	Ø 10.70	0.64

– *Additional sizes available on request

Grounding layout for Building B+



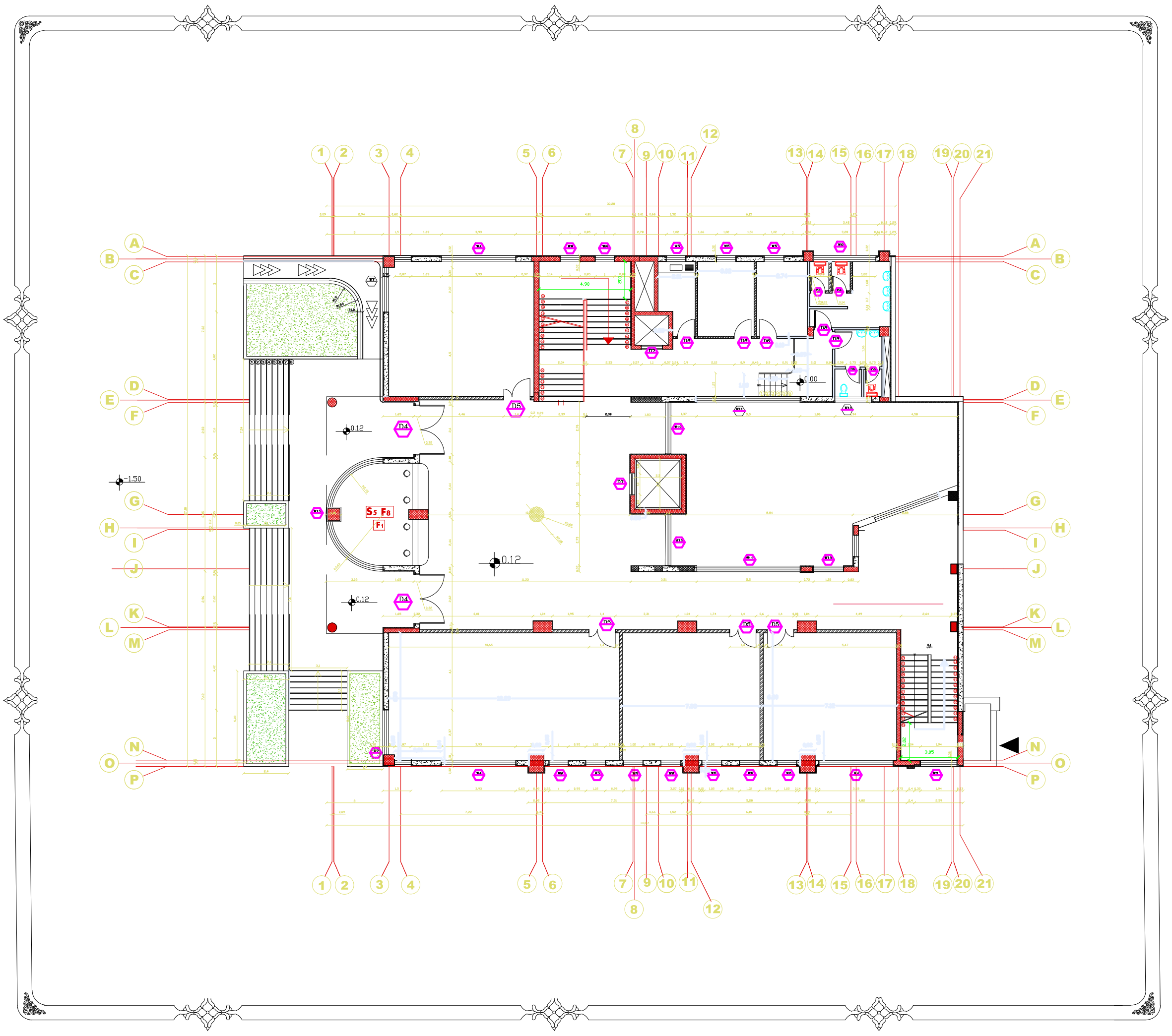
Green Color : Vertical Rod Electrodes

Purple Color : Horizontal strip or Round conductor electrodes

Appendix C

Design Drawings

We used the AutoCad Software to drawing all layout and deteals of the project



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى B+

تصميم نظام حماية من الصواعق و الجهد الزائد مبنى B+ فى حرم جامعة بوليتكنك فلسطين

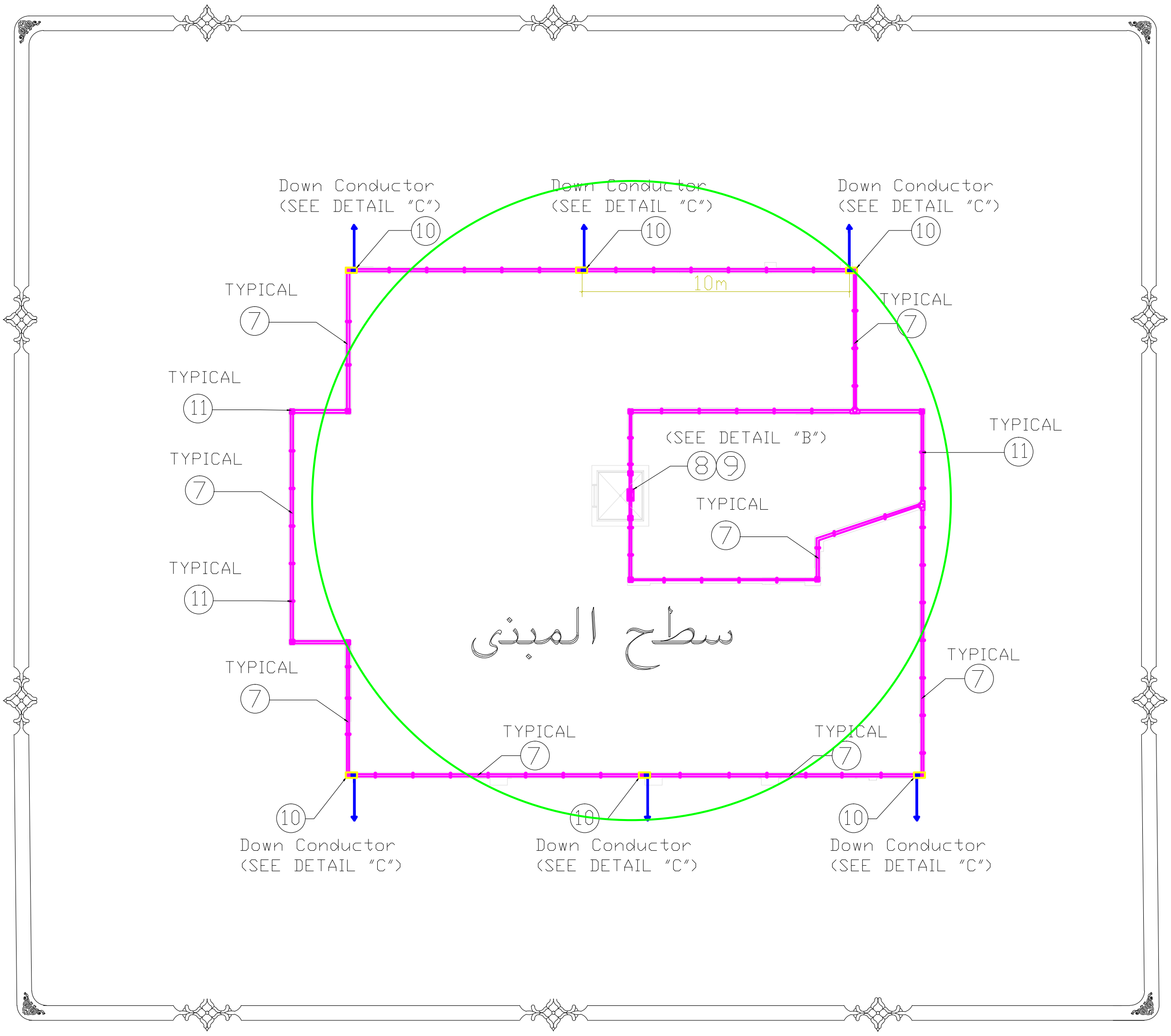
اسم اللوحة
مسقط افقى للمبنى

وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A1

التاريخ : 2018/ 12/ 6

مقياس الرسم 1:200



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى B+

تصميم نظام حماية من الصواعق و الجهد الزائد مبنى B+ فى حرم جامعة بوليتكنك فلسطين

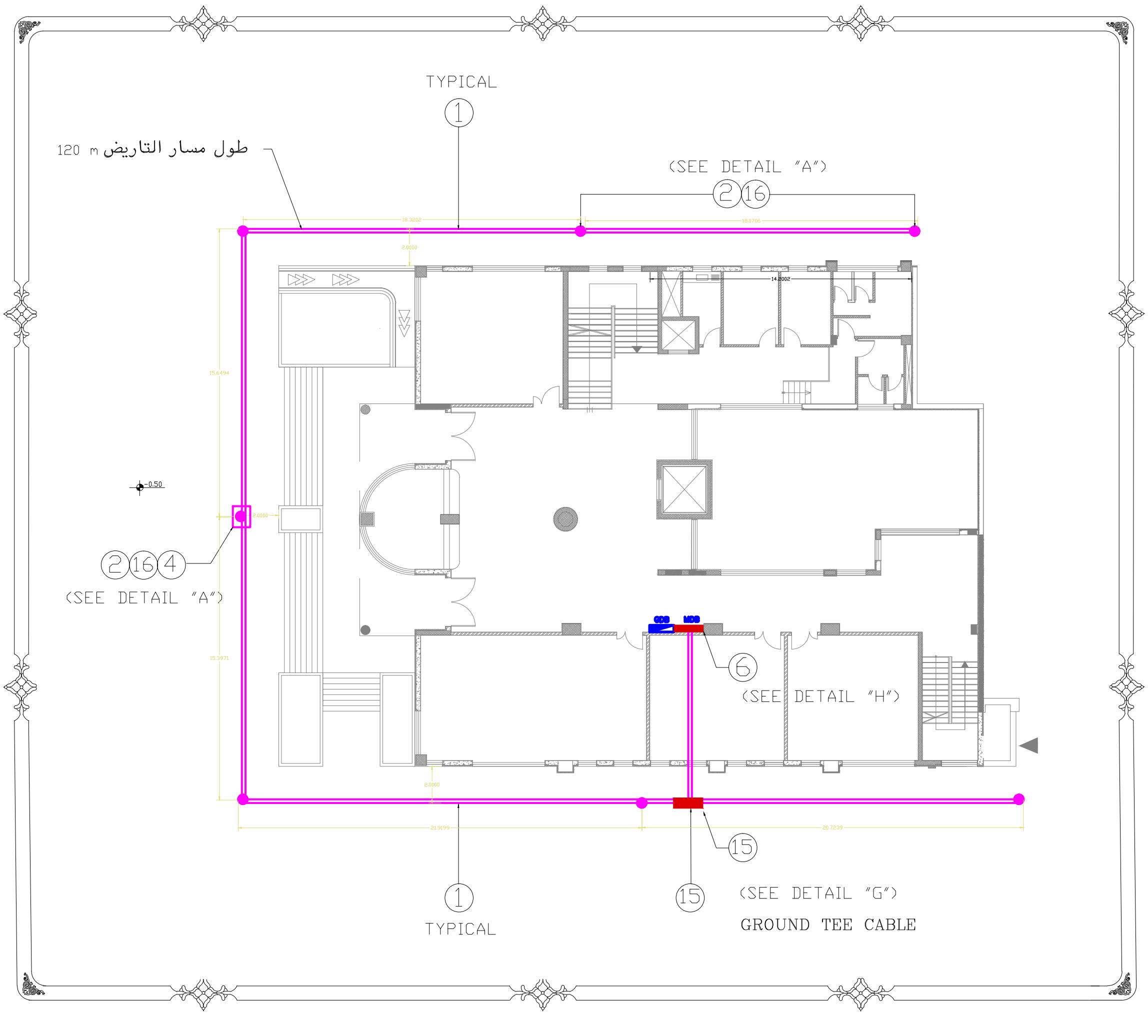
اسم اللوحة : مخطط الحماية الخارجية على سطح المبنى

وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A2

التاريخ : 2018/ 12/ 6

مقياس الرسم 1:200



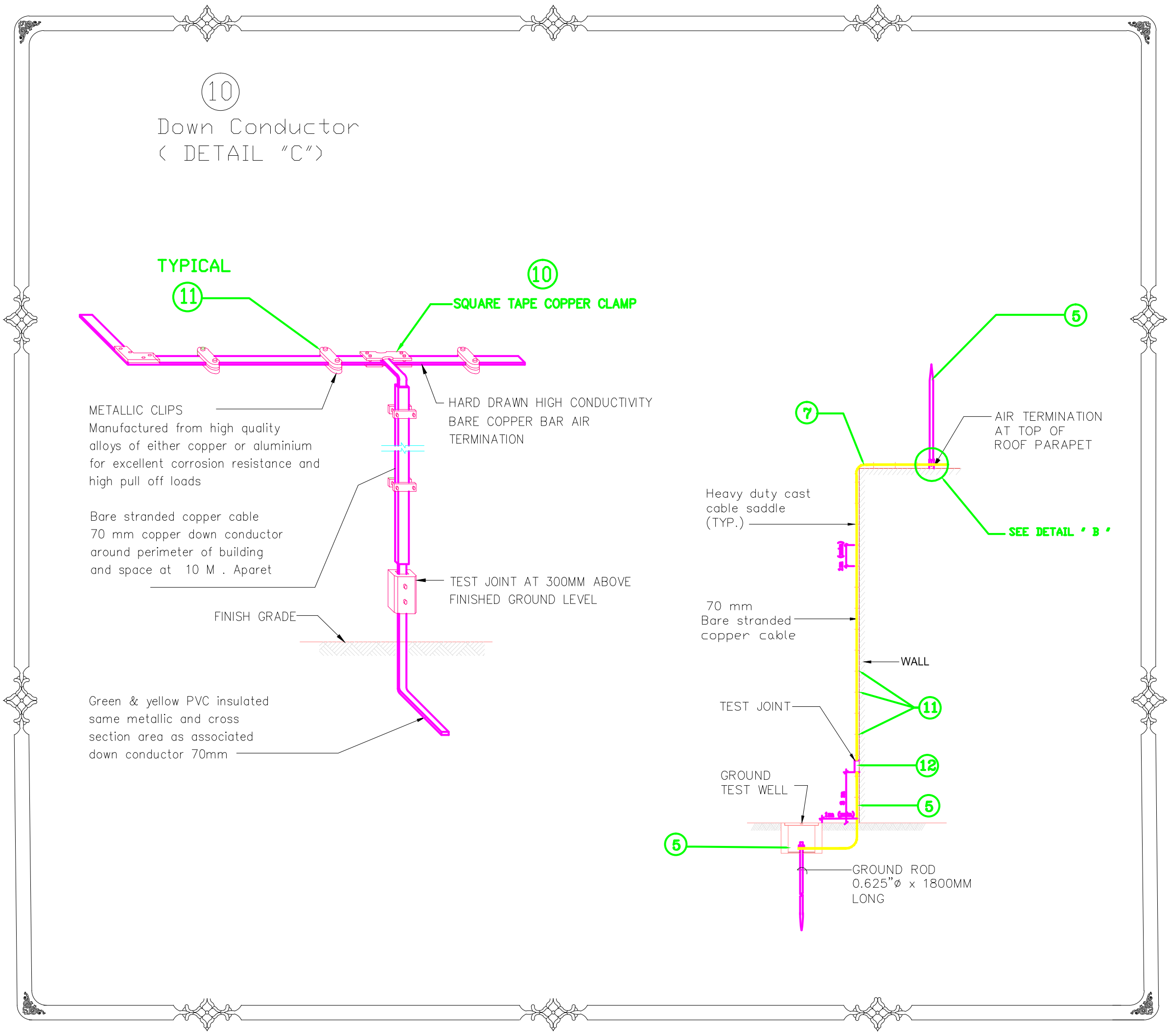
جامعة بوليتكنيك فلسطين
دائرة الهندسة الكهربائية
مبنى B+

تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى B+ فى حرم جامعة
بوليتكنك فلسطين

اسم اللوحة :
مخطط نظام التاريض للمبنى

وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 3
التاريخ : 2018/ 12/ 6
مقياس الرسم 1:200



جامعة بوليتكنيك فلسطين
دائرة الهندسة الكهربائية
مبنى B+

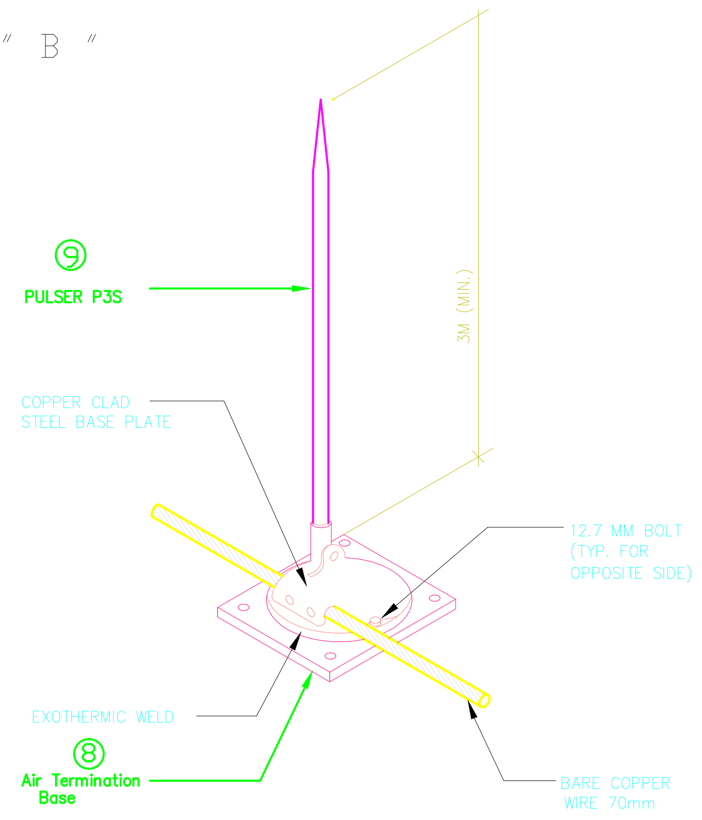
تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى B+ فى حرم جامعة
بوليتكنك فلسطين

اسم اللوحة :
Down Conductor

وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 4
التاريخ : 2018/ 12/ 6
مقياس الرسم 1:200

DETAIL " B "



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى B+

تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى B+ فى حرم جامعة
بوليتكنك فلسطين

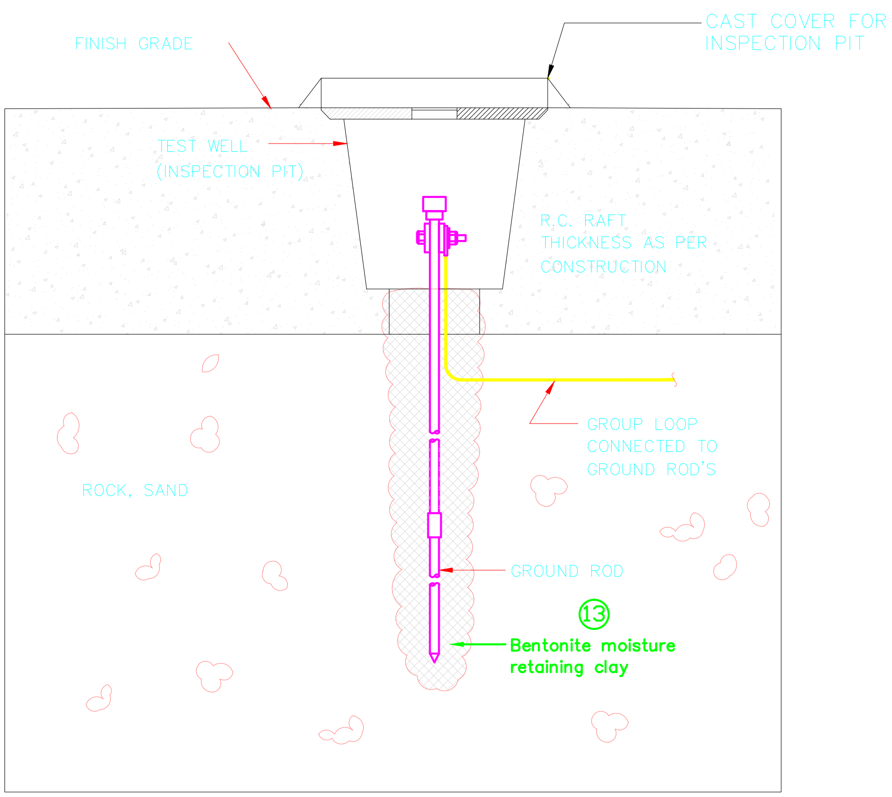
اسم اللوحة :
Air Termination

وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 5

التاريخ : 2018/ 12/ 6

مقياس الرسم 1:200



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى B+

تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى B+ فى حرم جامعة
بوليتكنك فلسطين

اسم اللوحة : معالجة التربة
كيميائيا لتقليل المقاومة

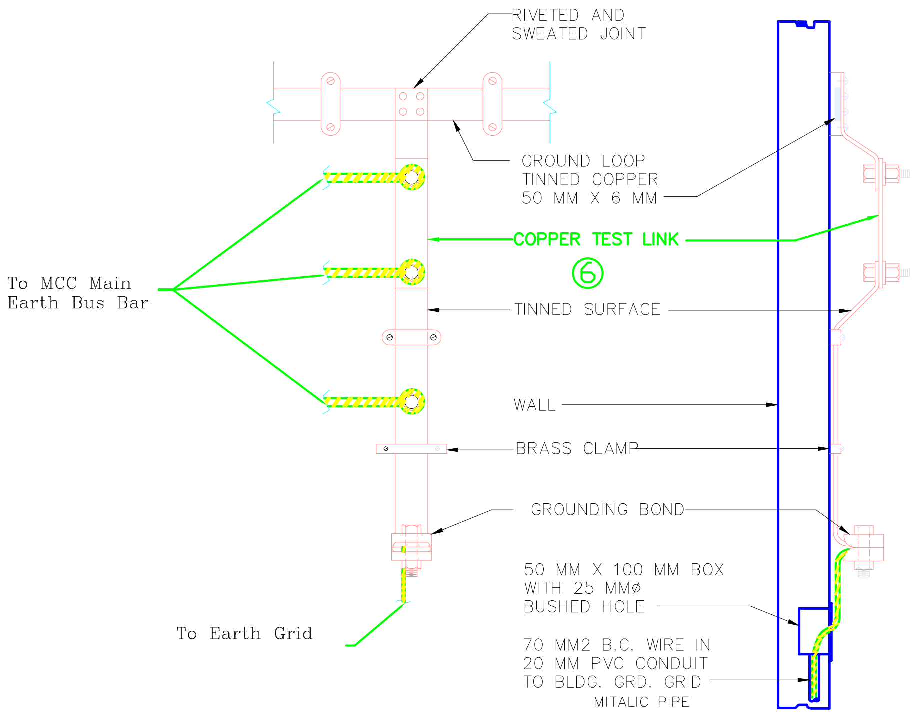
وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 6

التاريخ : 2018/ 12/ 6

مقياس الرسم 1:200

DETAIL " H "



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى **B+**

تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى **B+** فى حرم جامعة
بوليتكنك فلسطين

اسم اللوحة :
Earth BusBar in MDB

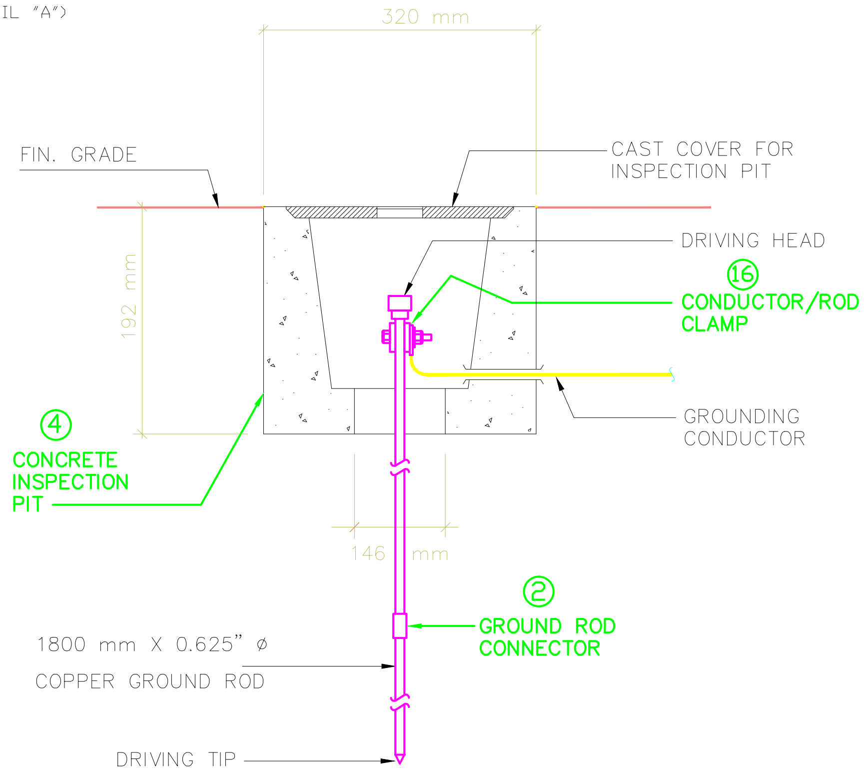
وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 7

التاريخ : 2018/ 12/ 6

مقياس الرسم **1:200**

(DETAIL "A")



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى **B+**

تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى **B+** فى حرم جامعة
بوليتكنك فلسطين

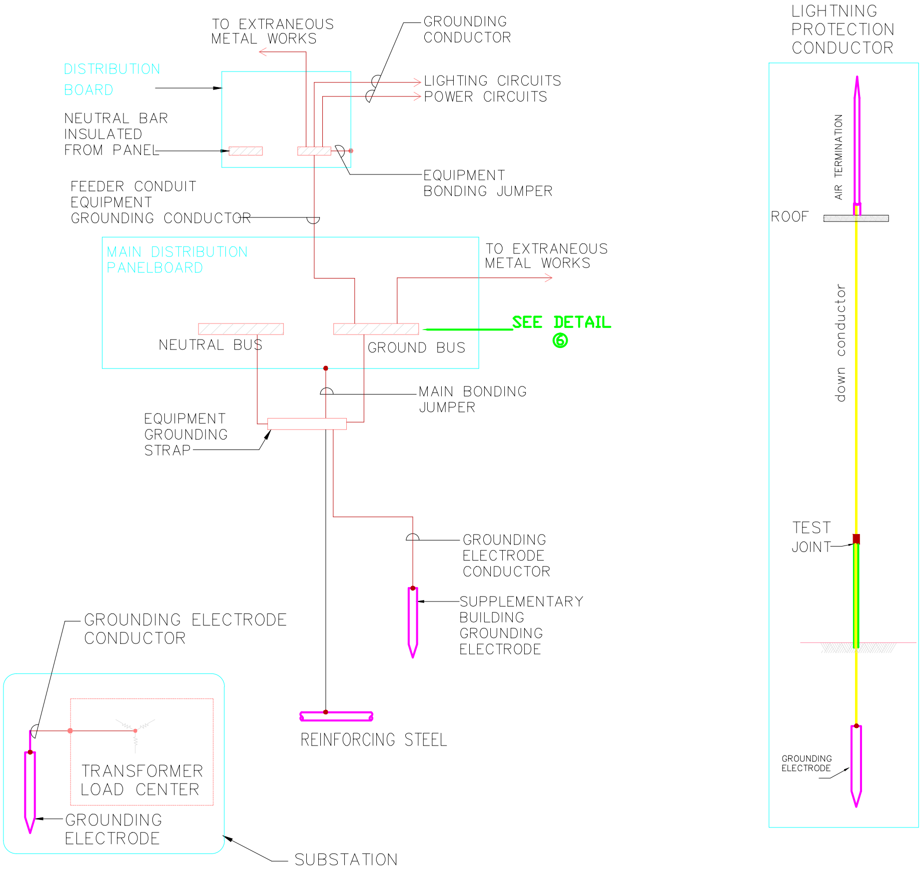
اسم اللوحة :
مخطط تفصيلى للالكترود التاريض

وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 8

التاريخ : 2018/ 12/ 6

مقياس الرسم **1:200**



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى B+

تصميم نظام حماية من الصواعق و الجهد الزائد مبنى B+ فى حرم جامعة بوليتكنك فلسطين

اسم اللوحة : مخطط نظام التاريض داخل شبكة T T

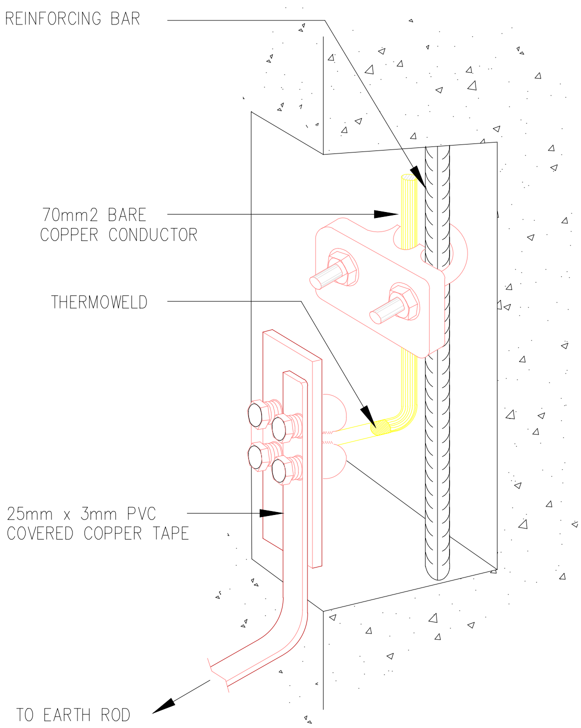
وليد مروان عمر اسعيد

انس رزق سالم ابوزنيد

رقم اللوحة A 9

التاريخ : 2018/ 12/ 6

مقياس الرسم 1:200



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى B+

تصميم نظام حماية من الصواعق و الجهد الزائد مبنى B+ فى حرم جامعة بوليتكنك فلسطين

اسم اللوحة : ربط الاساسات مع التاريض

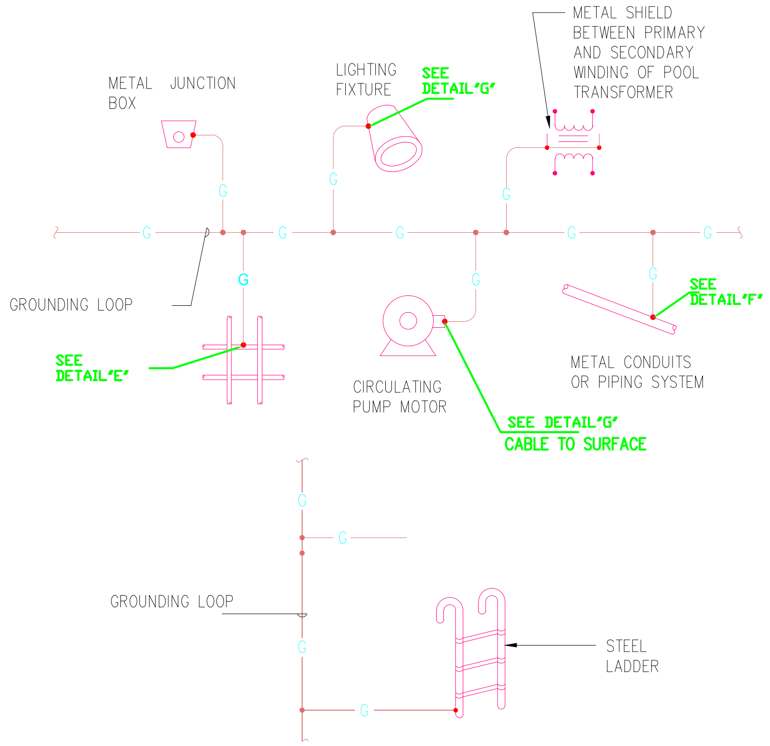
وليد مروان عمر اسعيد

انس رزق سالم ابوزنيد

رقم اللوحة A 10

التاريخ : 2018/ 12/ 6

مقياس الرسم 1:200



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى B+

تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى B+ فى حرم جامعة
بوليتكنك فلسطين

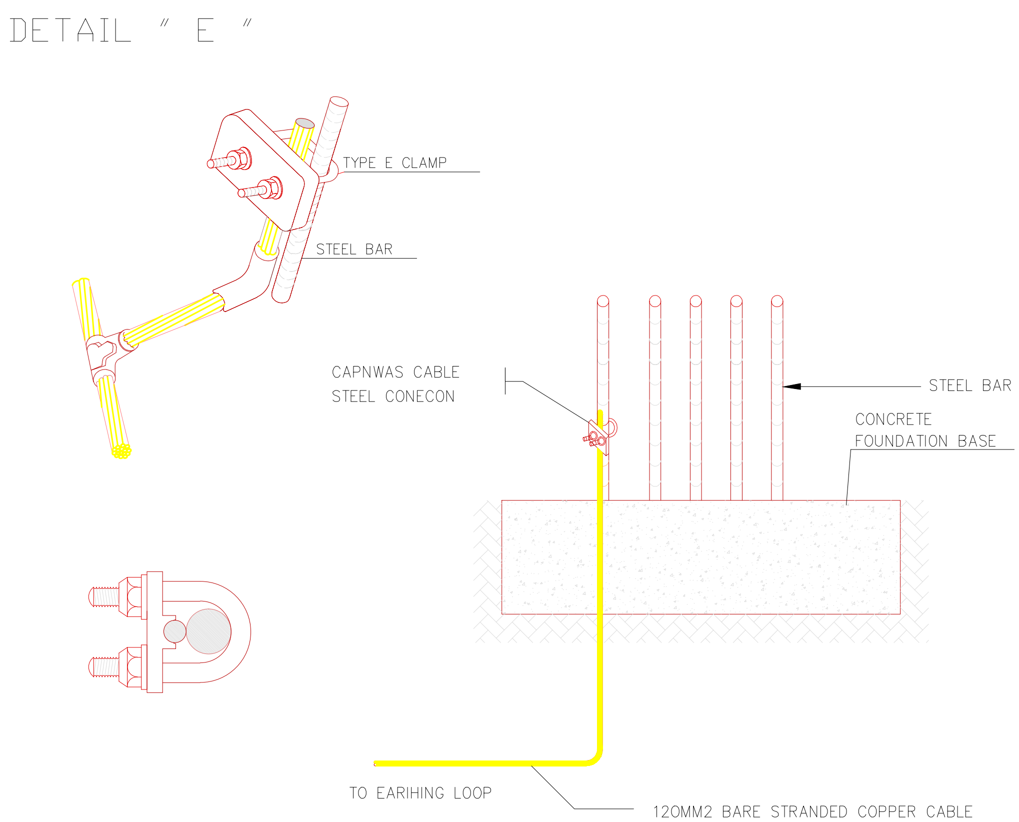
اسم اللوحة : ربط الاجزاء
المعدنية داخل المبنى بالتاريض

وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 11

التاريخ : 2018/ 12/ 6

مقياس الرسم 1:200



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى B+

تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى B+ فى حرم جامعة
بوليتكنك فلسطين

اسم اللوحة :
ربط الاساسات مع التاريض

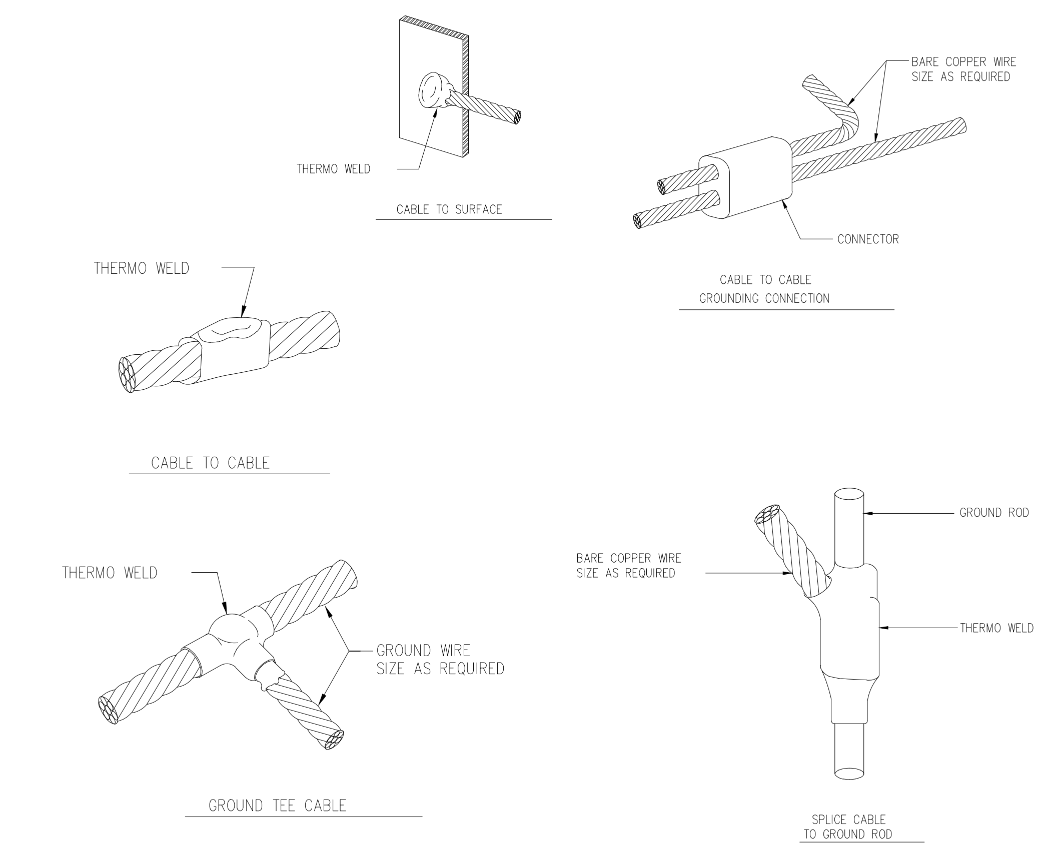
وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 12

التاريخ : 2018/ 12/ 6

مقياس الرسم 1:200

DETAIL " G "



جامعة بوليتكنيك فلسطين
دائرة الهندسة الكهربائية
مبنى B+

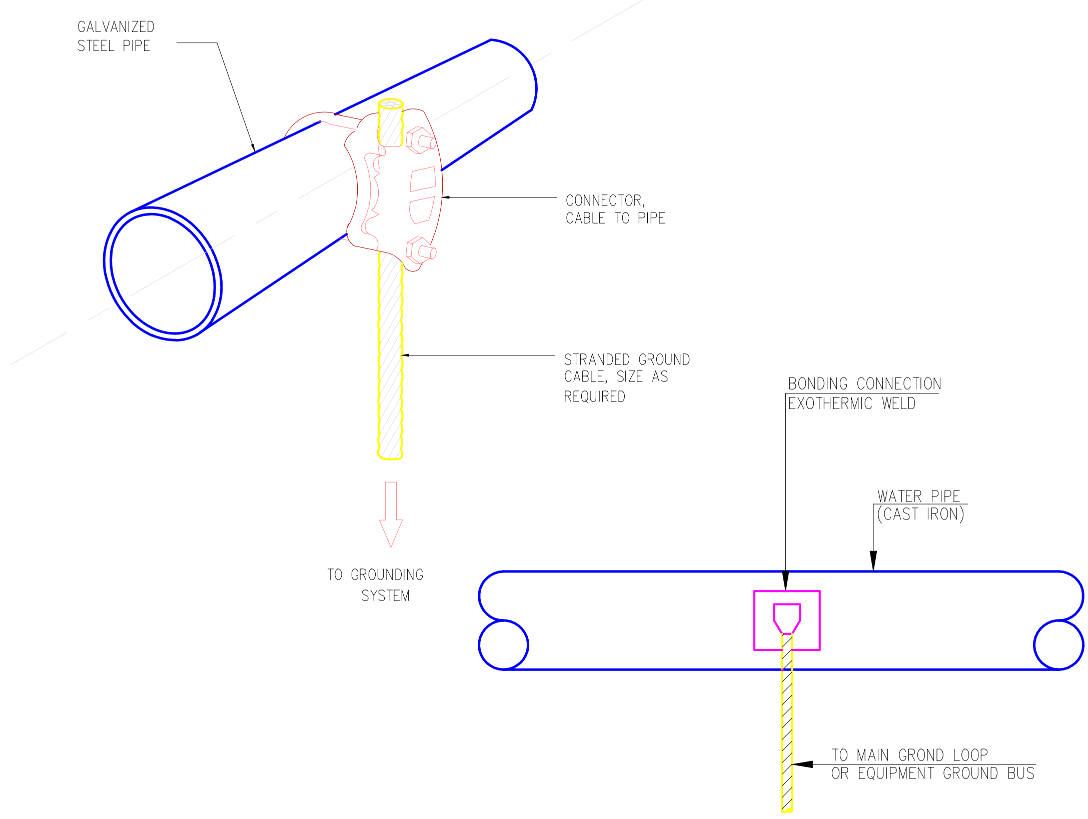
تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى B+ فى حرم جامعة
بوليتكنك فلسطين

اسم اللوحة :
طرق ربط الاسلاك

وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 13
التاريخ : 2018/ 12/ 6
مقياس الرسم 1:200

DETAIL " F "



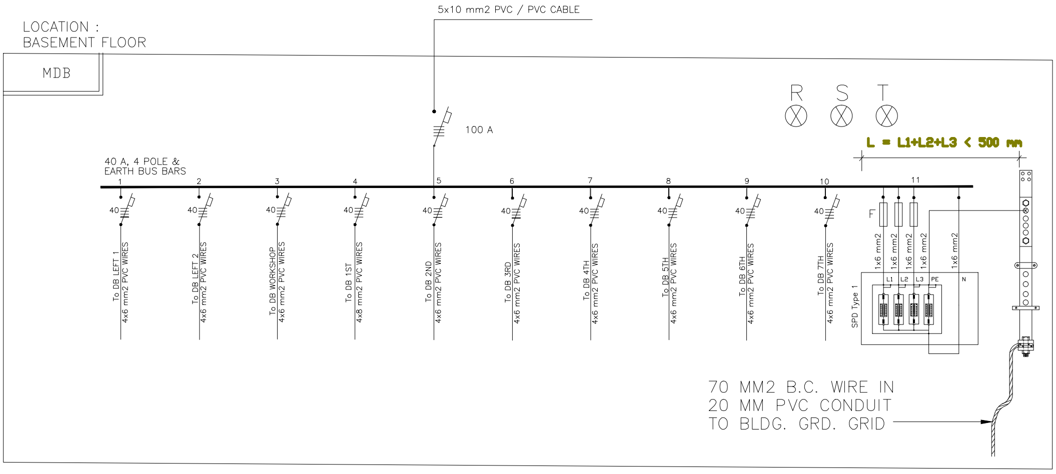
جامعة بوليتكنيك فلسطين
دائرة الهندسة الكهربائية
مبنى B+

تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى B+ فى حرم جامعة
بوليتكنك فلسطين

اسم اللوحة :
طرق ربط الاسلاك مع الانابيب

وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 14
التاريخ : 2018/ 12/ 6
مقياس الرسم 1:200



The SPD Type 1, fitted in the installation's main incoming electrical switchboard (MDB), is capable of deviating the energy of a direct lightning strike. This is the first stage of the electrical network's protection.

The behavior of the cables, subjected to a transient signal, limits the effectiveness of a surge arrester to 10 m. It is therefore necessary to use one or more surge arresters in the installation in order to obtain the required level of protection for the equipment.

Surge protection device (SPD) : designed to run-off energy caused by an overvoltage comparable to that of a direct lightning strike. It has successfully passed testing to the standard with the 10/350 wave (class I test).

جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى +B

تصميم نظام حماية

من الصواعق و الجهد الزائد

مبنى +B فى حرم جامعة

بوليتكنك فلسطين

اسم اللوحة : موقع

SPD Typy Iفى الوحة الرئيسة

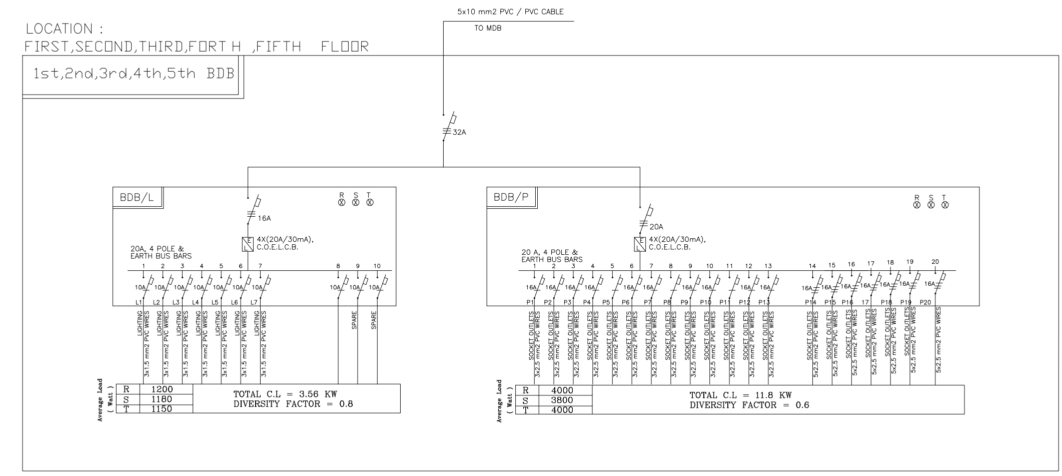
وليد مروان عمر اسعيد

انس رزق سالم ابوزنيد

رقم اللوحة A 15

التاريخ : 6 /12 /2018

مقياس الرسم 1:200



Note :

$$\text{Diversity Factor} = \frac{\text{Sum of Individual Max. Demand}}{\text{Max. Demand on power Station}}$$

جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى +B

تصميم نظام حماية

من الصواعق و الجهد الزائد

مبنى +B فى حرم جامعة

بوليتكنك فلسطين

اسم اللوحة :

مخطط نظام التاريض للمبنى

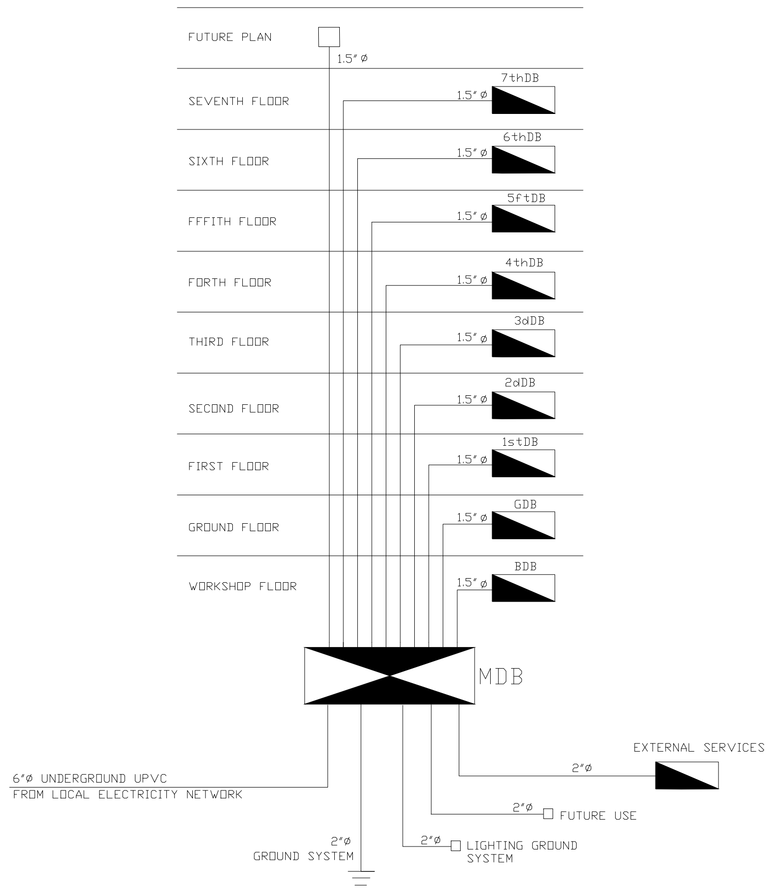
وليد مروان عمر اسعيد

انس رزق سالم ابوزنيد

رقم اللوحة A 16

التاريخ : 6 /12 /2018

مقياس الرسم 1:200



جامعة بوليتكنيك فلسطين

دائرة الهندسة الكهربائية

مبنى B+

تصميم نظام حماية
من الصواعق و الجهد الزائد
مبنى B+ فى حرم جامعة
بوليتكنك فلسطين

اسم اللوحة :

DB RISER DIAGRAM

وليد مروان عمر اسعيد
انس رزق سالم ابوزنيد

رقم اللوحة A 17

التاريخ : 2018/ 12/ 6

مقياس الرسم 1:200

Appendix D

Equipment specification of lightning protection system

choosing all component from ABB international Company (Earthing & lightning protection Total solution catalogue).

Paratonnerres hélita®
hélita® lightning protection systems

Direct Lightning Protection

Paratonnerre

Type :	**PULSAR P3S**
Part :	2CTH030007R0000
EAN :	3660308521767

Electrical characteristics

Caractéristiques électriques

Lightning current withstand (10/350µs) *Tenue en onde de foudre (10/350µs)*	kA	100
Gain in Sparkover Time *Avance à l'amorçage*	µs	10
EMC Interferences measurements / Interferences immunity *CEM : Mesure des perturbations / Immunité aux perturbations*		Compliance to EN 50 081.1 / EN 50 082.2 Conforme à EN 50 081.1 / EN 50 082.2
Rp : Pulsar's protection area (m) *Rp : Rayons de protection des PULSAR (m)*		

Protection level according to NFC17102 *Niveau de protection selon NFC17102*	h :PULSARr's heigh mounted with its tip (m) h : *Hauteur de la pointe des PULSAR(m)*										
	2	3	4	5	6	8	10	15	20	45	60
I (D=20m)	10	16	21	26	27	27	28	30	30	30	30
II (D=30m)	12	19	25	31	32	33	35	37	39	40	40
III (D=45m)	15	23	30	38	39	41	42	26	49	55	55
IV (D=60m)	17	26	35	43	45	47	49	54	57	68	70

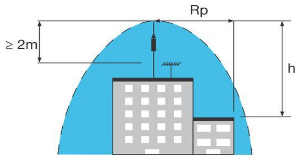
Mechanical characteristics

Caratéristiques mécaniques

Fixations *Fixations*		Threaded base M30x1.25 Embase taraudee M30x1.25
Degree of protection *Indice de protection*		IP 67
Wind withstand *Tenue au vent*	km/h	230
Marking *Marquage*		Serial number burn on product N° de serie grave sur le produit
Corrosion resistance *Tenue à la corrosion*		
Salt mist *Brouillard salin*		168h according to CEI 60068-2-11 / NF C20-711 168h selon la norme CEI 60068-2-11 / NF C20-711
Sulfur dioxide *Dioxyde de souffre*		7 days according to NF EN ISO 6988 7 jours suivant NF EN ISO 6988
Stability to thermal and humidity stresses *Stabilité aux contraintes thermiques et d'humidité*		According to CEI 60068-2-61 / NF C20-761 Selon la norme CEI 60068-2-61 / NF C20-761

Miscellaneous characteristics

Caractéristiques diverses



Stocking temperature / Operating temperature *Température de stockage / Température de fonctionnement*	°C	- 20 to +120 / - 20 to +120
Body weight *Poids du corps*	kg	2,4
Total weight *Poids total*	kg	2,4
Patent *Brevet*		EP 0 192 000 B1
Body dimensions *Dimensions corps (W x Ø)*	mm	170 x 74
Tip dimensions *Dimensions pointe (W x Ø)*	mm	46 x 18
Mast dimensions *Dimensions mat (W x Ø)*	mm	-
Color *Couleur*		Stainless steel Inox
Rodcheck protection *Protection Rodcheck*		Yes / Oui
State indicator *Indicateur d'état*		Yes / Oui

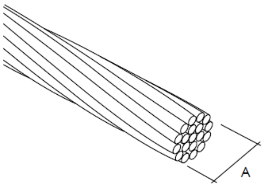
Bare stranded copper cable

Part no.	Cross-sectional area (mm²)	Stranding no. / mm ø	Nominal diameter (A) (mm)	Weight per metre (kg)
Soft drawn stranded copper cable				
CB006	6	7/1.04	Ø 3.12	0.05
CB016	16	7/1.70	Ø 5.10	0.15
CB025	25	7/2.14	Ø 6.42	0.23
CB035	35	7/2.52	Ø 7.56	0.32
CB050-FU	50	19/1.78	Ø 8.90	0.43
CB070	70	19/2.14	Ø 10.70	0.62
CB095	95	19/2.52	Ø 12.60	0.86
CB120	120	37/2.03	Ø 14.21	1.09
CB150-FU	150	37/2.25	Ø 15.75	1.33
CB185	185	37/2.52	Ø 17.64	1.67
CB240	240	61/2.25	Ø 20.25	2.20
CB300-FU	300	61/2.52	Ø 22.68	2.76
CB400-FU	400	61/2.85	Ø 25.65	3.53
Tinned soft drawn stranded copper cable				
CB070-T*	70	19/2.14	Ø 10.70	0.62
Hard drawn stranded copper cable				
CB071*	70	7/3.55	Ø 10.70	0.64

– *Additional sizes available on request

Standards

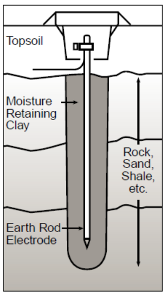
BS EN 60228 (soft drawn)
BS EN 7884 (hard drawn)



Bentonite moisture retaining clay

Part no.	Description	Weight each (kg)
CM015	Bentonite powder	25.00
CM020	Bentonite granules	25.00

– Used as an earth-electrode backfill to reduce soil resistivity by retaining moisture. The clay is a sodium activated montmorillonite, which when mixed with water swells to many times its dry volume. It has the ability to hold its moisture content for a considerable period of time and to absorb moisture from the surrounding soil (e.g. from rainfall)
CoSHH datasheet available on request



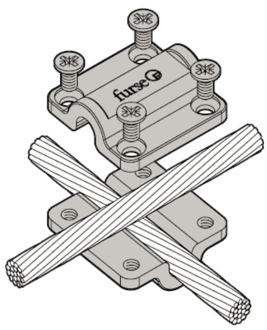
Cable to cable square clamp

Part no.	Conductor size (mm²)	Conductor material	Weight each (kg)
CR810	50	Copper	0.32
CR815	70	Copper	0.29
CR820	95	Copper	0.25

– Manufactured from high quality copper alloy. Simple to install, providing an effective low resistance connection between overlapping stranded conductors allowing cross, tee, through and right angle joints to be formed
– Tightening torque 5 Nm

Standards

BS EN 62561-1 Class H



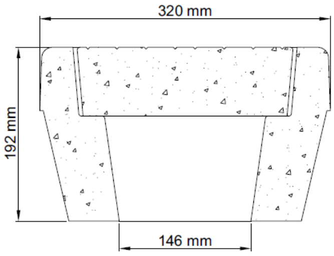
Concrete inspection pit

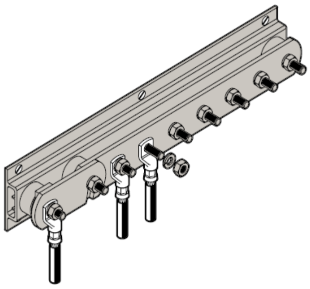
Part no.	Description	Weight each (kg)
Earth bars for concrete inspection pit		
PT005	Concrete inspection pit	30.00
Accessories		
PT006	5 hole earth bar	0.40
PT007	7 hole earth bar	0.58

– The concrete inspection pit is load rated to 3,500 kg and is suitable for most types of earthing and lightning protection installations
– It is not suitable for use in areas where high load, small wheel vehicles are used. The lightweight inspection pit (PT205) is recommended for this type of application

Standards

BS EN 62561-5



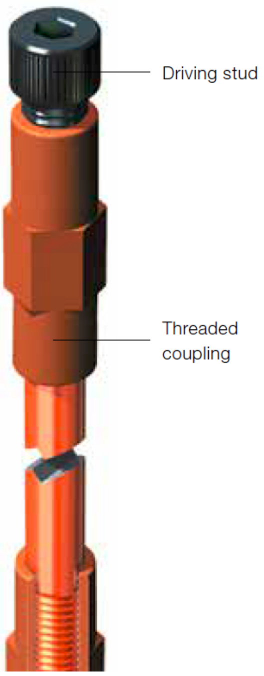


Earth bar with single disconnecting link

Part no.	Description	Length (mm)	Weight each (kg)
Copper earth bar			
LK243-6	6 way	475	2.30
LK243-8	8 way	575	2.70
LK243-10	10 way	725	3.30
LK243-12	12 way	825	3.70
LK243-14	14 way	925	4.10
LK243-16	16 way	1025	4.50
LK243-18	18 way	1125	4.90
LK243-20	20 way	1275	5.50
LK243-22	22 way	1375	5.90
LK243-24	24 way	1475	6.30
LK243-26	26 way	1575	6.70
LK243-28	28 way	1725	7.40
LK243-30	30 way	1825	7.80

Standards

BS 7430



Earth rods

Part no.	Nominal diameter (")	Length (mm)	Thread 'B' UNC (")	Shank 'A' (mm)	Weight each (kg)
RB105	Ø½	1,200	9/16	12.7	1.18
RB110	Ø½	1,500	9/16	12.7	1.55
RB115	Ø½	1,800	9/16	12.7	1.76
RB125	Ø½	2,400	9/16	12.7	2.36
RB205-FU	Ø⅝	1,200	⅝	14.2	1.53
RB210	Ø⅝	1,500	⅝	14.2	1.88
RB215	Ø⅝	1,800	⅝	14.2	2.29
RB220-FU	Ø⅝	2,100	⅝	14.2	2.51
RB225	Ø⅝	2,400	⅝	14.2	3.00
RB235	Ø⅝	3,000	⅝	14.2	3.79
RB305	Ø¾	1,200	¾	17.2	2.19
RB310	Ø¾	1,500	¾	17.2	2.73
RB315	Ø¾	1,800	¾	17.2	3.27
RB320-FU	Ø¾	2,100	¾	17.2	3.83
RB325	Ø¾	2,400	¾	17.2	4.35
RB335	Ø¾	3,000	¾	17.2	5.44

– High tensile low carbon steel core with minimum 250 microns of copper

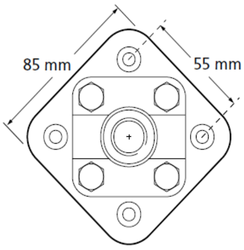
Flat saddle

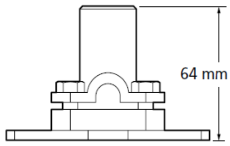
Part no.	Air rod diameter (mm)	Thread size	Conductor size (mm²)	Conductor material	Weight each (kg)
SD155	Ø 15	M16	50	Copper	1.03
SD160	Ø 15	M16	70	Copper	0.95
SD165	Ø 15	M16	95	Copper	0.95

– Manufactured from high quality copper alloy
– Simple to install, providing an effective connection between air rod and stranded conductor
– Fix using countersunk wood screws 1½" No. 10 or M6 (Part no. SW005) and wall plugs (Part no. PS305)
– Tightening torque 12 Nm

Standards

IEC/BS EN 62561-1 Class H





Free-standing interception pole

Part no.	Pole height (m)	Pole diameter (mm)	Pole construction	Weight each (kg)
912000-FU	3	Ø 10-42	2 piece	5.0
912001-FU	3.5	Ø 10-42	2 piece	5.5
912002-FU	4	Ø 10-42	2 piece	7.0
912003-FU	4.5	Ø 10-42	2 piece	9.2
912004-FU	5	Ø 10-42	2 piece	10.0
912005-FU	5.5	Ø 10-42	2 piece	10.6
912006-FU	6	Ø 10-60	3 piece	18.0
912007-FU	6.5	Ø 10-60	3 piece	19.0
912008-FU	7	Ø 10-60	3 piece	23.5
912009-FU	7.5	Ø 10-60	3 piece	26.0
912010-FU	8	Ø 10-60	3 piece	28.7
912011-FU	9	Ø 10-60	3 piece	30.5
912013-FU	10	Ø 10-60	3 piece	35.5

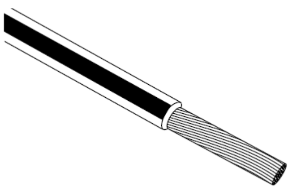
– Interception poles manufactured from stainless steel 304 with aluminium interception tip
– For construction of interception air rods from 3 to 10 m in height comprising interception pole, support frame and concrete bases
– Multi-component, stackable system with screw retention. Supplied with 3 terminal lugs for base frame connection

Green & yellow PVC insulated stranded copper cable

Part no.	Cross-sectional area (mm²)	Stranding no. / mm ø	Weight per metre (kg)	Colour range
CC016	16	7/1.70	0.19	Green & Yellow
CC025	25	7/2.14	0.29	Green & Yellow
CC035	35	7/2.52	0.41	Green & Yellow
CC050	50	19/1.78	0.53	Green & Yellow
CC070	70	19/2.14	0.73	Green & Yellow
CC095	95	19/2.52	1.00	Green & Yellow
CC120-FU	120	37/2.03	1.27	Green & Yellow
CC150-FU	150	37/2.25	1.54	Green & Yellow
CC185	185	37/2.52	2.01	Green & Yellow
CC240	240	61/2.25	2.49	Green & Yellow
CC300	300	61/2.52	3.05	Green & Yellow
CC400-FU	400	61/2.85	3.90	Green & Yellow

Standards

BS EN 50525 (copper)
BS 6746C (PVC colour)



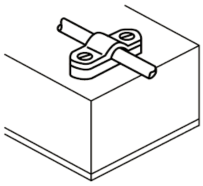
Standards

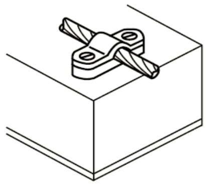
IEC/BS EN 62561-4

Heavy duty cast cable saddle

Part no.	Conductor size (mm)	Conductor material	Weight each (kg)
For use with solid circular conductor			
CP805	Ø 8	Copper	0.09
CP806	Ø 8	Aluminium	0.03
CP815	Ø 10*	Copper	0.10
CP816	Ø 10*	Aluminium	0.04
For use with stranded conductor			
CP810	50 mm²	Copper	0.10
CP815	70 mm²	Copper	0.10
CP835	95 mm²	Copper	0.10
CP855	120 mm²	Copper	0.10

– Manufactured from high quality alloys of either copper or aluminium for excellent corrosion resistance and high pull off loads
– Fix using countersunk wood screws 1½" No. 10 or M6 (Part no. SW005 or SW105) and wall plugs (Part no. PS305)
– *For use with PVC covered Ø8 mm conductor or for supporting air terminals when used in conjunction with wall mounted air rod bases.
– Can also be used with glazing bar holdfast and back plate holdfast stem

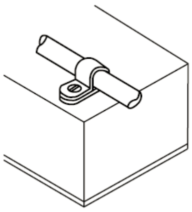


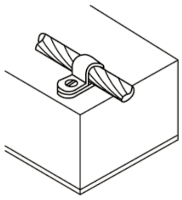


One hole cable clip

Part no.	Conductor size (mm)	Conductor material	Weight each (kg)
For use with solid circular conductor			
CP905	Ø 8	Copper	0.01
CP925	Ø 8	Aluminium	0.01
CP915	Ø 10*	Copper	0.01
CP935	Ø 10*	Aluminium	0.01
For use with stranded conductor			
CP910	50 mm²	Copper	0.01
CP915	70 mm²	Copper	0.01
CP920	95 mm²	Copper	0.01

– Manufactured from pure copper or aluminium, these pressed clips are available to suit bare and PVC covered copper and aluminium solid circular conductor, and bare copper stranded conductor
– Fix using roundhead wood screws 1½" No. 10 or M6 (Part no. SW305 or SW405) and wall plugs (Part no. PS305)
– *PVC covered Ø8 mm conductor
– Clip supplied in open position





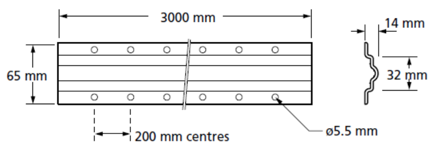
Standards

BS 1006 (PVC colour)

PVC protective down conductor guard

Part no.	Length (mm)	Weight each (kg)	Colour range
GC205	3000	1.00	Black
GC215	3000	1.00	Grey
GC220	3000	1.00	Stone
GC225	3000	1.00	White
GC230	3000	1.00	Brown

– Protects against vandalism and opportunity theft
– High impact PVC, UV stabilized to BS 1006 to reduce colour degradation
– Suitable to protect bare 25 x 3 mm flat tape, Ø 8 mm solid circular and 50 mm² stranded cable
– Fix using roundhead wood screws (Part no. SW405) and wall plugs (PS305)
– Other colours available to order



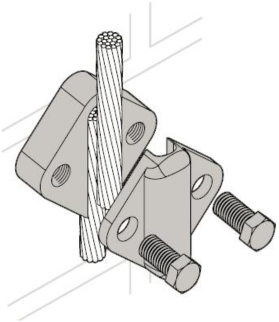
Square test clamp

Part no.	Conductor diameter (mm^2)	Conductor material	Weight each (kg)
CR855	50	Copper	0.39
CR860	70	Copper	0.40
CR865	95	Copper	0.40

– Manufactured from high quality copper alloy
– Simple to install, providing an effective low resistance overlap connection between stranded copper cables
– Fix using countersunk wood screws 1½" No. 10 or M6 (Part no. SW005) and wall plugs (Part no. PS305)
– Tightening torque 12 Nm

Standards

BS EN 62561-1 Class H



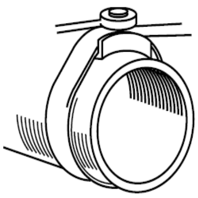
Watermain bond

Part no.	Maximum tape width (mm)	Conductor material	Weight each (kg)
BN120	26	Copper	0.26

– For bonding tape to large diameter pipes

Standards

BS 7430



Insulating tape

Part no.	Size	Weight each (kg)
TP120-FU	25 mm x 33 m	0.14

– Green/yellow general purpose insulating tape

ABB Surge Protective Device range

Lightning current arresters (Spark gap) - Type 1

OVR T1 3L 25 255

OVR T1 3N 25 255 TS

PRACTICAL INFO

Type 1 SPDs are installed at the entrance of the installation (such as main distribution board).

They provide either common mode or common and differential mode protection.

Type 1 Surge Protective Devices are lightning current arresters: they are designed to discharge high energy from lightning impulse current while ensuring equipotential bonding in case of direct lightning strike on the installation.

Standards Info

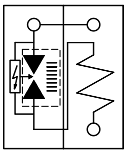
Type 1 SPDs comply with IEC 61643-1.

Type 1 SPDs are recommended for locations having a high exposure to lightning, for example, line entrances to buildings protected by lightning rods or powered by aerial lines. These products are installed at the entrance of the installation (such as main distribution board).

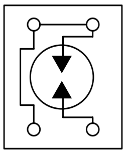
The coordination of the Type 1 SPDs with the upstream fuse avoids nuisance tripping, for a better continuity of service.

The Type 1 SPD is immune to variations in the network voltage up to 400 V, thanks to its high TOV (Temporary Overvoltage) withstand.

Schematic diagrams

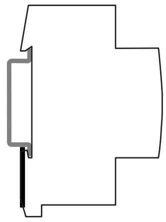


OVR T1 25 255

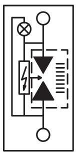


OVR T1 50 N
OVR T1 100 N

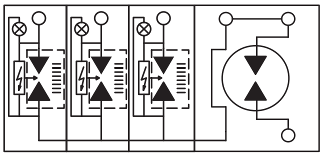
Fixing



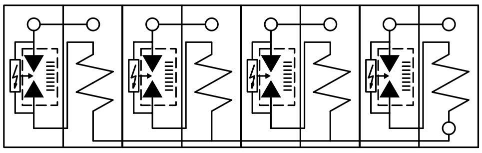
Simply clips onto DIN rail.



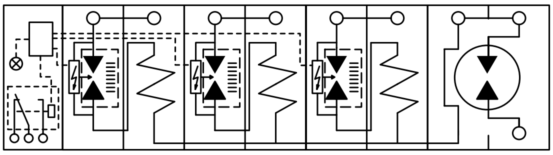
OVR T1 25 255-7



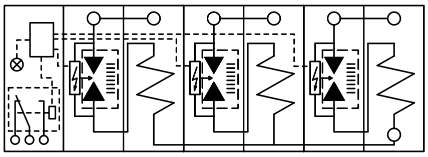
OVR T1 3N 25 255-7



OVR T1 4L 25 255



OVR T1 3N 25 255 TS

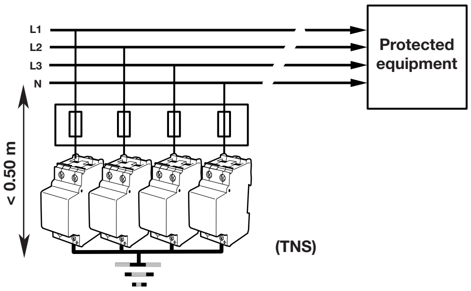


OVR T1 3L 25 255 TS

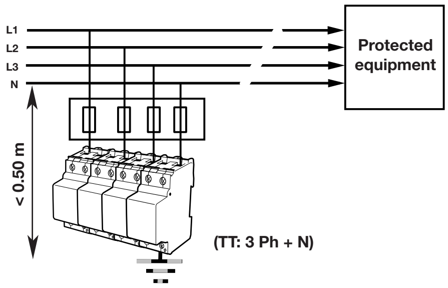
Dimensions

Dimensions	W (mm)	H (mm)	D (mm)
OVR T1 25 255-7	17.5	85	63
OVR T1 3N 25 255-7	87.5	85	63
OVR T1 25 255 / OVR T1 50 N / OVR T1 100 N	35	85	58
OVR T1 1N 25 255	70	85	58
OVR T1 3L 25 255	105	85	58
OVR T1 3N 25 255 / OVR T1 4L 25 255	140	85	58
OVR T1 1N 25 255 TS	87.5	85	58
OVR T1 3L 25 255 TS	122.5	85	58
OVR T1 3N 25 255 TS / OVR T1 4L 25 255 TS	157.5	85	58

Connection



OVR T1 25 255



OVR T1 3N 25 255

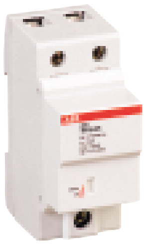
ABB Surge Protective Device range

Lightning current arresters (Spark gap) - Characteristics

	More info	OVR T1 25 255-7 (2CTB815101R8700)	OVR T1 3N 25 255-7 (2CTB815101R8800)	OVR T1 25 255 (2CTB815101R0100)	OVR T1 3L 25 255 (2CTB815101R1300)	OVR T1 3L 25 255 TS (2CTB815101R0600)	OVR T1 4L 25 255 (2CTB815101R1400)	OVR T1 4L 25 255 TS (2CTB815101R0800)	OVR T1 1N 25 255 (2CTB815101R1500)	OVR T1 1N 25 255 TS (2CTB815101R1000)	OVR T1 3N 25 255 (2CTB815101R1600)	OVR T1 3N 25 255 TS (2CTB815101R0700)	OVR T1 25 440-50 (2CTB815101R9300) New !	OVR T1 50 N (2CTB815101R0400)	OVR T1 100 N (2CTB815101R0500)
		25 kA (10/350)												Neutral 50 kA (10/350)	Neutral 100 kA (10/350)
Electrical characteristics															
Types of network	p.10	TNS-TNC-TT	TT	TNS-TNC-TT	TNC	TNC	TNS-TT	TNS-TT	TT	TT	TT	TT	TNC-TNS-TT-IT	TT	TT
Number of poles		1	4	1	3	3	4	4	2	2	4	4	1	1	1
Type of surge arrester		1	1	1	1	1	1	1	1	1	1	1	1	1	1
Type of current		A.C.	A.C.	A.C.	A.C.	A.C.	A.C.	A.C.	A.C.	A.C.	A.C.	A.C.	A.C.	A.C.	A.C.
Nominal voltage: U_n	p. 7	230 V	230 V	230 V	230 V	230 V	230 V	230 V	230 V	230 V	230 V	230 V	400 V	-	-
Max. cont operating voltage: U_c	p. 8	255 V	255 V	255 V	255 V	255 V	255 V	255 V	255 V	255 V	255 V	255 V	440 V	255 V	255 V
Impulse current: I_{imp} (10/350 wave)	p. 7	25 kA	25/100 kA	25 kA	25/75 kA	25/75 kA	25/100 kA	25/100 kA	25/50 kA	25/50 kA	25/100 kA	25/100 kA	25 kA	50 kA	100 kA
Nominal discharge current: I_n (8/20 wave)	p. 7	25 kA	25 kA	25 kA	25 kA	25 kA	25 kA	25 kA	25 kA	25 kA	25 kA	25 kA	25 kA	50 kA	100 kA
Voltage protection level: U_p	p. 7	2.5 kV	2.5 kV	2.5 kV	2.5 kV	2.5 kV	2.5 kV	2.5 kV	2.5 / 1.5 kV	2.5 / 1.5 kV	2.5 / 1.5 kV	2.5 / 1.5 kV	2 kV	1.5 kV	1.5 kV
Follow current: I_f		7 kA	7 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	0.1 kA	0.1 kA
TOV withstand: U_T (5 s.)		650 V	650 V	400 V	400 V	400 V	400 V	400 V	400 V	400 V	400 V	400 V	690 V	1200 V (200 ms)	
Continuous operating current: I_c		< 1 mA	< 1 mA	< 0.2 mA	< 0.2 mA	< 10 mA	< 0.2 mA	< 10 mA	< 0.2 mA	< 10 mA	< 0.2 mA	< 10 mA	< 0.2 mA	< 0.2 mA	< 0.2 mA
Short-circuit withstand capability: I_{sc}		50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	50 kA	N/A	N/A
Response time: t_A		< 100 ns.	< 100 ns.	< 100 ns.	< 100 ns.	< 100 ns.	< 100 ns.	< 100 ns.	< 100 ns.	< 100 ns.	< 100 ns.	< 100 ns.	< 500 ns.	< 100 ns.	< 100 ns.
Load current: I_{load}		-	-	125 A	125 A	125 A	125 A	125 A	125 A	125 A	125 A	125 A	-	125 A	125 A
Max. back-up fuse: gG / gL	p. 45	125 A	125 A	125 A	125 A	125 A	125 A	125 A	125 A	125 A	125 A	125 A	125 A	125 A	125 A
Mechanical and installation characteristics															
L/N/PE connection terminals: – solid wire		2.5 ... 50 mm²													
– stranded wire		2.5 ... 35 mm²													
L/N/PE stripping length		15													
L/N/PE tightening torque		3.5													
Indicator	p. 18	Yes	Yes	No	No	Yes	No	Yes	No	Yes	No	Yes	No	No	No
Remote indicator (TS)	p. 18	No	No	No	No	Yes	No	Yes	No	Yes	No	Yes	No	No	No
Miscellaneous characteristics															
Degree of protection		IP 20													
Temperature range		-40 °C to +80 °C													
Maximum altitude		2000 m													
Case material		PA grey RAL 7035													
Insulating material		UL94 V0 classification													
Reference standards		IEC 61643-1 / EN 61643-11													
Weight		125 g	625 g	250 g	750 g	850 g	1000 g	1100 g	1000 g	1100 g	1000 g	1100 g	270 g	250 g	250 g

ABB Surge Protective Device range

Single-block multi-pole surge arresters - Type 2



OVR 1N 15 275

OVR 4L 65 440 s

The single-block multi-pole modular power Type 2 surge arresters provide protection for equipment against transient overvoltages that occur on the electrical network (mains).

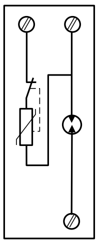
The maximum available discharge currents (I_{max}) range from 15 to 65 kA (8/20 µs waveform). The range consist of 2 and 4-pole models.

Standards Info

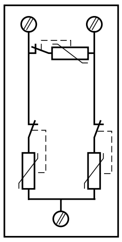
The modular power Type 2 surge arresters comply with IEC 61643-1 and EN 61643-11.

The relevant standard for the installation of this type of surge arrester is: IEC 61643-12.

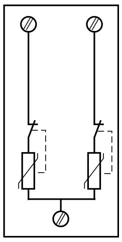
Schematic diagrams



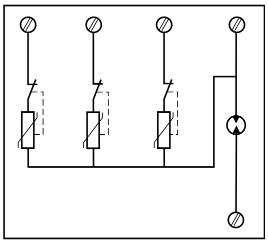
OVR 1N 10



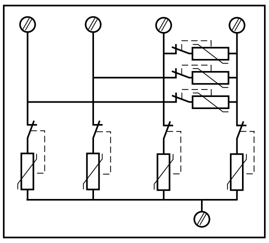
OVR 1N 15 / 40



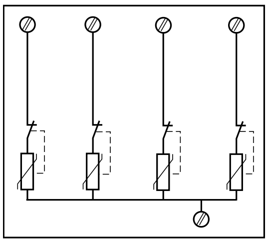
OVR 2L 65



OVR 3N 10

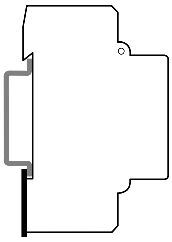


OVR 3N 15 / 40



OVR 4L 65

Fixing

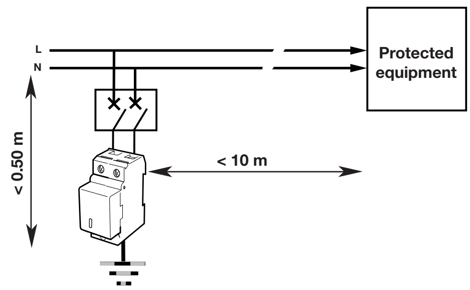


Simply clips onto DIN rail.

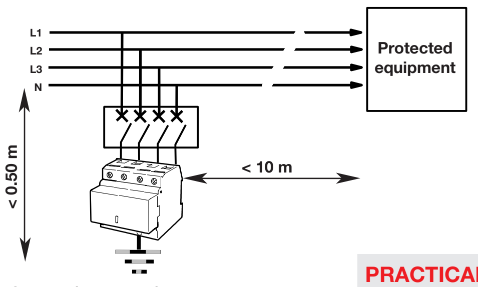
Dimensions

Dimensions	W (mm)	H (mm)	D (mm)
OVR 1N	35	85	63
OVR 3N / 4L	70	85	63

Connection

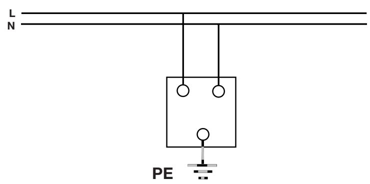


OVR 1N (all models)

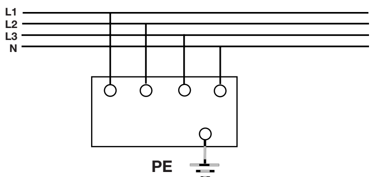


OVR 3N (all models)

Types of network



TT - TNS networks (2-pole models)



TT - TNS networks (4-pole models)

PRACTICAL INFO

Modular power Type 2 surge arresters are installed in sub-distribution boards using DIN rail. They provide common mode and differential mode protection (apart from OVR 2L / 4L 65 kA models, common mode only).

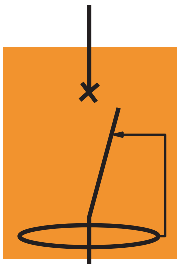
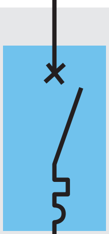
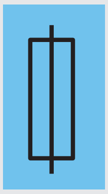
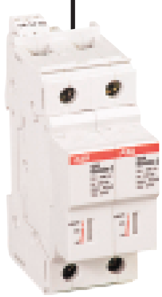
ABB Surge Protective Device range

Single-block multi-pole surge arresters - Characteristics

	More info	10 kA (8/20)		15 kA (8/20)		40 kA (8/20)		65 kA (8/20)			
		OVR 1N 10 275 (2CTB813912R1000)	OVR 3N 10 275 (2CTB813913R1000)	OVR 1N 15 275 (2CTB813912R0400)	OVR 3N 15 275 (2CTB813913R0400)	OVR 1N 40 275 (2CTB813912R0300)	OVR 3N 40 275 (2CTB813913R0300)	OVR 2L 65 440 (2CTB813912R0200)	OVR 2L 65 440 s (2CTB813812R0700)	OVR 4L 65 440 (2CTB813913R0200)	OVR 4L 65 440 s (2CTB813813R0700)
Electrical characteristics											
Types of network	p.10	TNS-TT		TNS-TT-IT		TNS-TT-IT		IT-TNS-TT			
Number of poles		2	4	2	4	2	4	2		4	
Type of surge arrester		2		2		2		2			
Type of current		A.C.		A.C.		A.C.		A.C.			
Nominal voltage: U_n	p. 7	230 V		230 V		230 V		230 V			
Max cont operating voltage: U_c (L-N / N-PE)	p. 8	260 V		275 / 440 V		275 / 440 V		440 V (L-PE / N-PE)			
Max. discharge current: I_{max} (8/20)	p. 7	10 kA		15 kA		40 kA		65 kA			
Nominal discharge current: I_n (8/20)	p. 7	2 kA		5 kA		10 kA		20 kA			
Voltage protection level: U_p at I_n (L-N / N-PE)	p. 7	0.9 kV		1.2 / 1.8 kV		1.2 / 1.8 kV		1.8 kV (L-PE / N-PE)			
Residual voltage: U_{res} at 3 kA		-		1.0 / 1.5 kV		0.9 / 1.4 kV		1.3 kV (L-PE / N-PE)			
TOV withstand: U_T (5 s) (L-N / N-PE)	p. 8	334 / 440 V		334 / 440 V		334 / 440 V		440 V (L-PE / N-PE)			
Continuous operating current: I_c		< 1 mA		< 1 mA		< 1 mA		< 1 mA			
Short-circuit withstand capability: I_{sc}		10 kA		10 kA		25 kA		25 kA			
Response time: t_A		≤ 25 ns		≤ 25 ns		≤ 25 ns		≤ 25 ns			
Associated breaking device:											
– gG - gL fuse	p. 45	16 A		16 A		16 A		20 A			
– curve C circuit-breaker	p. 45	10 A		10 A		25 A		32 A			
Mechanical and installation characteristics											
L/N connection terminals:											
– solid wire		2.5 ... 25 mm²									
– stranded wire		2.5 ... 16 mm²									
L/N stripping length		12.5 mm									
L/N tightening torque		2 Nm									
PE connection terminal:											
– solid wire		2.5 ... 50 mm²									
– stranded wire		2.5 ... 35 mm²									
PE stripping length		15 mm									
PE tightening torque		3.5 Nm									
Integrated thermal disconnector		Yes									
End of life indicator	p. 18	Yes									
Compatibility with OVR Sign	p. 18	Yes									
Safety reserve (s)	p. 18	No	No	No		No		No	Yes	No	Yes
Remote indicator (TS)	p. 18	No	No	No		No		No			
Miscellaneous characteristics											
Degree of protection		IP 20									
Temperature range		-40 °C to +80 °C									
Maximum altitude		2000 m									
Case material		PC grey RAL 7035									
Insulating material		UL94 V0 classification									
Reference standards		IEC 61643-1 / EN 61643-11									
Weight		200 g	400 g	200 g	400 g	200 g	400 g	200 g		400 g	

Choice of disconnector

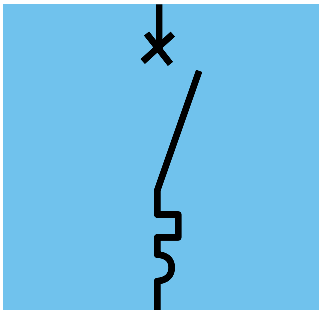
Surge arresters must be associated with upstream short-circuit protection and residual current protection against indirect contact (usually already present in the installation).

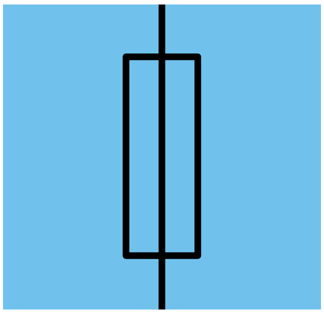
	Function	Application
	**Protection against indirect contact**	• Residual current circuit-breaker compulsory for TT systems • Residual current circuit-breaker possible for TN-S, IT and TN-C-S systems • Residual current circuit-breaker forbidden for TN-C systems If a residual current circuit-breaker is used, it is preferable to use a type S. Otherwise there is a risk of nuisance tripping. This does not affect the effectiveness of the surge arrester, but may cause the circuit to be opened.
 **or** 	**Protection against fault currents**	The breaking device associated with the surge arrester can be either a circuit breaker or a fuse. Its rating should take into consideration the surge arrester's characteristics and the short-circuit current of the installation.
	**Thermal protection**	Thermal protection is integrated into the surge arrester.

Installation rules

Choice of disconnector (fuse / circuit-breaker)

Maximum circuit-breaker or fuse protection rating depending on I_{max} and I_{imp} of the surge arrester.





Type 1 surge arresters	Circuit-breaker (curve C)	Fuse (gG)
25 kA (10/350): OVR T1	-	≤ 125 A

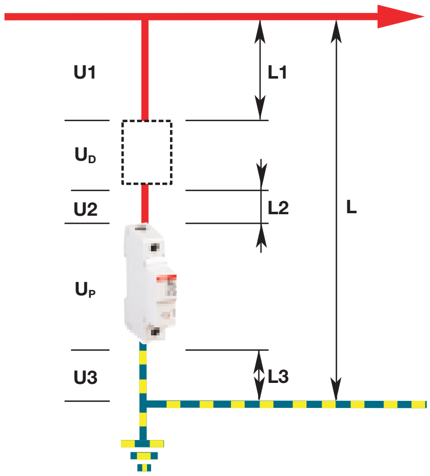
Type 1+2 surge arresters	Circuit-breaker (curve C)	Fuse (gG)
15 or 25 kA (10/350): OVR T1+2	-	≤ 125 A
15 kA (10/350): OVR HL		
• I_p = 300 A to 1 kA	40 A (1)	25 A
• I_p = 1 kA to 7 kA	40 A to 50 A (2)	50 A
• I_p = 7 kA and above	40 A to 50 A (3)	63 A
7 kA (10/350): OVR T1+2		
• I_p = 300 A to 1 kA	32 A (1)	20 A
• I_p = 1 kA to 7 kA	32 A to 40 A (2)	40 A
• I_p = 7 kA and above	32 A to 63 A (3)	63 A

Type 2 surge arresters	Circuit-breaker (curve C)	Fuse (gG)
100 kA (8/20)		
• I_p = 300 A to 1 kA	40 A (1)	25 A
• I_p = 1 kA to 7 kA	40 A to 50 A (2)	50 A
• I_p = 7 kA and above	40 A to 50 A (3)	63 A
70 kA (8/20)		
• I_p = 300 A to 1 kA	32 A (1)	20 A
• I_p = 1 kA to 7 kA	32 A to 40 A (2)	40 A
• I_p = 7 kA and above	32 A to 63 A (3)	63 A
40 kA (8/20)		
• I_p = 300 A to 1 kA	25 A (1)	16 A
• I_p = 1 kA to 7 kA	25 A (2)	25 A
• I_p = 7 kA and above	25 A to 50 A (3)	50 A
15 kA (8/20)		
• I_p = 300 A to 1 kA	10 A to 25 A (1)	16 A
• I_p = 1 kA to 7 kA	10 A to 32 A (2)	16 A
• I_p = 7 kA and above	10 A to 40 A (3)	25 A to 40 A

(1) Series S 200 L or S 941 N.
(2) Series S 200 L and S 200 / S 200 M.
(3) Series S 200 M / S 200 P / S 500 / S 800.

50 cm rule

Remember that a 10 kA lightning current passing through a 1 m length of cable generates 1000 Volts. Equipment protected by a surge arrester is subjected to a voltage equal to the sum of the U_p voltage of the surge arrester, U_d of its disconnector and the sum of the inductive voltages of connecting cables (**U1**+**U2**+**U3**).
It is therefore essential that the total length (L = L1+L2+L3) of the connecting cables is as short as possible (0.50 m).



If this length (L = L1 + L2+L3) exceeds 0.50m, it is necessary to carry out one of the following:

- Reduce this length by moving the connection terminals.
- Choose a surge arrester with a lower U_p value.
- Install a second, coordinated surge arrester near the device to be protected so as to adapt the combined U_p value to the impulse withstand of the equipment to be protected.

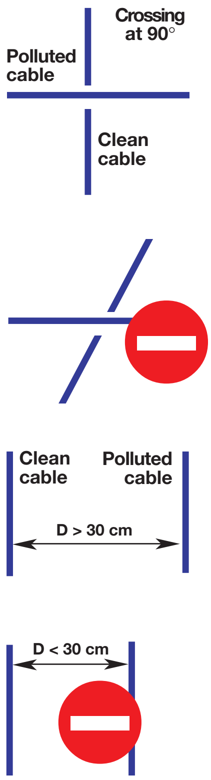
Wiring ring surfaces

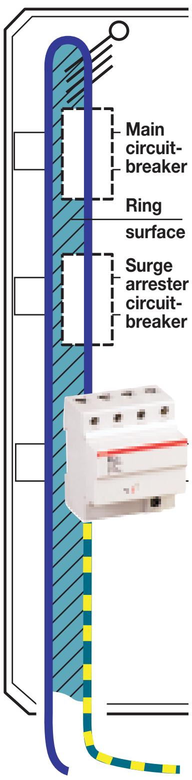
The wires must be arranged in such a way that they are as close to each other as possible (see adjacent diagram) to avoid overvoltages induced by a ring surface between phases, the neutral and the PE conductor.

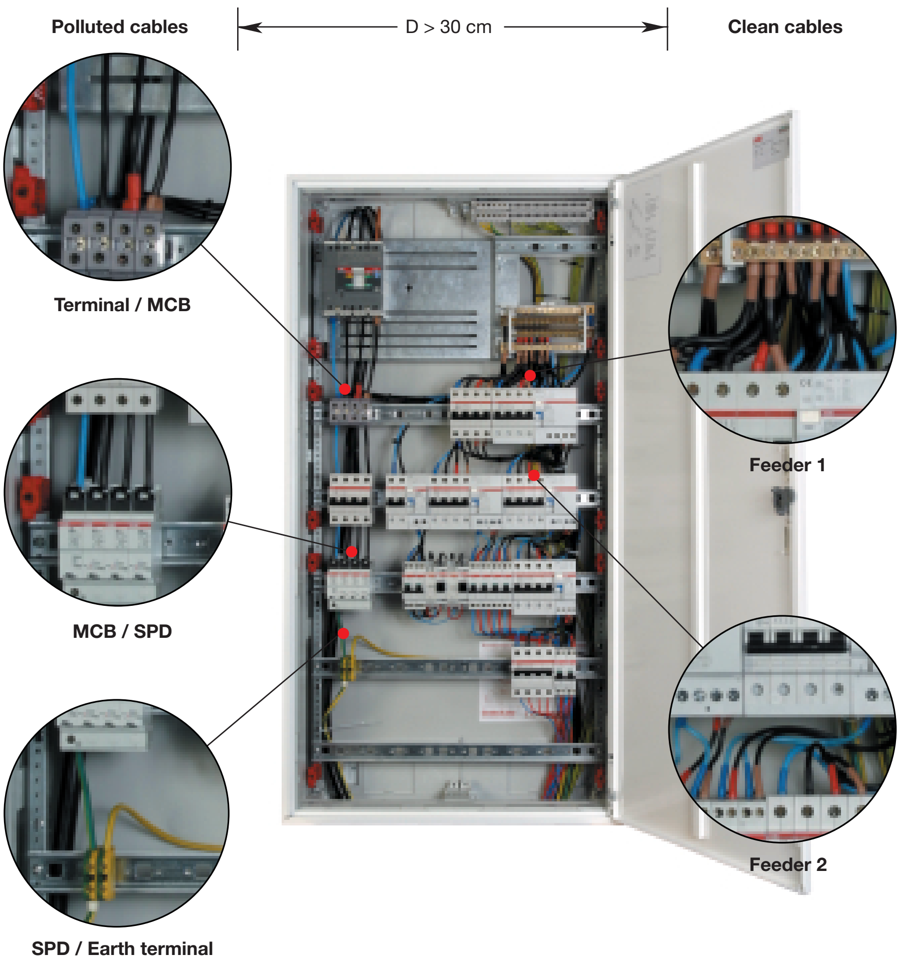
Routing of clean cables and polluted cables

During installation, lay clean cables (protected) and polluted cables as shown in the adjacent diagrams.

To avoid magnetic coupling between the different cable types (clean and polluted), it is strongly advised that they are kept apart (> 30 cm) and if a crossing cannot be avoided, it should be at right angles (90°).







Note:
The cross-section of the connecting cables is calculated according to the local short-circuit current level (where the surge arrester is installed). It must be equal to the cross-section of the installation's upstream cables.

The minimum cross-section for the earth conductor is 4 mm² if there is not a lightning conductor and 10 mm² if there is a lightning conductor.

Equipotential grounding:

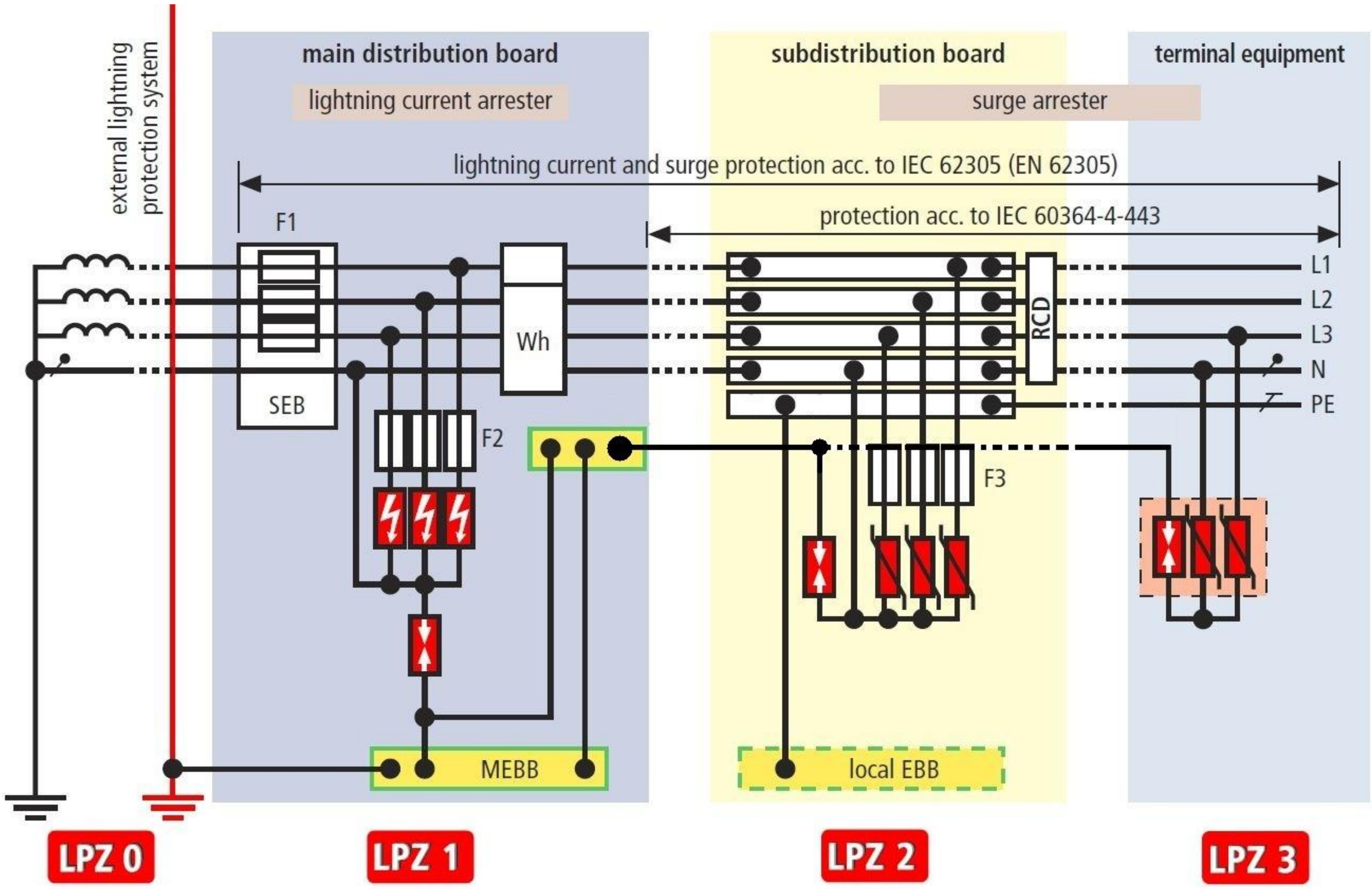
It is critical to check the earth equipotentiality of the various items of equipment.

Appendix E

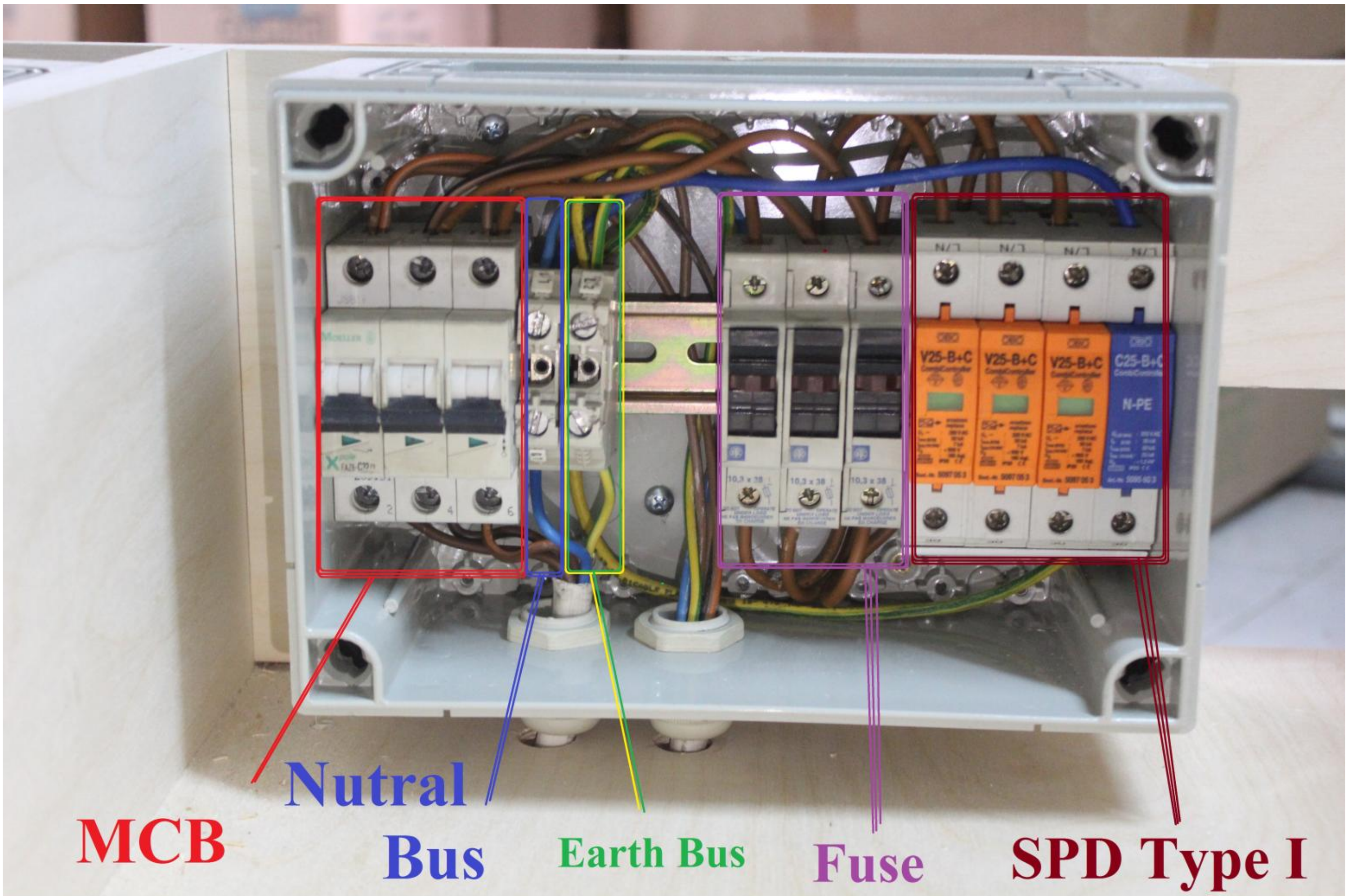
Prototype model of project

A prototype educational model was created for the building, and the necessary protection equipment was dropped to understand the principle of lightning protection systems

Electrical Circuit



Main Distribution Board (MDB)



Distribution Board (DB)