LIGHTNING & SURGE PROTECTION SYSTEM

VLP ENGINEERING SDN BHD

AGENDA

- **Introduction to Lightning**
  - Thunderstorm Days per Year
  - Worldwide isokeraunic levels
  - Lightning in Malaysia
- **Incidents & Tragedies**
- **"Lightning And Surge" The Basic Concept**
  - What is Lightning
  - What is Surge
- **Needs for Protection**
- **Current Practices**
  - Types of LPS
  - Unconventional LPS
  - Shortcoming of unconventional LPS
  - Conventional LPS
- **Our Specialties**
  - Faraday Cage LPS Solution
  - Surge Protection System Solution

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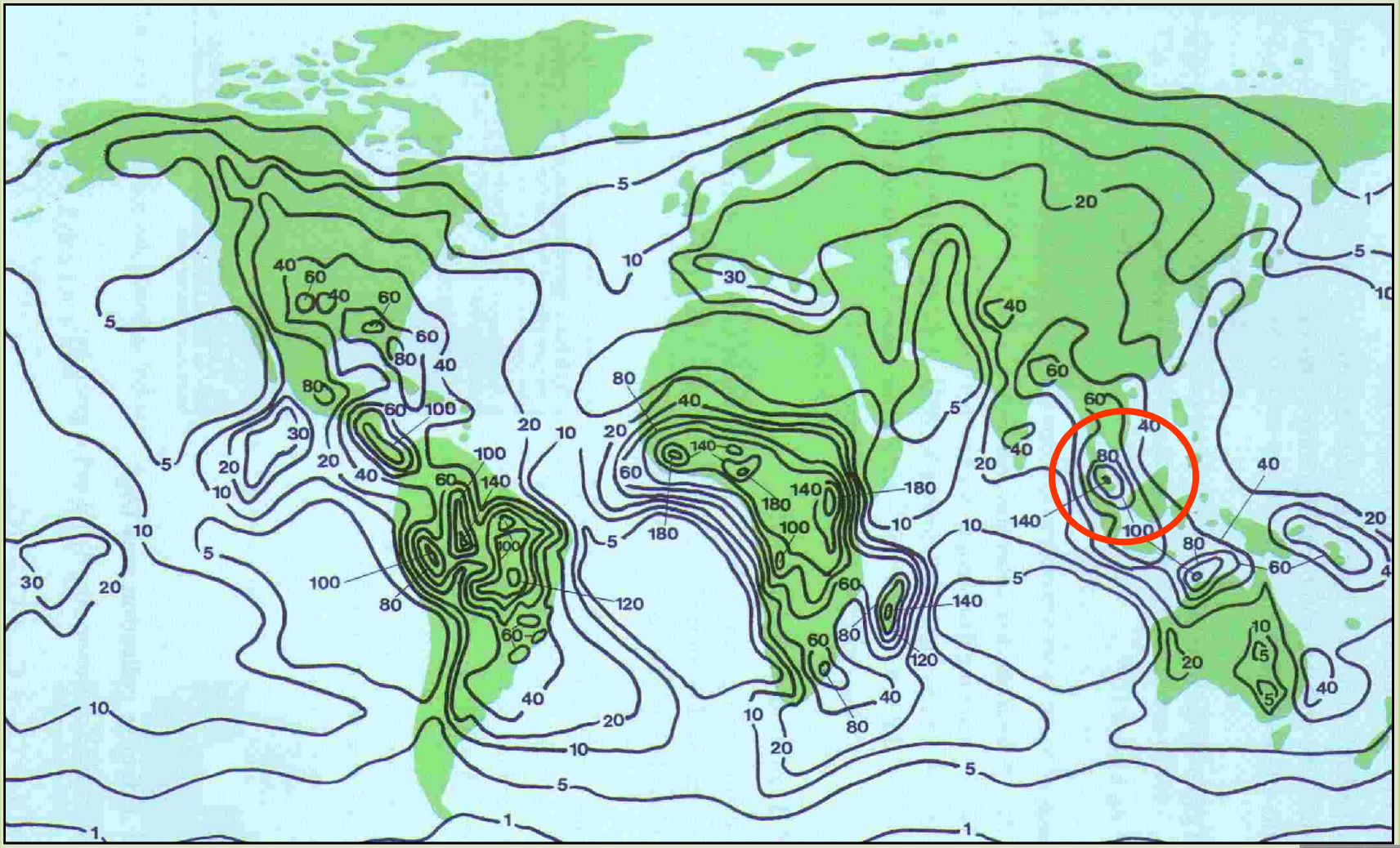
INTRODUCTION TO LIGHTNING

WORLDWIDE ISOKERAUNIC LEVELS

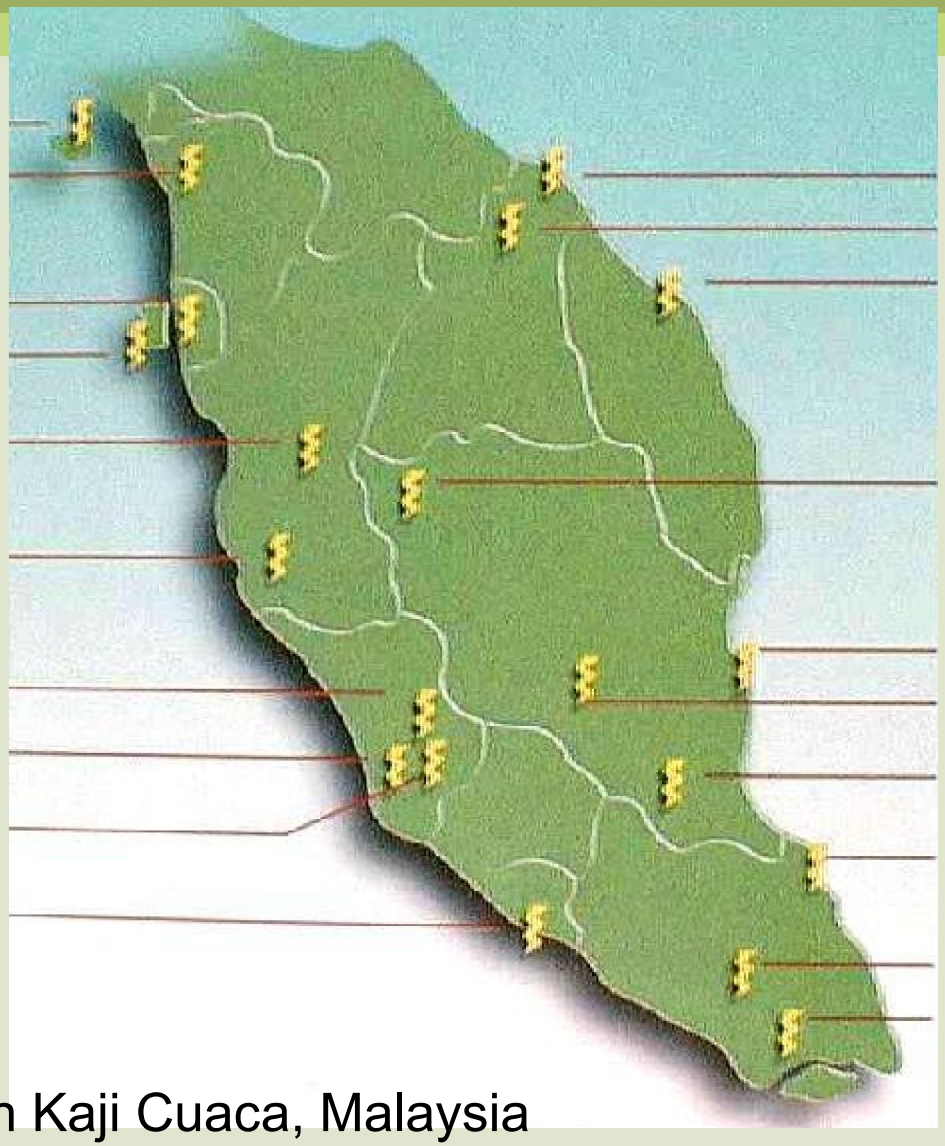


THUNDERSTORM DAYS PER YEAR
Comparative Statistic

Argentina	30-80
Brazil	40-200
Hong Kong	90-100
Indonesia	180-260
Malaysia	**180-300**
Singapore	160-220
Thailand	90-200

Malaysia: Average number of days = 204, which is equivalent to 40 strikes per square kilometer per year

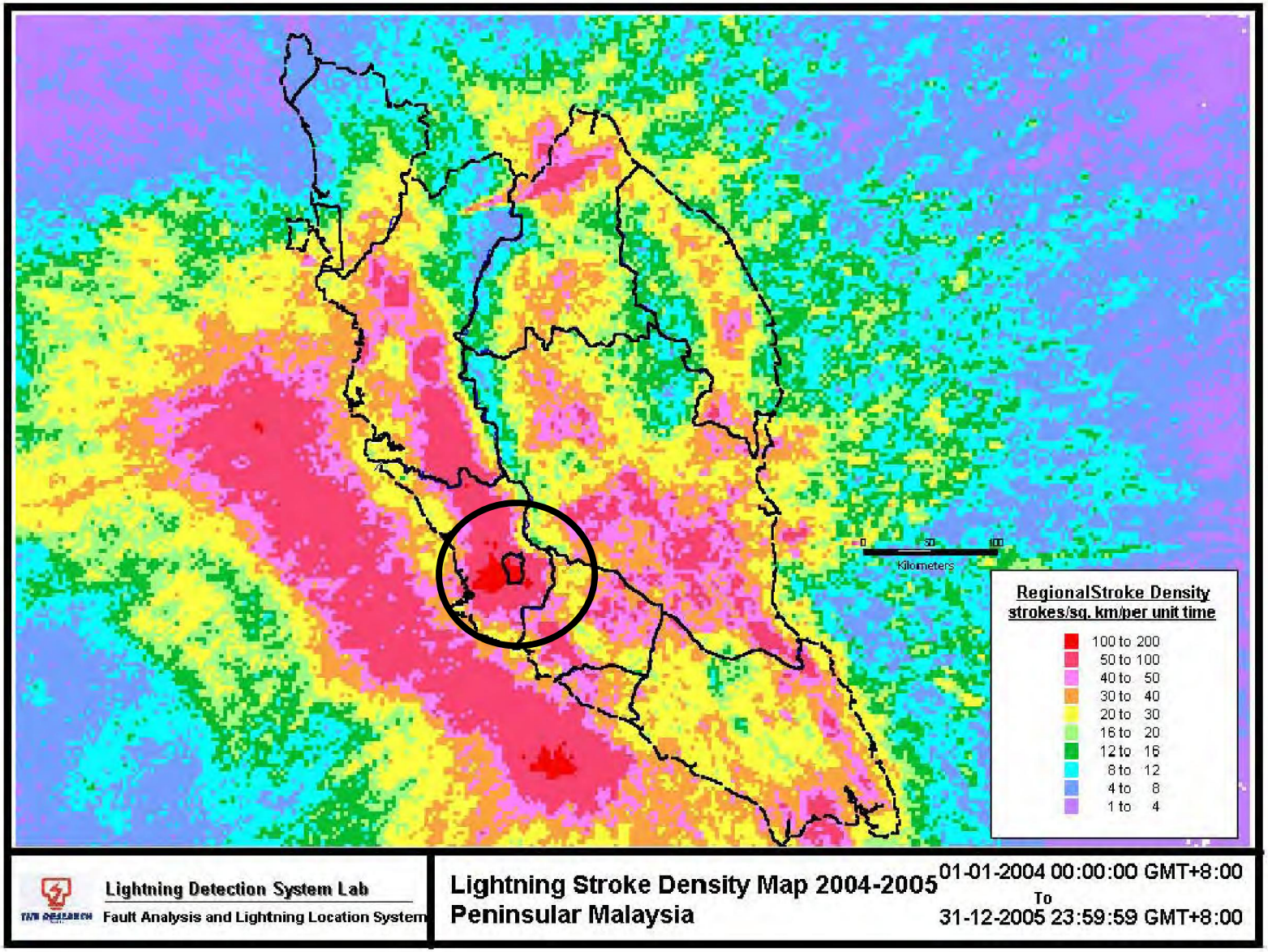
THUNDERSTORM DAYS - P.MALAYSIA



Pulau Langkawi (220)
Alor Setar (247)
Butterworth (278)
Bayan Lepas (293)
Ipoh (278)
Sitiawan (270)
Kuala Lumpur (280)
Subang (240)
Petaling Jaya (192)
Melaka (265)

Kota Bharu (209)
Kuala Krai (217)
Kuala Trengganu (229)
Cameron Highland (159)
Kuantan (208)
Temerloh (185)
Muadzam Shah(181)
Mersing (238)
Kluang (211)
Senai (185)

Source : Jabatan Kaji Cuaca, Malaysia


0
50
100
Kilometers
RegionalStroke Density
strokes/sq. km/per unit time
100 to 200
50 to 100
40 to 50
30 to 40
20 to 30
16 to 20
12 to 16
8 to 12
4 to 8
1 to 4
Lightning Detection System Lab
Fault Analysis and Lightning Location System
Lightning Stroke Density Map 2004-2005
Peninsular Malaysia
01-01-2004 00:00:00 GMT+8:00
To
31-12-2005 23:59:59 GMT+8:00

LIGHTNING IN MALAYSIA

- Malaysia ranks one of the highest lightning activity in the world
- Average Thunder day Level for Kuala Lumpur is within 180 - 300 days per annum
- 80% of lightning discharge currents to the ground in Malaysia exceed 20 kA with potentials approaching 50-100 MV
- 50% of strokes in *Kuala Lumpur* exceed 36 kA, compared to only 28kA *worldwide*

INCIDENTS & TRAGEDIES

The Star (30/04/06)

30 April 2006

AYAN AND FARIK ZOLKEPLI

RECORDS OF MEAN ANNUAL TEMPERATURE IN MALAYSIA *(Unit °C)*

Year	Mean Annual
1995	26.9
1996	26.8
1997	27.1
1998	27.7
1999	26.9
2000	27.0
2001	27.1
2002	27.4
2003	27.1
2004	27.2
2005	27.3

SCHOOL ON FIRE: Firemen using a water hose to put out the blaze at the top floor of SK Sungai Tiram in Ulu Tiram.

Lightning struck school, too

JOHOR BARU: Bolts of lightning during a thunderstorm not only wreaked havoc at the Petronas fuel depot in Pasir Gudang but also caused a fire at a primary school in Ulu Tiram about 20km away.

The fire destroyed a music room and the prefects' room on the fourth floor of the SK Sungai Tiram during the 6.05pm incident on Friday, which was about the same time the fire started at the depot.

School safety committee secretary Norazreen Raduan said that teachers and students had been engrossed with preparations for their annual sports day today when nearby villagers came and told them the school was on fire.

"Some of us went to try and save the instruments and furniture in the music room while the students and teachers were evacuated to the canteen.

"We managed to save a keyboard, a television and some instruments", he said, adding, they had to stop when the fire got bigger.

Norazreen, who has been teaching at the school for the last three years, said that his main concern was his students.

"At first the fire was not too big, but in about 15 minutes, it had spread.

"That was when we started fearing for the safety of our students", he said.

He said that it was still too early to estimate the losses but said it would probably run into thousands of ringgit.

Norazreen said it was fortunate that the resource room located next to the two destroyed rooms had not been touched by the flames.

"Thank God the fire was under control before it could spread there. Otherwise, many books would also have been lost," he said.

Security guard Musa Adnan, 54, who began working at the school just 16 days ago said that he was at his guard post when he saw the roof on fire.

Fire and Rescue Department operations commander Ayob Deni said 21 men and three fire engines rushed to the school as soon as they received a distress call at 6.40pm.

"We managed to control the fire within 15 minutes," he said, adding that they believed the fire had been caused by a lightning strike.

The Star (30/04/06)

Blast threw steel lid 10m away

BLASTED AWAY: Part of the wreckage, believed to be the steel lid of Tank 14, found strewn on the ground following the fire.

By NELSON BENJAMIN, MEERA VIJAYAN AND FARIK ZOLKEPLI

JOHOR BARU: The explosion that blew apart Tank 14 at the Petronas Fuel Depot in Pasir Gudang was so powerful that it threw the steel lid about 10m away.

The explosion caused the fire to spread to Tank 15 and Tank 16, resulting in almost 800,000 litres of petrol and aviation fuel going up in flames during the 6.05pm incident on Friday.

Tank 14 contained some 85,000 litres of petrol, while Tank 15 had 450,000 litres of petrol and Tank 16 had 250,000 litres of aviation fuel.

A lightning bolt hitting Tank 14 caused the explosion.

More than 100 firemen had used foam to battle the inferno for almost eight hours before completely dousing the blaze at about 2.49am.

Fire and Rescue Department deputy director-general Datuk Wan Mohd Nor Ibrahim, who flew in by helicopter from Putrajaya to tour the affected area, said the quick action by firemen to cool off the remaining tanks in the depot prevented further explosions.

"At least three other tanks with huge amounts of petrol were only damaged, with their outer surface blackened by the heat and flames," he said.

There are 16 storage tanks within the depot storing millions of litres of diesel, aviation fuel and petrol.

On lightning causing fires at fuel storage tanks, Wan Mohd Nor said there had been such cases overseas but they were rare in Malaysia.

"I have never heard of such cases in Malaysia in my many years as a fireman," he said.

He admitted that there had been a surge in lightning related deaths and fires this year, with Johor recording three deaths recently.

He commended the cooperation forged between members of the Pasir Gudang Emergency Mutual Aid (Pagema) and the Fire and Rescue Department in handling fuel depot fires.

Pagema, comprising fire fighters from private companies, was formed in 1988 to assist in any disaster involving the 350 factories in Pasir Gudang.

Of that total, 40 factories are categorised as high-risk, including those involved in petrochemical, gas and palm oil production.

A team from the Singapore Civil Defence was also despatched to the scene to assist in putting out the fire.

The Star (8/10/06)

Lightning havoc

A lightning strike near the Ipoh Selatan toll exit of the North-South Expressway at 4.46pm yesterday caused a traffic congestion that stretched 8km from the toll plaza. The computerised system suffered a short-circuit forcing PLUS personnel to collect the toll manually from motorists. A check at the scene found that the back-up generator had failed. The traffic jam continued until well after dark.

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CCTV rosak dua kali

Juruteknik perlu selaras catatan masa

>>Oleh Murni Wan Omar dan Mohd Razlan Salleh
am@hmetro.com.my

SHAH ALAM: Kamera litar tertutup (CCTV) yang merakamkan pengguna melalui Plaza Tol Kota Damansara mengalami kerosakan sebanyak dua kali pada Oktober tahun lalu.

Dua juruteknik Projek Penyelenggaraan Lebuhraya Bhd (Propel), Rasidi Abdul Razak, 36, dan Mohamad Rasidi Ali, 34, mengesahkan kamera itu mengalami kerosakan pada 14 dan 25 Oktober 2006 ketika memberi keterangan secara berasingan.

Menurut Rasidi, pada kedua-dua tarikh itu, dia dan Mohamad Rasidi diminta membaiki kamera berkenaan.

Dia memberitahu mahkamah bahawa penyelia plaza itu memaklumkan bahawa sistem yang merekodkan imej rosak dan menyebabkan tiada gambar dapat direkodkan.

"Apabila CCTV rosak semua fungsinya akan mengalami gangguan dan catatan masanya juga terhenti. Apabila saya datang membaikinya saya akan selaraskan semula.

"Masa pada CCTV dan transaksi Touch n'go sepatutnya selari antara satu sama lain kecuali kerosakan berlaku," katanya ketika menjawab soalan Timbalan Pendakwa Raya, Tun Abdul Majid Tun Hamzah.

Rasidi berkata, terdapat beberapa punca yang membawa kepada kerosakan sistem itu iaitu ketika petir, Tenaga Nasional Berhad (TNB) mengalami masalah selain kesilapan manusia.

Sementara itu, ketika menjawab soalan peguam Zaidi Zain, Rasidi menyatakan tidak pasti sama ada kamera itu mengalami kerosakan pada 19 Oktober 2006 (hari wanita Mongolia, Altantuya Shaariibuu didakwa dibunuh).

Dia juga memberitahu mahkamah bahawa dia tidak pasti sama ada penyelianya ada meminta membaiki sebarang kerosakan pada hari berkenaan.

Sementara itu, Mohamad Rasidi dalam keterangannya, memberitahu bahawa CCTV itu mengalami kerosakan yang sama iaitu tidak boleh merakam sebarang imej.

"Kebiasaannya jika masa di CCTV berbeza, pihak plaza akan menghubungi Propel dan kami akan datang untuk selaraskannya kembali," katanya.

Rasidi berkata, terdapat beberapa punca yang membawa kepada kerosakan sistem itu iaitu ketika petir, Tenaga Nasional Berhad (TNB) mengalami masalah selain kesilapan manusia

On the evening of March 3, 2004, a Seremban-bound KTM Komuter train in the Rawang-Seremban Route collided with the rear of another Komuter train facing the same direction, which had been waiting at a signal light between the Tiroi station and Seremban station for five minutes. Forty were injured, but no deaths were reported. The accident was generally attributed to the faulty signal light (struck by lightning) that stopped the earlier train, though the driver of the rear-ending train is reported to have run a red light into the section occupied by the rear-ended train. The resulting crashed disrupted KTM Komuter services along the line for a day. This is so far the worst accident involving the KM Komuter service.

* source: http://en.wikipedia.org/wiki/KTM_Komuter

Lightning causes train disruption

Thousands of commuters are facing long delays after lightning struck the signalling system at York.

Commuters heading through York station face delays

Some trains have resumed running through the station but there will be hold-ups as a backlog of services wait to get through.

Network Rail said the lightning strike knocked out 12 signalling modules, causing severe disruption.

Managers said they could not tell how long the delays would continue and are still assessing the damage.

Travellers are being advised to expect delays to all local and main line services.

Replacement coaches are being laid on between York and Doncaster.

The lightning strike followed storms in the area just before the morning rush hour. No-one has been reported hurt.

York railway station is on the East Coast Main Line between London's King's Cross station and Edinburgh's Waverley Station.

Many other rail operators also run services through the busy junction, including TransPennine Express; Virgin Cross-Country and Northern Rail.

Lightning-hit West Rail to spend HK$20m

Damage caused by lightning strikes on West Rail lines has caused seven disruptions of service this year. Now Kowloon-Canton Railway Corporation (KCRC) is to spend HK$20 million to fix the problem and prevent further disruption, Chairman Michael Tien said yesterday.

Since 40 per cent of West Rail consists of raised tracks, they are more vulnerable to lightning, he said.

Lightning strikes damaged electronic parts and computer cards of the system, Tien said.

During the construction of West Rail, KCRC sought the professional opinions overseas, but those experts did not know about the intensity of thunderstorms in Hong Kong.

West Rail had already taken steps to improve the situation, including stocking more spare parts in control rooms, strengthening the maintenance team and improving the way the news of service disruptions are announced, Tien said.

Now the company is ready to redress the problem by spending about HK$10-20 million and six months to overhaul the West Rail system, the KCRC chairman said.

The revamp may be completed by the start of the next rainy season, he said.

Tien defended the deteriorating track records of the KCRC railways.

He noted that East Rail had shortened the minimum duration of service disruption that requires an announcement to the public from 20 minutes to eight. As such, it had appeared that disruptions were happening more frequently.

As to West Rail, the high frequency of service disruptions, was due to its length - the greatest among local railways - and this had made it difficult to find out where damage occurred, he said.

Among the 16 service disruptions along West Rail this year, 11 were caused by failure of the signal system.

80% MRT WILL RUN ON RAISED TRACKS, WILL USE A LOTS OF ELECTRONIC EQUIPMENT & MALAYSIAN LIGHTNING CONDITION IS FAR SEVERE THAN HONG KONG! THEREFORE THE BEST SOLUTION IS TO USE LOCAL EXPERTISE.

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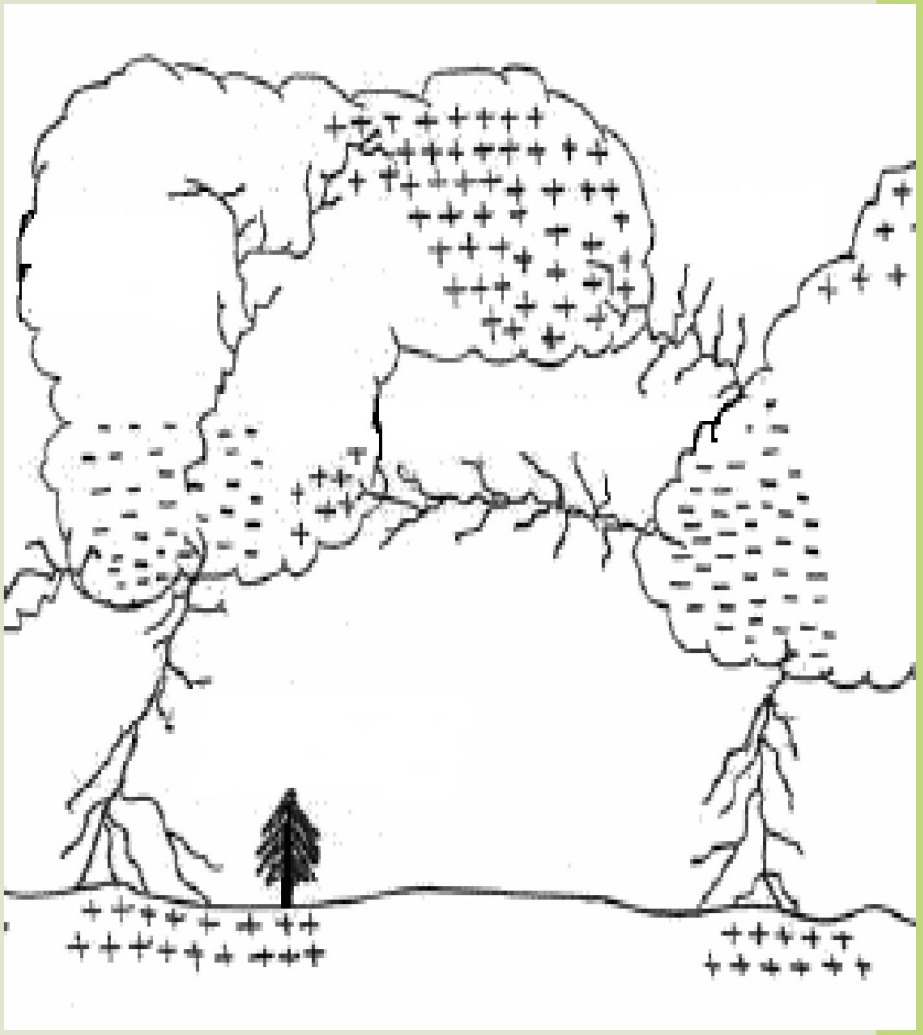
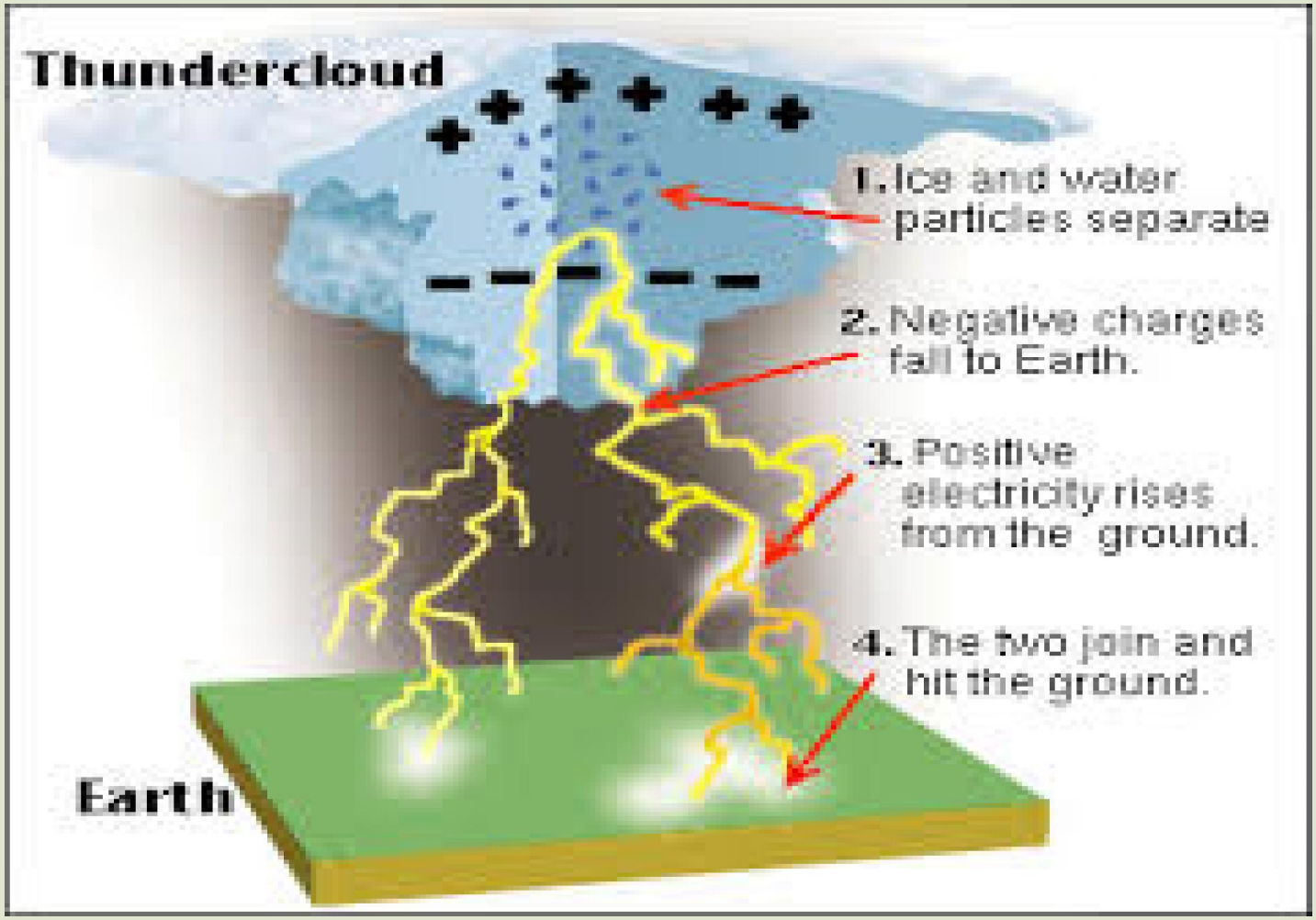
WHAT IS LIGHTNING ?

DEFINITION OF LIGHTNING

- A natural discharge of electrical current
- between a cloud and the ground or within a cloud
- short duration and high voltage
- Can reach several millions of volts



WHEN DOES LIGHTNING SRIKE?



CATEGORIES OF LIGHTNING EFFECT

- Primary Effect of Lightning
  - Direct Strike
  - Flash Over
- Secondary Effect of Lightning
  - Surges
  - Ground Potential

PRIMARY EFFECT

PRIMARY EFFECT – DIRECT STRIKE

A photograph of direct lightning striking the air terminal on the Prime Minister Department building.

*Picture courtesy of Star Publication.

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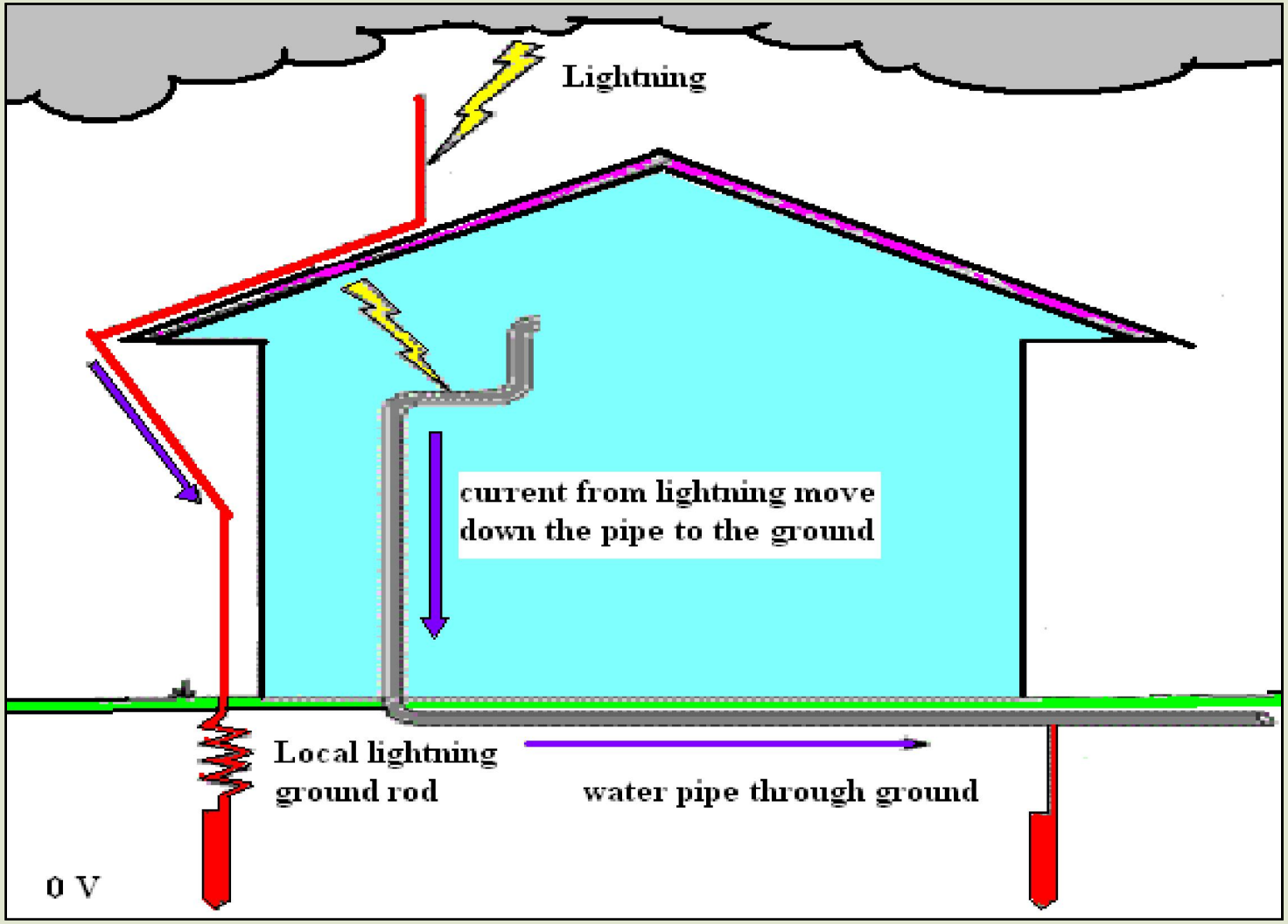
PRIMARY EFFECT - FLASH OVER

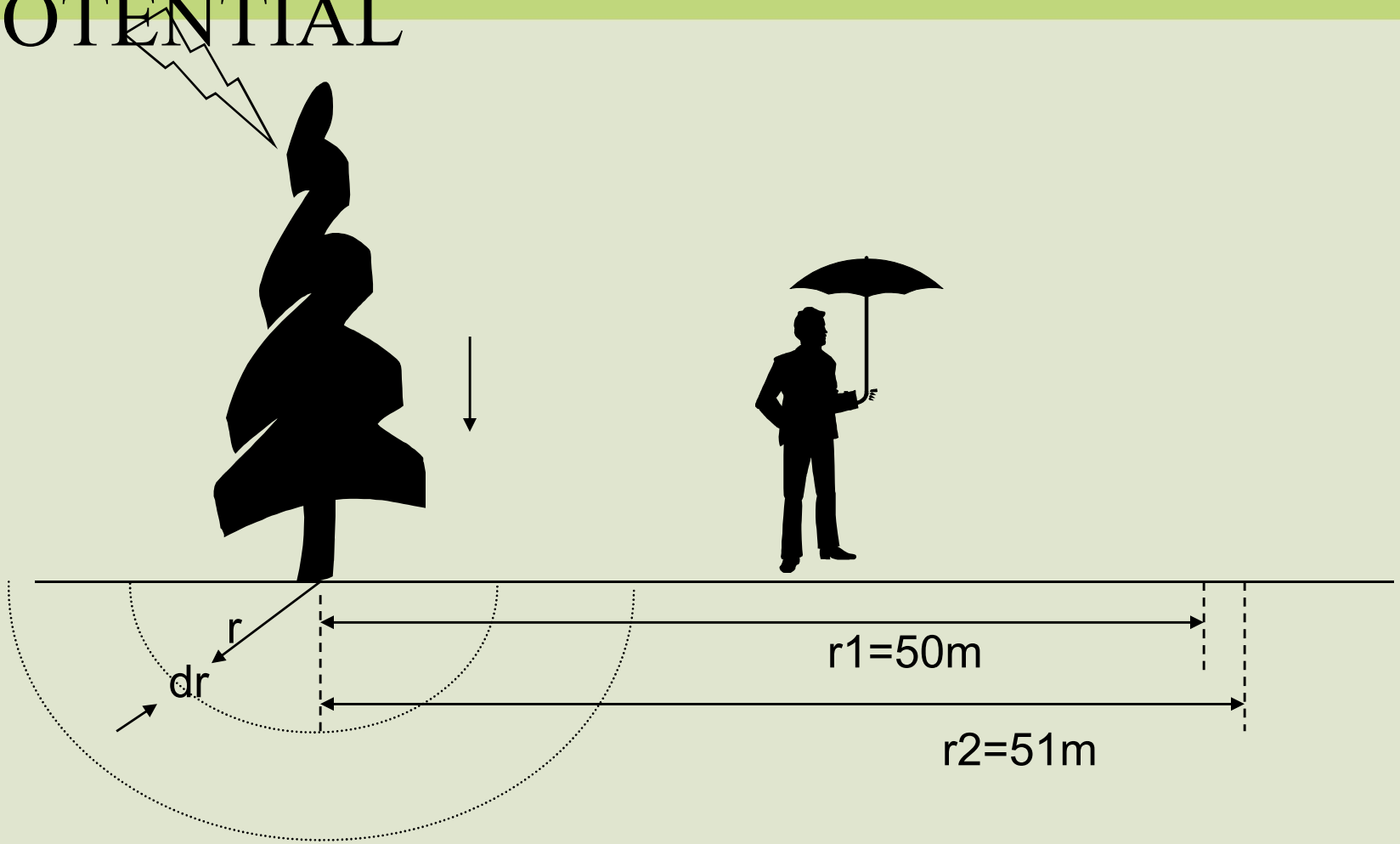


SECONDARY EFFECT

1. GROUND POTENTIAL

2. SURGES

SECONDARY EFFECT – GROUND POTENTIAL



If Lethal Voltage is 0.5kV

Soil Resistivity 100 ohm-meter

Using V=I/2 { I/r1 - I/r2 }

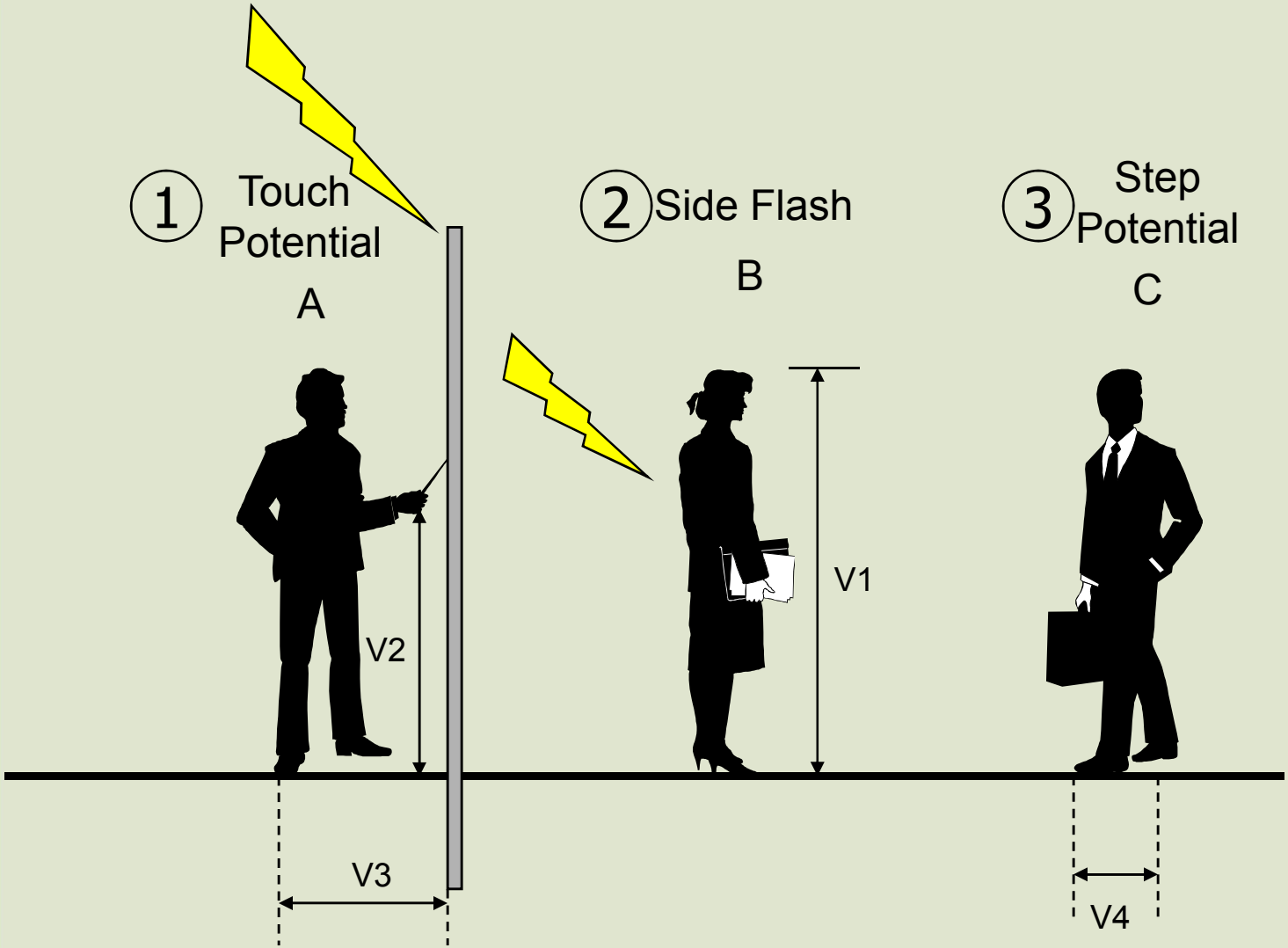
I = 80kA

GROUND POTENTIAL FATALITY RATES

Probability of golfer be fatally injured due to a step voltage when lightning strike nearby tree

- If he stand 50 meters away is 12%
- If he stand 25 meters away is 80%

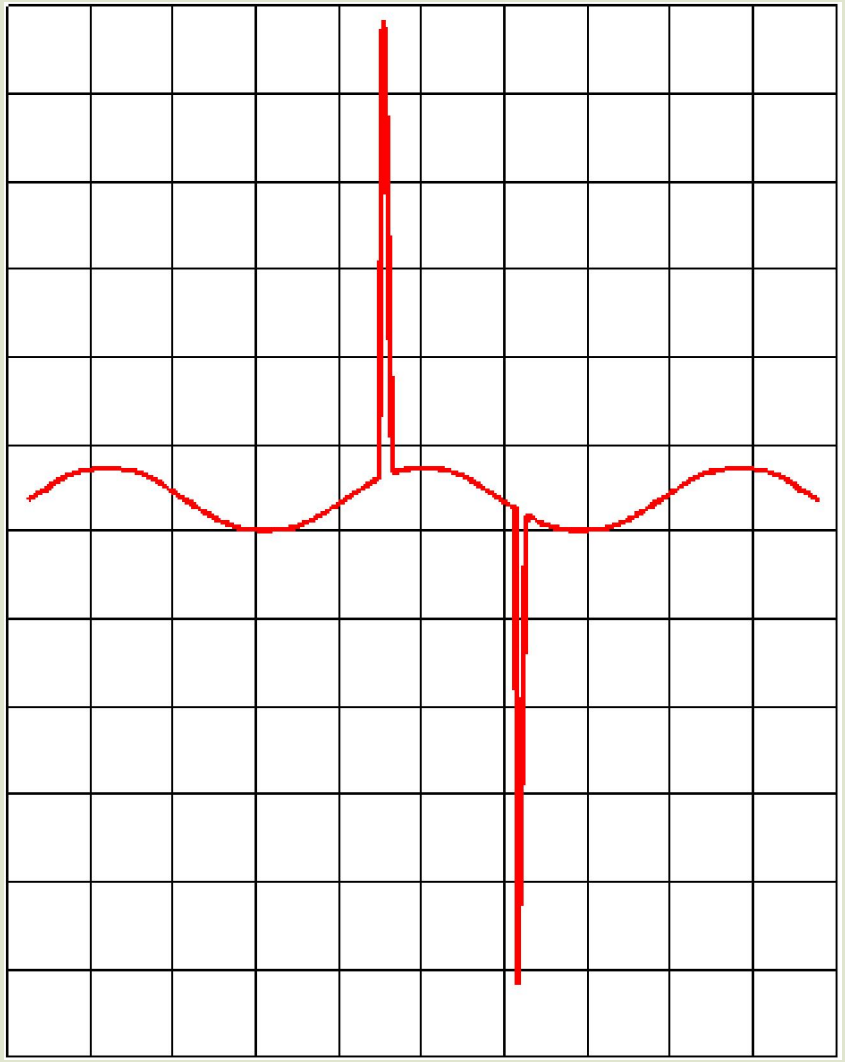
INJURY POSSIBILITIES DUE TO LIGHTNING



WHAT IS SURGE ?

WHAT IS SURGE ?

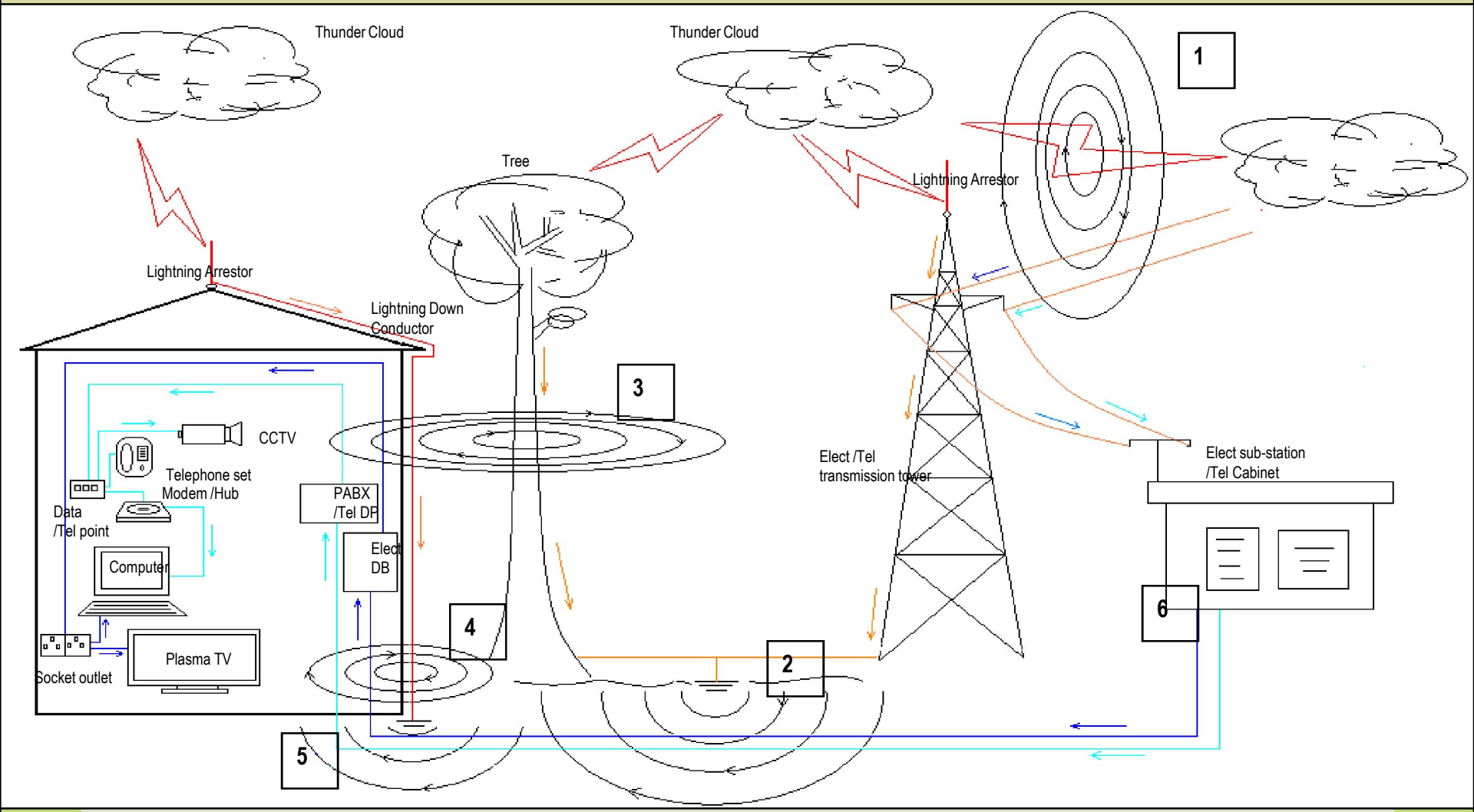
- A sudden increase amplitude from normal operating level
- Microsecond activities
- Can reach several thousands of volts
- Transient overvoltages



SOURCE OF SURGES

- Externally Induced
  - Lightning
- Internally Induced
  - Power line switching
  - Large motors/inductive load -- turned off/on
  - Electro-magnetic Interference/Radio Frequency Interference
  - Short circuits
  - Fault/Fuse clearing

POSSIBLE SOURCES OF SURGES



Lightning Strike

Lightning Current

Telephone/Data Line

Power Line

Surge Current in Telephone/Data Line

Surge Current In Power LIne

Ground Potential

Inductive Coupling

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PHOTOGRAPHIC EVIDENCES

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DAMAGE TO MAIN ELECTRICAL PANEL

All wiring and everything plugged in was very severely burned and melted

DAMAGE TO MAIN ELECTRICAL PANEL

Distribution board's burned and melted mark at wall Cause by very high magnitude of surge generated by lightning.

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DAMAGE TO COMMUNICATION MODULE

A surge has damaged this communication card; note that the two MOV surge diverters (green disc's) have not prevented it. Surge protection installed before the unit may have stopped the spike getting this far.

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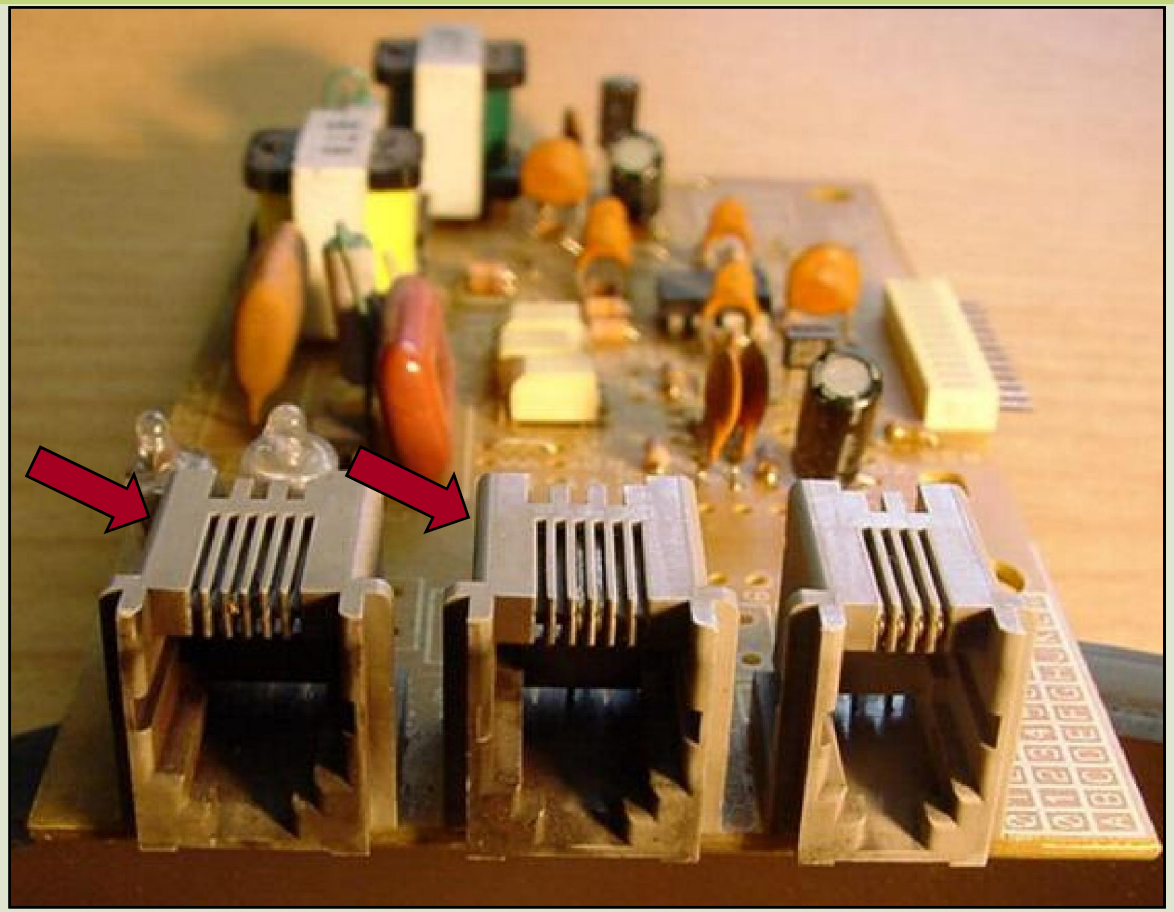
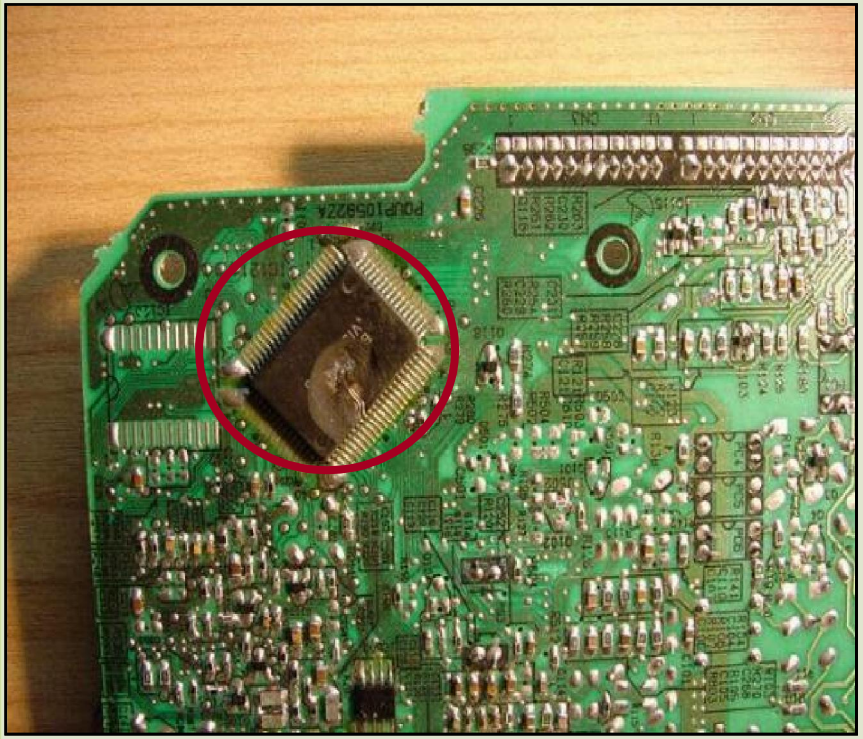
DAMAGE TO CONNECTOR

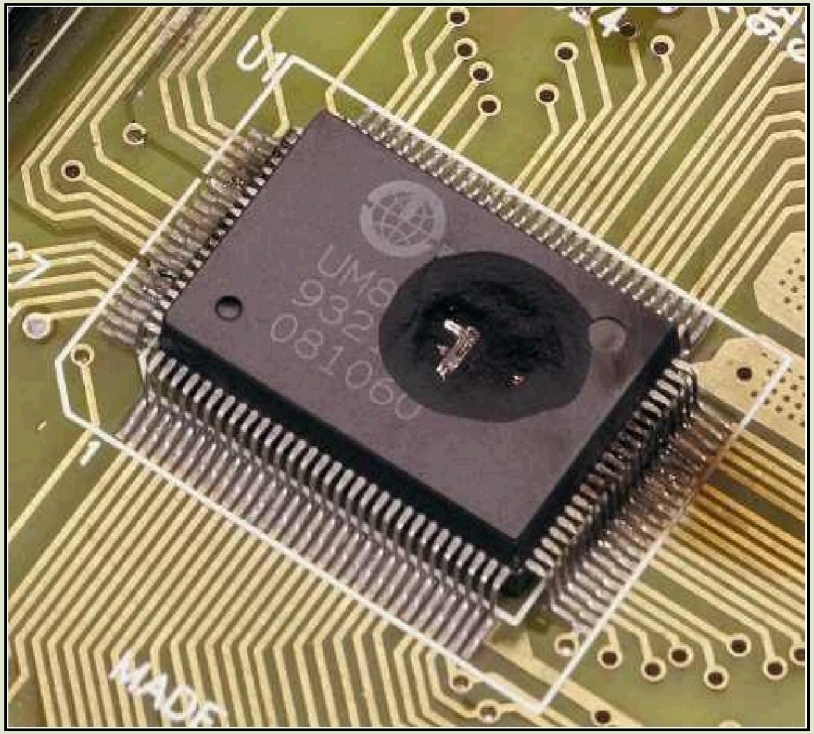


Flashover has occurred within the connectors on this communication board

DAMAGE TO SENSITIVE COMPONENTS



A piece has been blown from this IC, but nothing else appears damaged



IC stressed by surge voltage!

IMPACT TO ELECTRONIC EQUIPMENT

- Computers and peripherals
- Modems
- Network equipment
- Television
- Alarm systems
- Electric fence energizers
- CCTV cameras and equipment
- Security systems
- Electric gate motors
- Intercom systems Telephones
- PABX

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EFFECTS OF LIGHTNING & SURGE

Disruptions

Degradation

Damages

3 D

NEEDS FOR PROTECTION

of pollutants, causing incorrect operation or permanent damage during operation, transport or storage.

8.4.3 Chemically active pollutants may occur in the atmosphere near sea water or in industrial areas. In the latter case gases may dissolve in condensation or themselves condense in or on equipment. Equipment shall be protected against the effects of such corrosive substances.

8.4.4 Equipment exposed to the weather shall be resistant to attack by detergents, sewage, toxic substances such as weed killer and lubricating and fuel oils.

8.5 **Solar Radiation**

8.5.1 Systems and equipment shall be impervious to and shall not deteriorate or discolour under the effects of direct solar radiation.

8.6 **Electromagnetic Effects**

8.6.1 All equipment and systems which are susceptible to electromagnetic effects shall be suitably protected with electromagnetic noise free screened enclosures to ensure correct operation and avoid permanent degradation.

8.7 **Lightning**

8.7.1 As the project area is a region with a high incidence of thunderstorms with very severe lightning, adequate protection against damage or malfunctioning of systems, plant and equipment, cable plant etc. due to high transient voltages and currents shall be incorporated. Equipment to be connected to the power supply mains and items to be connected to or

The importance of providing adequate safeguards for prevention of damage by lightning cannot be too strongly stressed; details of high voltage surge arrestors, fuses, chokes, etc. being provided for this purpose must be included in the tender.

8.7.2 The specific protection requirements mentioned in this section shall be regarded as only the minimum requirements, which may not necessarily be adequate in particular situations.

8.7.3 For protection against transient high voltages and currents introduced via the mains power supply, the minimum protection shall be a Surge Reduction Filter (S.R.F.) of appropriate size fitted to the incoming supply lines and having the following features :-

(a) Either three-phase or single phase type according to the type of supply at the particular place, and rated for operation at 415 V 50 Hz (3-phase) or 240V 50Hz (single phase).

(b) Provide protection against both differential and common mode transients from the supply lines.

(c) Incorporate high energy clamping devices and filtering components with low frequency (low-pass) characteristics. Inductors shall be air-cored (non-saturable) and capacitors shall be of 'self-healing' type.

(d) The neutral conductor shall not be bonded to earth (ground), but it shall be so protected that any surge arriving via the neutral conductor will also be diverted to earth.

8.7.4 For protection against transient high voltage and high current surges introduced via the communications' lines, data lines, and other lines connected to equipment having electronic components, the minimum protection shall be by Transient Protection Units (T.P.U.) of appropriate size fitted to the external lines and having the following features :-

(a) For balanced lines (for example, 600 Ohm balanced telephone or data lines) the T.P.U. shall be of the balanced type and provide protection against both differential and common mode transients.

(b) For unbalanced lines, the T.P.U. shall be of the corresponding type, and provide protection against transient voltages between the line and the return connection and also between the line, return connection and earth (ground).

ELECTRIFIED DOUBLE TRACK NEEDS STATEMENT

As the project area is a region with a high incidence of thunderstorm with very severe lightning, adequate protection against damage or malfunctioning of systems, plant and equipment, cable plant etc, due to high transient voltages and currents shall be incorporated.

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The following are the environmental design requirements for the areas specified:

a) Ambient temperature:

Area Classification	Maximum Ambient Temperature	Relative Humidity
indoor ventilated	40° C	95%
outdoor (uncovered)	40° C	100%
air conditioned	27° C	60%

b) Rainfall:

average annual rainfall	2441 mm
maximum monthly rainfall	276 mm

c) Keraunic level: 190 Thunderstorm Days per Year (from Lightning Report by Dr. Liew Ah Choy, dated 22 May 1995).

d) Seismic requirements: 0.06 g acceleration in any direction

e) Elevation: 200 m ASL

DESIGN CRITERIA

c) Keraunic level — **190 Thunderstorm Days per Year (from Lightning Report Dr. Liew Ah Choy, dated 22 May 1995).**

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transient fault conditions. The following conditions will be examined:

a) Steady State EMI:

1) power frequency and harmonic capacitive and inductive coupling from TNB transmission line to LRT distribution system;

2) harmonic conductive coupling from LRT traction power equipment to TNB distribution system;

3) inductive coupling from 25 kV line to LRT distribution system.

b) Transient EMI:

1) inductive coupling due to a short circuit from TNB transmission line to LRT system;

2) inductive coupling due to switching and lightning surge currents from TNB transmission line to LRT system;

3) line to earth fault induced potential rise conductive coupling from TNB transmission line along the corridor to LRT system;

4) line to earth fault induced potential rise conductive coupling from 25 kV line along the corridor to LRT system.

2.6 Reliability study

The reliability and the allocation of reliability values for the power supply subsystem are defined as follows:

- the Mean Time Between Service Affecting Failures (MTBSAF) of the power distribution system is required to be no less than 50,000 hours. A MTBSAF is defined as the situation in which the voltage at power rail is outside the vehicle acceptable range.

- the Mean Time Between Service Failures (MTBSF) of each substation shall be no less than 20,000 hours.

- the system availability shall be 99.979%.

By utilizing the component failure rates from IEEE Standard 493-1990 and statistical

DESIGN CRITERIA

b) Transient EMI

1) Inductive coupling due to a short circuit from TNB transmission line to LRT system.

2) Inductive coupling due to switching and lightning surge currents from TNB transmission line to LRT system.

3) Line to earth fault induced potential rise conductive coupling from TNB transmission line along the corridor to LRT system.

4) Line to earth fault induced potential rise conductive coupling from 25kV line along the corridor to LRT system.

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CURRENT PRACTICES

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TYPES OF LPS

LPS

UNCONVENTIONAL

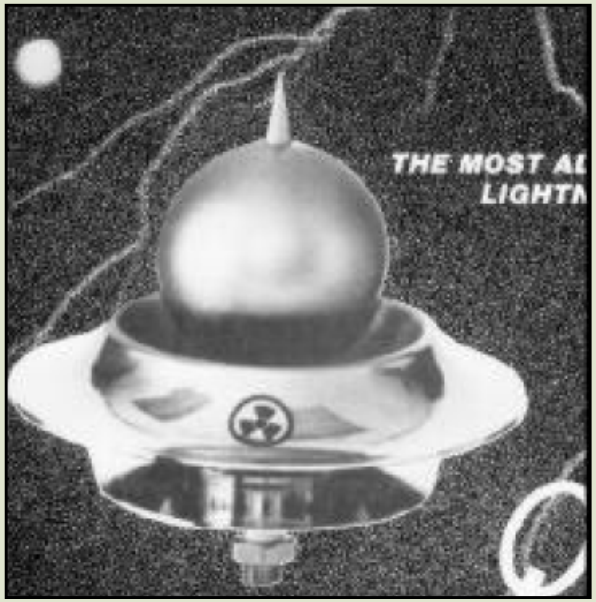
- Radioactive Air Terminal
- Early Streamer Emission (ESE)
- Dissipative Array System (DAS)
- Semiconductor Lightning Eliminator

CONVENTIONAL

- Franklin Rod
- Faraday Cage

UNCONVENTIONAL LPS
Radioactive Air Terminal

- Claim: the radioactive air terminal can attract lightning
- Only one centrally located on top of building
- Banned worldwide due to hazardous effects



Government bans import, sale of these lightning rods

New Straits Times Wed 28th June 1989

By ROMLI IBRAHIM

KUALA LUMPUR, Tues. — The Government has banned, with immediate effect, the further import and sale of lightning rods containing radioactive material.

Present users, however, are allowed to retain such rods but are advised to register with the Atomic Energy Licensing Board.

The Government has also allowed the continued use of smoke detectors (ICSD or ionisation chamber smoke detector) containing radioactive matter as the radioactive content in these devices is too small and, therefore, quite harmless.

Announcing this today, the executive secretary of the board, Encik Kasbun Kamat, said: "We have found that such lightning rods have no extra advantages over the conventional ones."

Some people think that such lightning rods are more effective because of their radioactive content.

Tall buildings

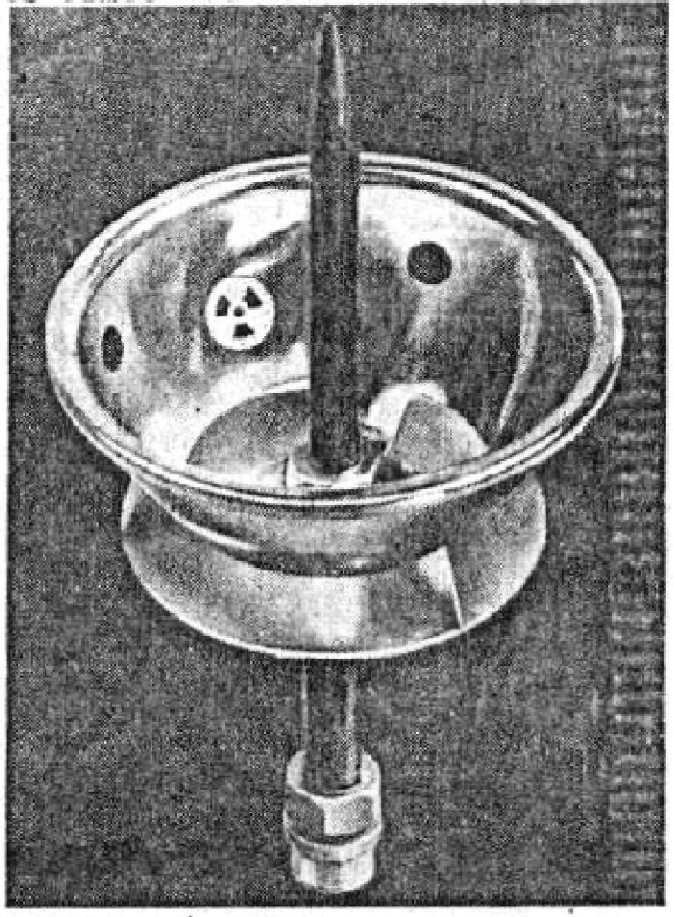
"That is not so. Such lightning rods are not superior to the conventional ones."

He said countries like the Unites States, Sweden, France, Australia and Argentina, which had produced the radioactive rods, had imposed a ban on their use.

The board also decided to impose the ban because of the problem of disposal that would arise with the wider use of the radioactive rods.

"The Government wants to ensure that Malaysia will not become a dumping ground for radioactive rods."

There are now about 50 radioactive rods in



A lightning rod containing radioactive material.

The ban on the radioactive lightning rods that took effect in June 1989.

UNCONVENTIONAL LPS
Early Streamer Emission (ESE)

- Provide same kind of protection as radioactive air terminal
- One ESE centrally located for entire building protection
- Scientific studies proven ESE failed to capture lightning
- Most commonly use in Malaysia




VLP ENGINEERING SDN BHD

UNCONVENTIONAL LPS
Dissipative Array System (DAS)

- Claimed to be able to prevent lightning from striking the facility it was installed on

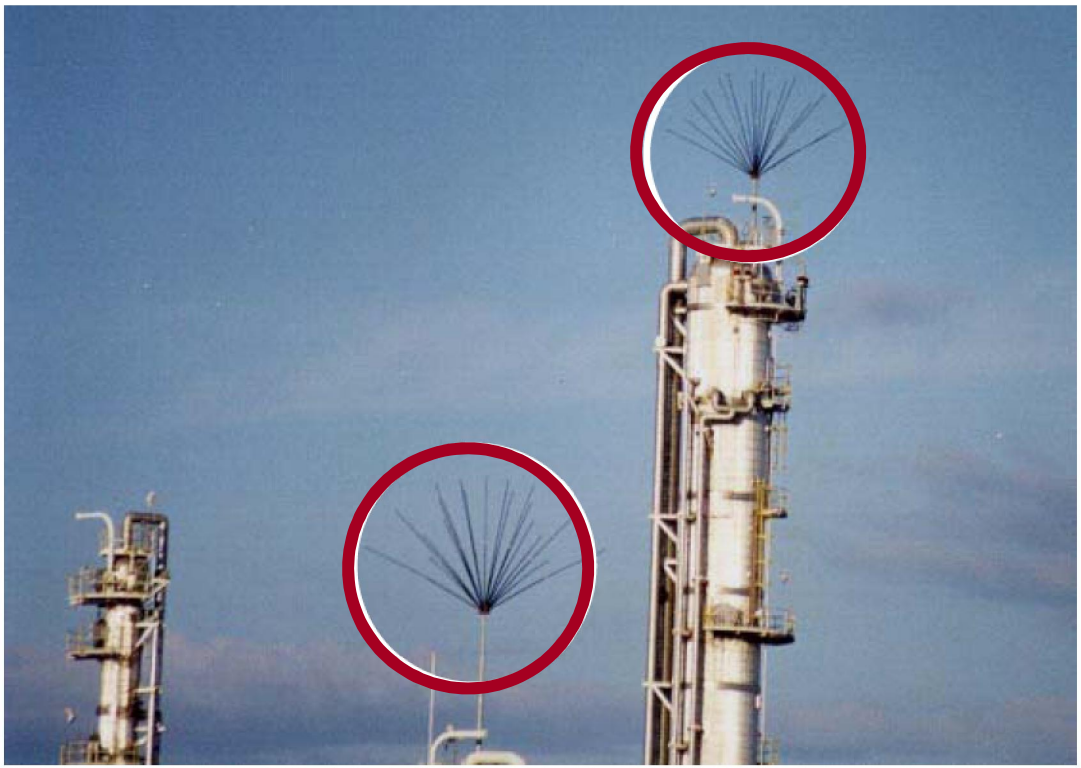
A DAS air terminal (circled) installed at a petroleum gas pumping station in Kapar. Similar installations in the USA have been struck by lightning and have been reported in several scientific papers.

*Picture courtesy of Hartono and Rubiah.

VLP ENGINEERING SDN BHD

UNCONVENTIONAL LPS
Semiconductor Lightning Eliminator (SLE)

- Claimed: able to reduce lightning current by 99%
- Equipped with lightning counter circuit



SLE air terminals (circled) installed on petrochemical processing plants in Trengganu. Their claimed ability to reduce the captured lightning current by 99% has been disproved by scientists from the Chinese Academy of Sciences.

*Picture courtesy of Hartono and Rubiah.

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UNCONVENTIONAL LPS
What You Need To Know

- All unconventional LPS failed to comply with their claims
- Manufacturers failed to provide "scientific paper" for their invention
- No validated proof for their invention works
- Disapproved by standard bodies and scientist worldwide
- Performance equal to a single Franklin rod

SHORTCOMING OF UNCONVENTIONAL LPS

The Royal Selangor Club

BEFORE

Picture taken in 1998 soon after the ESE was installed.

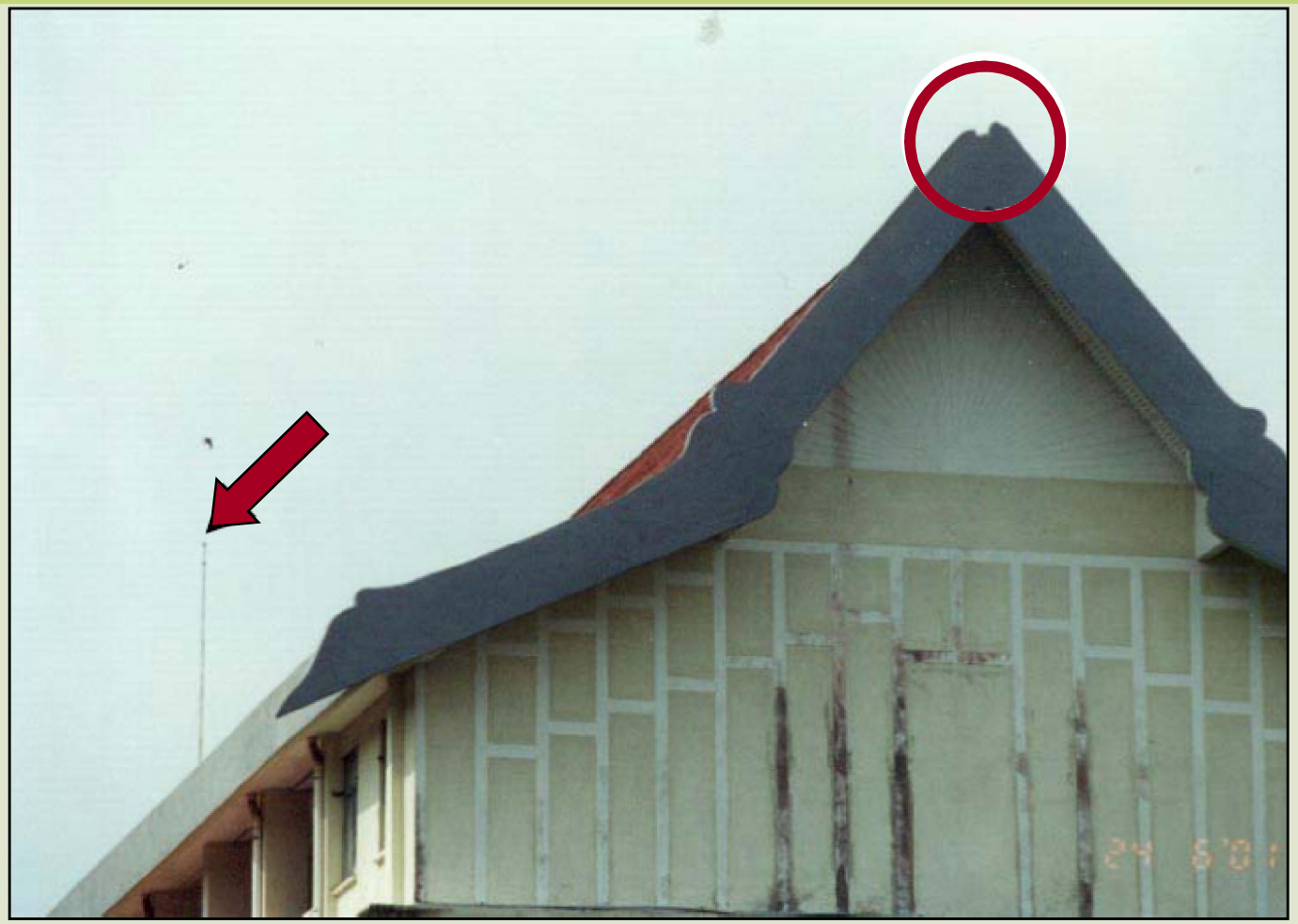
AFTER

Picture taken in 2001 after the building struck by lightning.

*Picture courtesy of Hartono and Rubiah.

VLP ENGINEERING SDN BHD

UNCONVENTIONAL
UTM Skudai



The building facade damaged by lightning (circled) even with ESE (arrowed) installed.

*Picture courtesy of Hartono and Rubiah.

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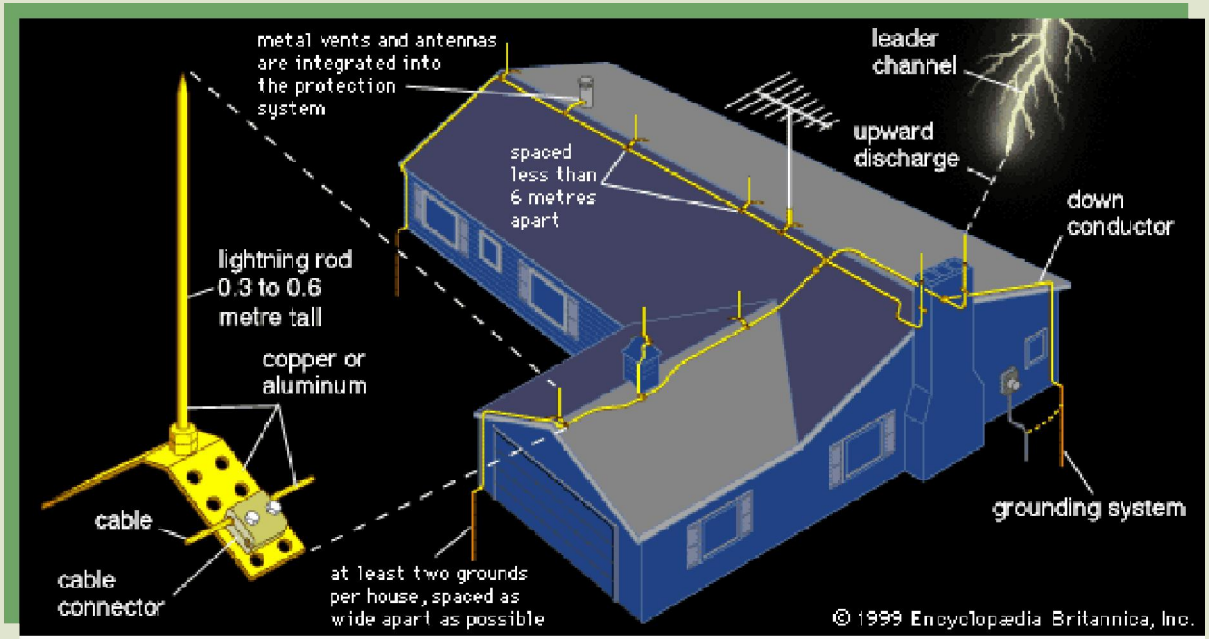
CONVENTIONAL LPS
Franklin Rod

- Standard LPS comply with technical standard
- Places at regular interval on the highest portion of structure
- Copper tape connecting rods providing paths to ground.



CONVENTIONAL LPS
Franklin Rod (Cont.)

Although meet the standard:

- Building's aesthetic value compromised.
- Can only work efficiently provided soil resistance is low for earthing.
- Open to theft and vandalism.

CONVENTIONAL LPS
Franklin Rod (Cont.)

VLP ENGINEERING SDN BHD

CONVENTIONAL LPS
Faraday Cage

- Standard LPS comply with technical standard
- Direct strike protection by dissipate the lightning discharge current to the ground
- Minimizing the possible generation of induce voltage by proper grounding & bonding

LIGHTNING PROTECTION SOLUTION

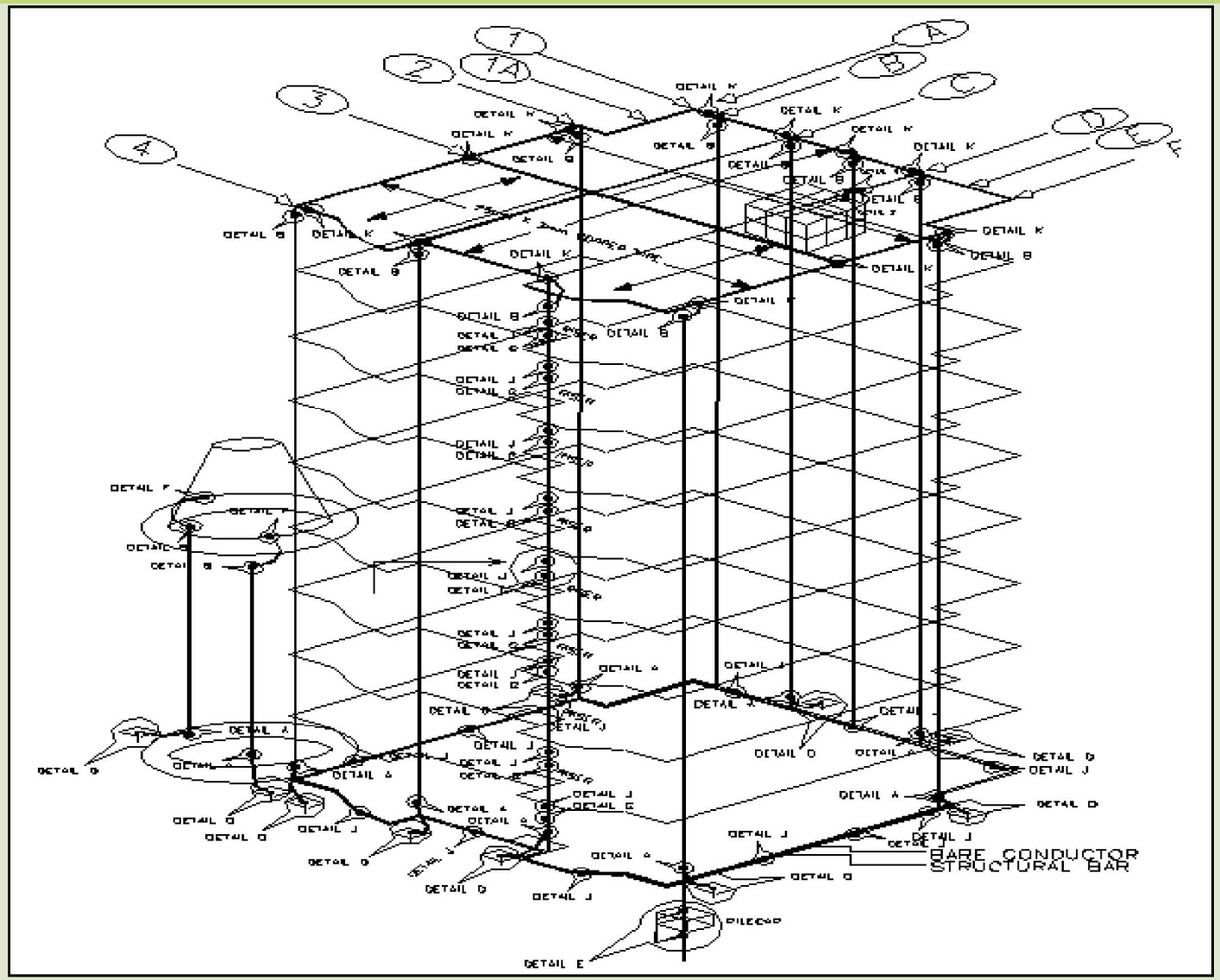
(FARADAY CAGE)

VLP ENGINEERING SDN BHD

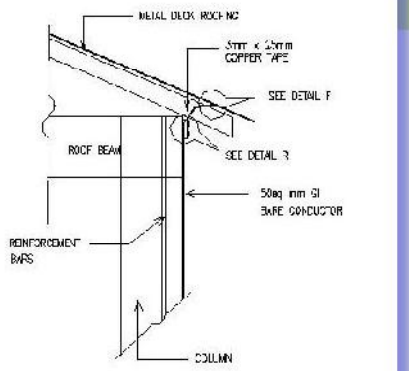
FARADAY CAGE
Lightning Protection Design

- Mechanical and electrically bonded
- Routing of the conductor
- Achieving the required earthing
- Reliable surge protectors
- Intended to last the life of the structure
- Blend with the style and materials of a structure
- Include in provisional sum
- Aesthetic of the building
- Prevent vandalism

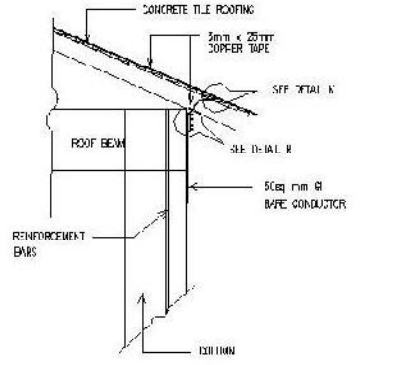
Our Sample Design



DETAILS



DETAIL 'A'



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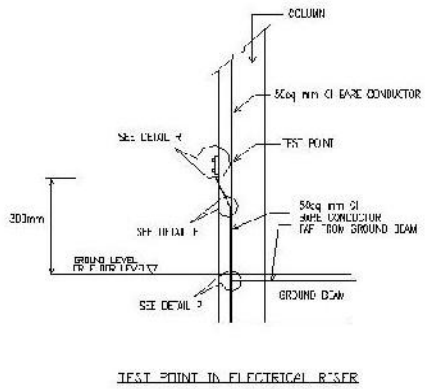
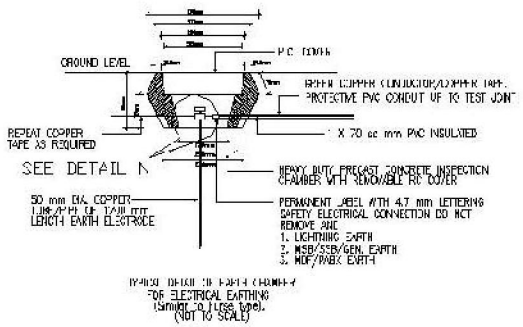
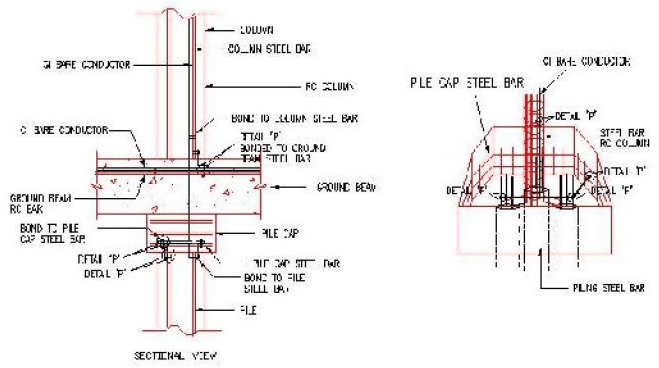


TEST POINT IN ELECTRICAL RISER

DETAIL 'C'



DETAIL 'D'



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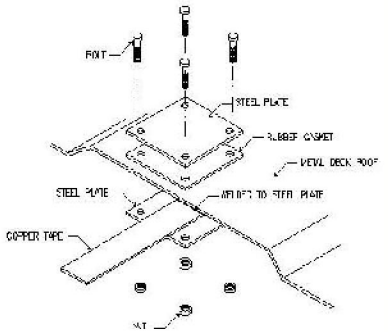

DETAIL 'F'

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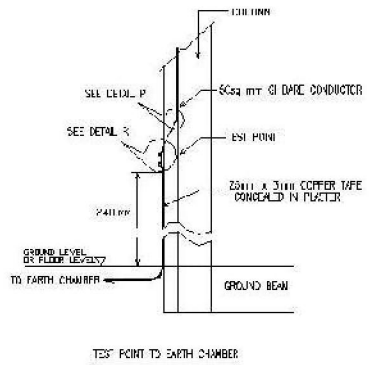
DETAILS (Cont.)



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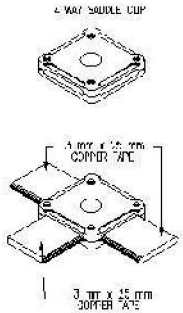
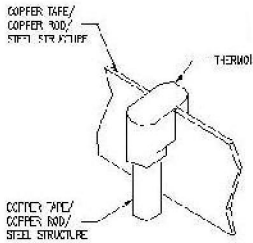


DETAIL 'K'



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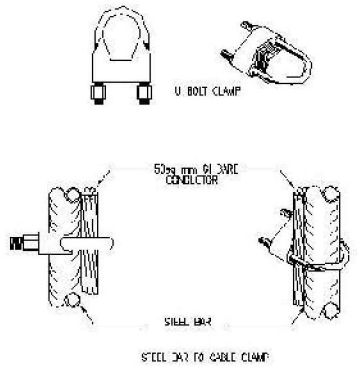
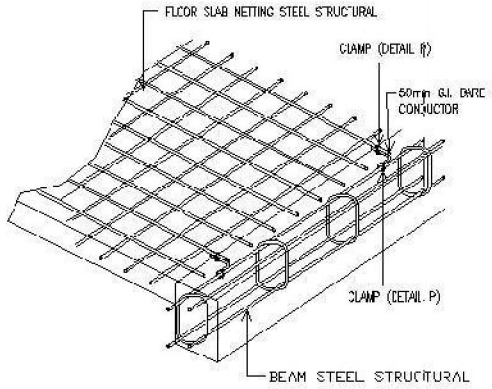
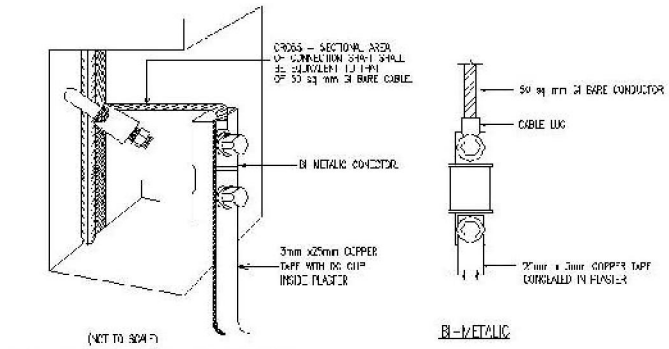


DETAIL 'P'



DETAIL 'Q'



DETAIL OF BONDING TO THE BUILDING STRUCTURAL REINFORCING BARS

DETAIL 'R'

FARADAY CAGE
Lightning Protection Assessment

- ***Quantify the risk*** of a lightning strike to your business premises
- ***Identify vital equipment*** which could be damaged in the event of such a strike
- ***Assess building material*** used & structure design
- ***Accurately estimate the impact*** in terms of both cost and image that downtime due to a lightning strike could have on your business
- ***Develop and implement a strategy*** to limit the impact of such a strike
- ***Schedule a future reassessment*** to ensure that your strategy keeps pace with the growth of your company and maintenance is not neglected

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Generally, the spacing between the poles shall not exceed three times the mounting height of the pole. The lamps for the light fittings shall be of SON type. The illumination level on the ground/road surface shall be not less than 1.5 lumens.

Suitable path lighting with PL lamps shall be provided in the parks and gardens and at the walk paths. Suitable lightings shall be provided for guard house, signage, fountain and ponds, decorative fencing, etc. if any. Area flood light shall be provided where necessary.

Suitable lighting with SON/Metal Halide lamps shall be provided for games courts such as tennis courts, badminton courts, volleyball courts etc. The light fittings shall be on lighting poles with climbing rungs and easy maintenance, etc

All external compound/street/flood/path lightings shall be provided with time switches with reserve and manual bypass or by other appropriate method for automatic and manual switching. The lighting systems shall be of such design so that after mid-night the lighting levels can be reduced if required.

Facade lighting consisting of floodlight, directional lights, etc. shall be provided to enhance the facade of the buildings. These lights shall be centrally controlled.

Installation of obstruction lights for high rise buildings must comply to the Law.

(D) Lightning Protection System and Earthing

Lightning protection systems using copper conductors shall be provided and it shall comply to latest version of BS 6651 "Code of Practice for Protection of Structures Against Lightning".

However buildings and structures required to be protected due to security reason or safety reason or locations on high ground or environmental requirements shall be provided with lightning systems regardless of the heights.

The Faraday cage concept together with the earthed reinforcements of the building structure and foundations shall form the basis of the lightning protection system for the office building. An air termination networks and the bonding of all external metallic fixtures/structures to the reinforcements and down conductors, together with the earth electrodes shall be an integral component of the lightning protection scheme.

The bonding between the reinforcement and the external connections shall be way of or type bond. Lightning counters shall also be provided.

Separate Centralised Earthing Bars of appropriate size shall be provided for the Main Switch Boards, generators, Telecommunication System, CATV/Security/AV System, Data and Computer System which are in turn bonded to the building reinforcement as well as to external earth electrodes. Metal pipes for all services shall also be bonded to the single point grounding system.

JKR NEEDS STATEMENT

The Faraday cage concept together with the earthed reinforcements of the building structure and foundations shall form the basis of the lightning protection system for the office building.

THEATER SHAH ALAM

STADIUM TERENGGANU

VLP ENGINEERING SDN BHD

IKM MUAR

MAHA SERDANG

SURGE PROTECTION SOLUTION

(SURGE PROTECTION SYSTEM)

VLP ENGINEERING SDN BHD

Increase Of Surge Risks

THEN…

BIG, MECHANICAL EQUIPMENT

Increase Of Surge Risks

Advances in technology have caused electronics to become sensitive to voltage impulses, as:

- Most electronics are never totally turned off
- Most electronics require a good grounding and wiring system
- Many electronics have connections to another cable system, besides power
- Most electronics can be damaged by very low-level voltages that get into the circuits
- Micro-miniaturization in electronic systems increase sensitivity to transient effect

SURGE PROTECTION SYSTEM

- Protection of the electrical & electronic equipment against surges from lightning strike or other transient effects
- Building with a proper lightning protection system will reduce possibilities of induced voltage surges in power or data lines
- Design requirement for surge protection will be coordinated with lightning protection system

Earth electrodes shall be of 16mm dia. copper jacketed rod and the earth inspection chambers shall be of heavy duty precast concrete similar to Furse type.

(E) Surge Protection Systems and Voltage Stabilizing System

Surge protection devices (SPDs) shall be provided for the main electrical distribution system including sub-switch boards and distribution boards, computers, electronic equipment, fire alarm panel, PABX equipment, UPS equipment, CCTV equipment, MATV equipment, card access equipment, etc. which are susceptible to lightning and switching surges. The proposed surge protection system shall consist of Classes One, Two and Three Surge Suppressors and shall be suitable for the use with computerized equipment. They shall be installed in various locations of low voltage and equipment installation and the Contractor shall indicate these in the design drawings.

The SPDs shall be one-port type compatible with the 240/415 V, 3 phase, 4 wire, 50 Hz with solidly earthed neutral supply system it is protecting. The SPDs modes of protection shall be each phase-to-neutral, each phase-to-earth and neutral-to-earth for either single phase or three phase supply system. However, for cases where the incoming feeder circuit breaker in the main switchboard is rated 600A or less, SPDs with modes of protection at each phase-to-neutral and neutral-to-earth may be allowed to be installed in the whole electrical installation. SPDs for three phase supply system installation shall be of mono block or modular type. Unless otherwise specified, SPDs shall be of the type complying with MS IEC 61643-1 and MS IEC 61643-12 and in accordance with recommendations of IEC 62305 and the relevant parts and sections of MS IEC 60364.

The SPDs shall be of voltage limiting type with metal oxide varistors (MOVs) or combination type with MOVs and gas discharge tube (GDT)/spark gap. MOVs and GDT/spark gap shall comply with MS IEC 61643-331 and MS IEC 61643-311 respectively. The normal operating voltage shall be 240V and the maximum continuous operating voltage (U_c) of SPDs shall be minimum 275V (phase-to-neutral, phase-to-earth and neutral-to-earth). The continuous operating current (I_c) for each mode of protection shall not exceed 3 mA. In the case where the MOVs are used, the SPDs shall be provided with integrated thermal protection function to avoid thermal runaway due to degradation.

The impulse current (I_{imp}), nominal discharge current (I_n), maximum discharge current (I_{max}) and open-circuit voltage (U_{oc}) rating per mode of protection of SPD and the respective voltage protection level (U_p) shall be as indicated in Table 1. Unless otherwise specified, the class of SPDs to be installed with respect to the location of switchboard and/or distribution board shall be as in Table 1.

JKR NEEDS STATEMENT

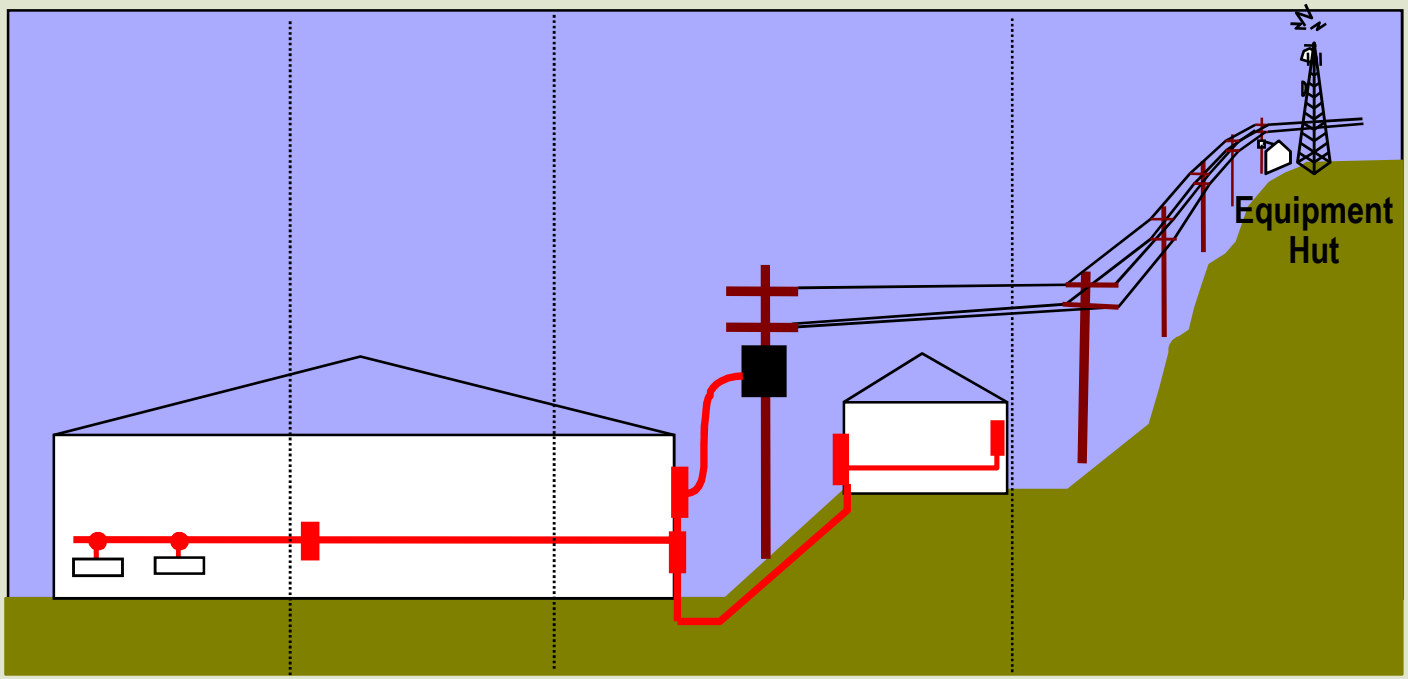
Surge protection devices (SPDs) shall be provided for the main electrical distribution system including sub-switch boards and distribution boards, computers, electronic equipment, fire alarm panel, PABX equipment, UPS equipment, CCTV equipment, MATV equipment, card access equipment etc which are susceptible to lightning and switching surges.

SURGE PROTECTION DESIGN

- Risk analysis to determine level of protection required
- Protector selection based on:
  - Survivability
  - Transient control level
  - System compatibility
- Justification on the categories used for specific zone
- Consideration on leakage current to prevent interruption of power supply

Location Categories

Area 1	Area 2	Area 3	Area 4
Long final sub-circuits and power outlets	Major sub mains < short final sub-circuits & load centers	External services, overhead lines to detached buildings	Highly exposed elevated & critical positions



	Cat A	Cat B	Cat C	Cat D
0.5 us/100 kHz	6 kV	6 kV	None	None
0.5 us/100 kHz	200 A	500 A	None	None
1.2/50 us	2KV	6 kV	20 kV	6 kV
8/20 us	1KA	3 kA	10 kA	70 kA

GENERAL SPECIFICATIONS FOR SPD

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CODES OF PRACTICE

- Malaysian Standard MS IEC 61643-1:2004
- American Standard ANSI/IEEE C62.41:1991
- British Standard BS6651-1999,Annex C
- International Telecommunications Unions (formerly known as CCITT) ITU IX K17

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TECHNICAL SPECIFICATIONS FOR SPD

SPD for power lines

- 7 module full mode protection
- Monoblock type
- Not interrupt the system
- kA rating determine by the weakest link
- Enclosed in rugged, safe, all metal enclosure
- Provided with solid state indicators (LED)
- Installed in parallel
- Design to withstand multiple strikes

SPD for data/signal

- Compatible & transparent to existing system
- Not interrupt operation system

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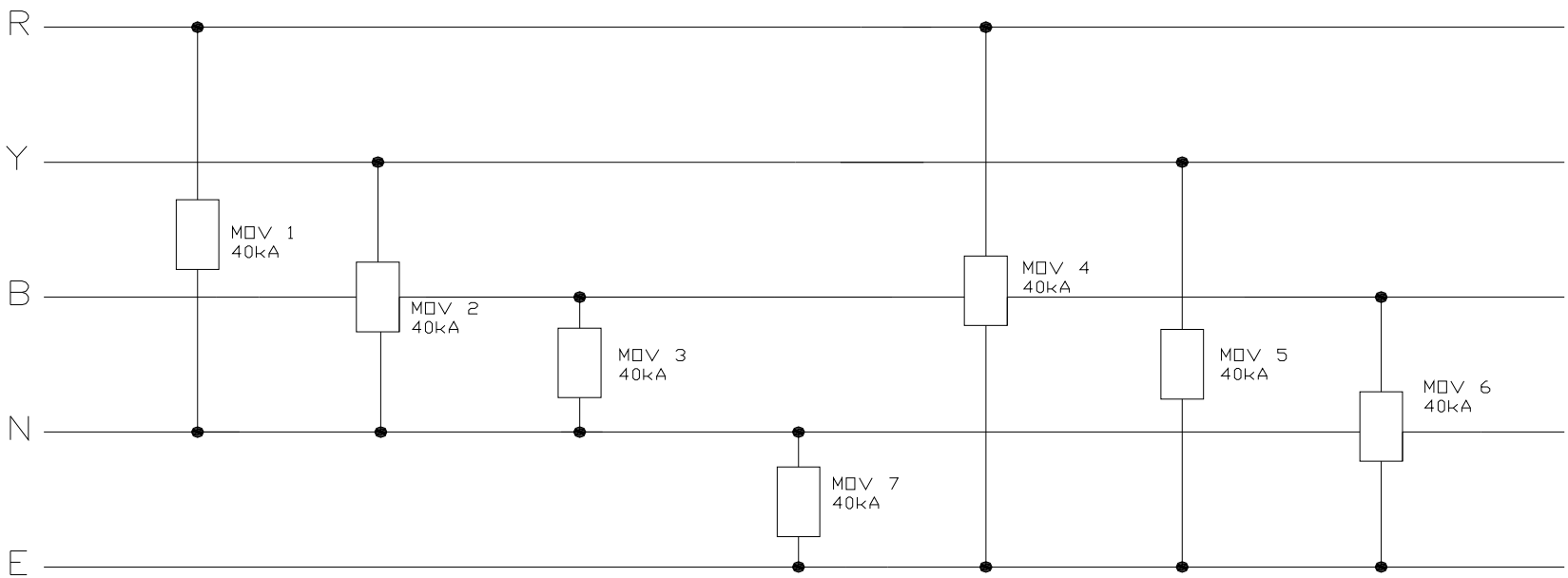
SPD DESIGN REQUIREMENT

VLP ENGINEERING SDN BHD

FULL MODE SPD

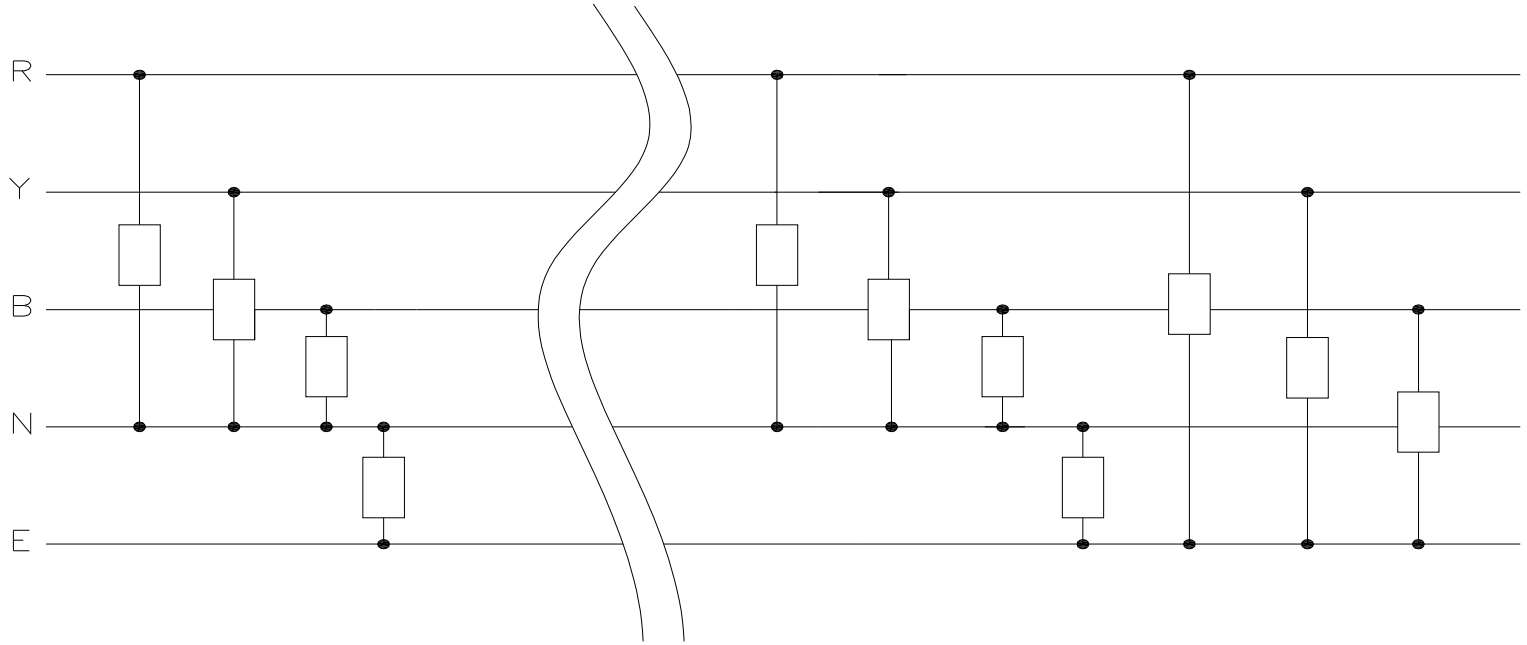


7 MODULE (FULL MODE)

KA RATING 40KA PER PHASE (L–N, N–E, L–E)

VLP ENGINEERING SDN BHD

3+1 MODULE Vs 7 MODULE



3 + 1 MODULE
NOT RECOMMENDED

7 MODULE (FULL MODE)

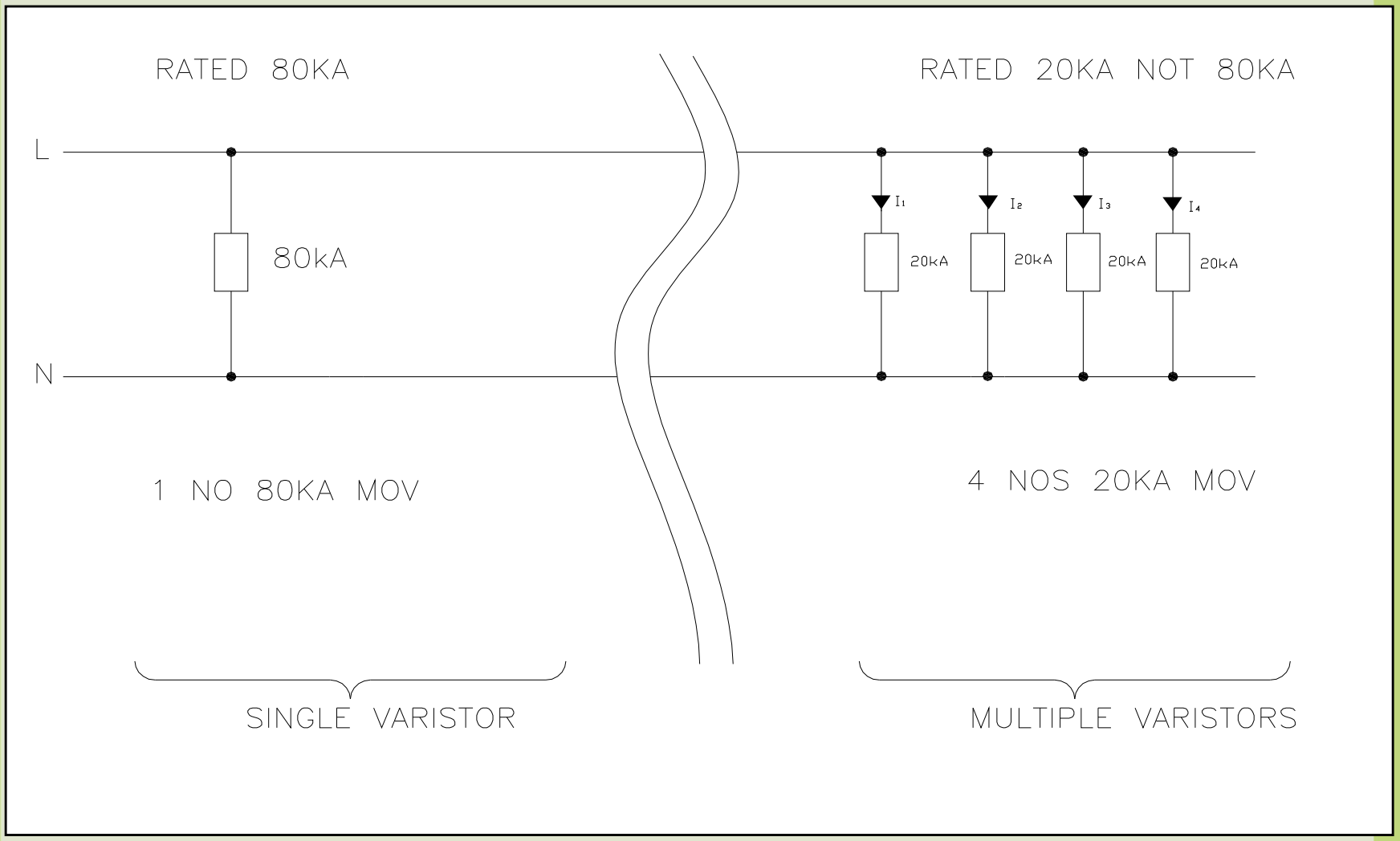
3+1 MODULE Vs 7 MODULE (cont.)

Physical & Technical Comparison

7 Modules		3 + 1 Modules	
1)	Protection between Live - Neutral, Live – Earth & Neutral – Earth	1)	Protection only between Live – Neutral & Neutral – Earth Only
2)	All MOV operates on its own rating	2)	The neutral to earth protection have more burden as all current will pass through this MOV irrespective of surge entrance and may damage faster
3)	Longer life cycle since more path for surge to travel to earth	3)	Less path for discharge current and weakest point at Neutral to Earth makes it life cycle shorter

VLP ENGINEERING SDN BHD

SINGLE VS MULTIPLE VARISTOR



VLP ENGINEERING SDN BHD

MONOBLOCK TYPE Vs MODULAR TYPE

MODULAR TYPE

MONOBLOCK TYPE

VLP ENGINEERING SDN BHD

MONOBLOCK TYPE Vs MODULAR TYPE (cont.)

Technical Comparison

Monoblock Type		Modular type	
1)	Lower Impedance since most contact are soldered & permanent	1)	Higher Impedance since there are many mechanical contact
2)	Low risk of sparking	2)	Mechanical contact can result in sparking. When one module is being replace, the contact become loose and may cause more sparking.
3)	There is only one unit and the indicator shows the exact status i.e. good or damaged	3)	When one module is damaged the whole unit has to be replaces as well to avoid more sparking.

SURGE PROTECTION DESIGN

- Risk analysis to determine level of protection required
- Protector selection based on:
  - Survivability
  - Transient control level
  - System compatibility
- Justification on the categories used for specific zone
- Consideration on leakage current to prevent interruption of power supply

Location Categories

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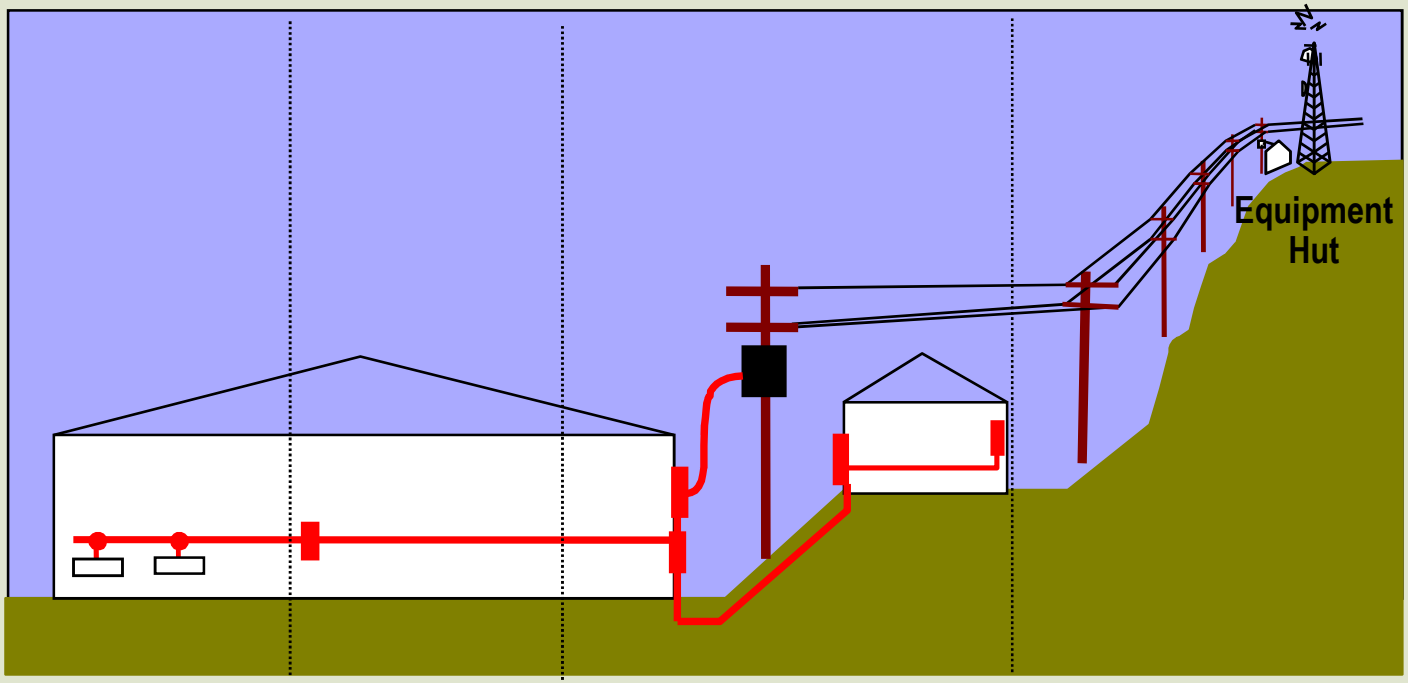


	Cat A	Cat B	Cat C	Cat D
0.5 us/100 kHz	6 kV	6 kV	None	None
0.5 us/100 kHz	200 A	500 A	None	None
1.2/50 us	2KV	6 kV	20 kV	6 kV
8/20 us	1KA	3 kA	10 kA	70 kA

TEST WAVEFORM

Fig 2 : Combination Wave, Short Circuit Current

VLP ENGINEERING SDN BHD

TEST WAVEFORM

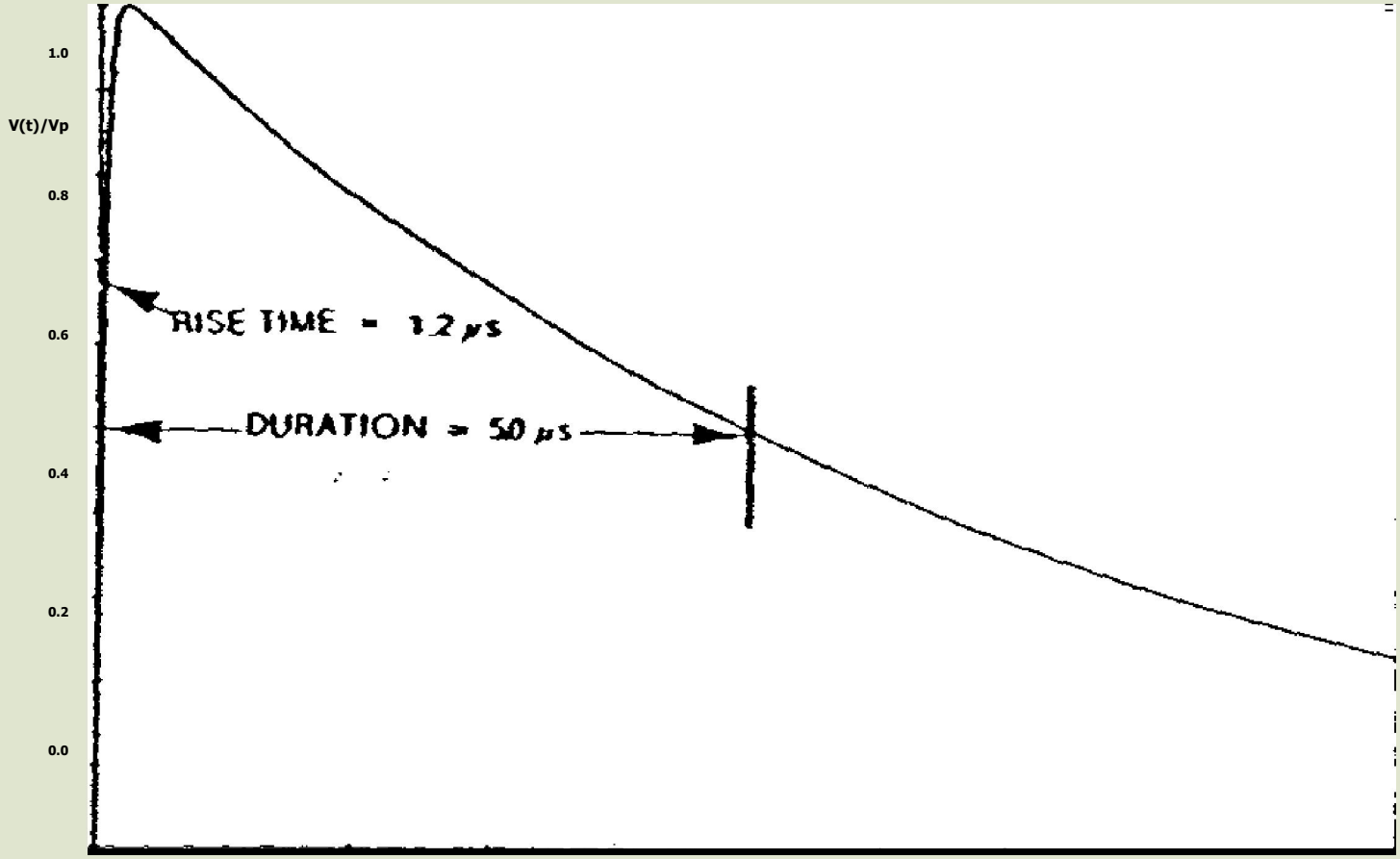
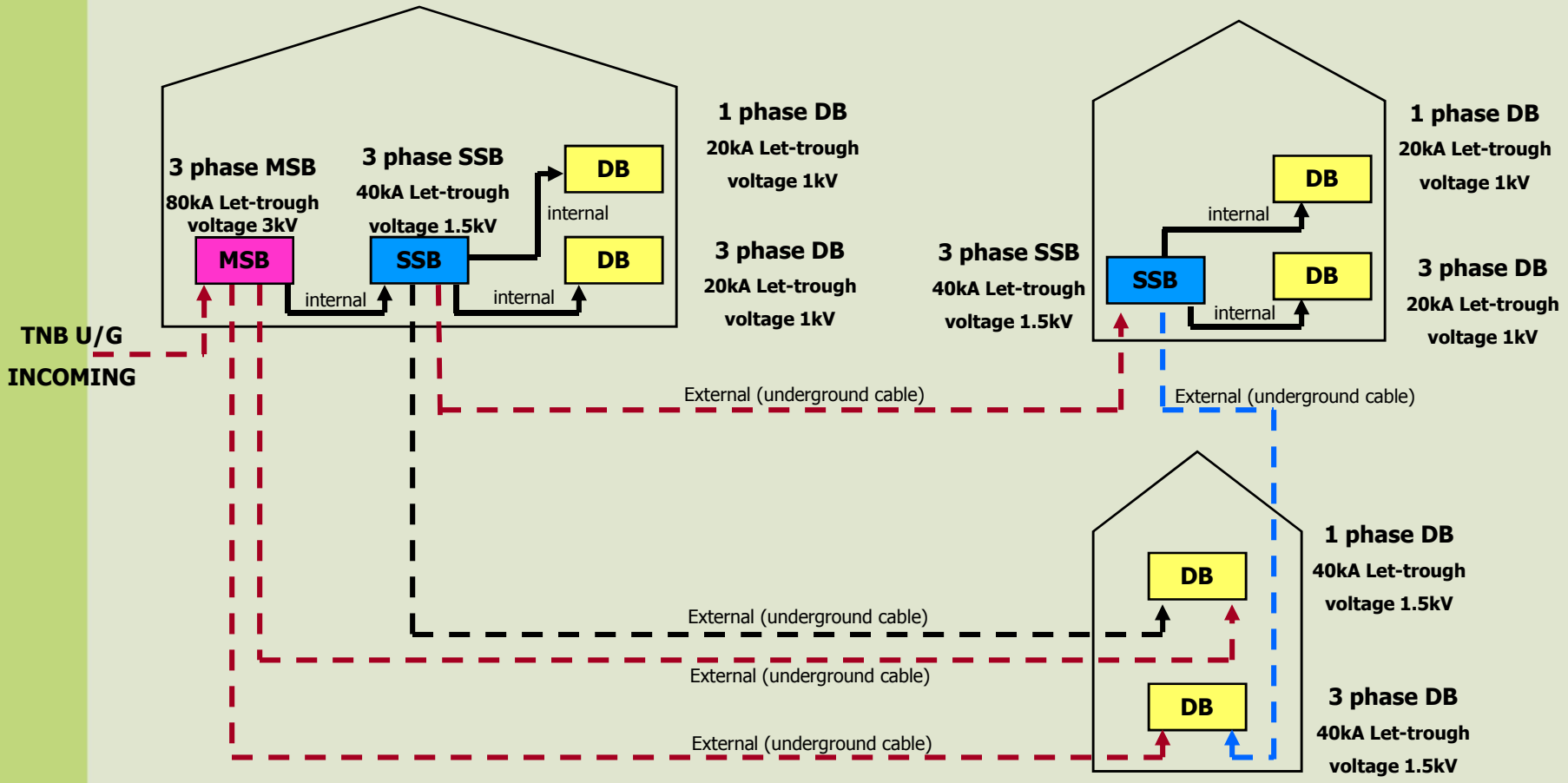


Fig 1 : Combination Wave, Open Circuit Voltage

VLP ENGINEERING SDN BHD

DESIGN EXAMPLES

TYPICAL SURGE PROTECTION FOR POWER SYSTEM



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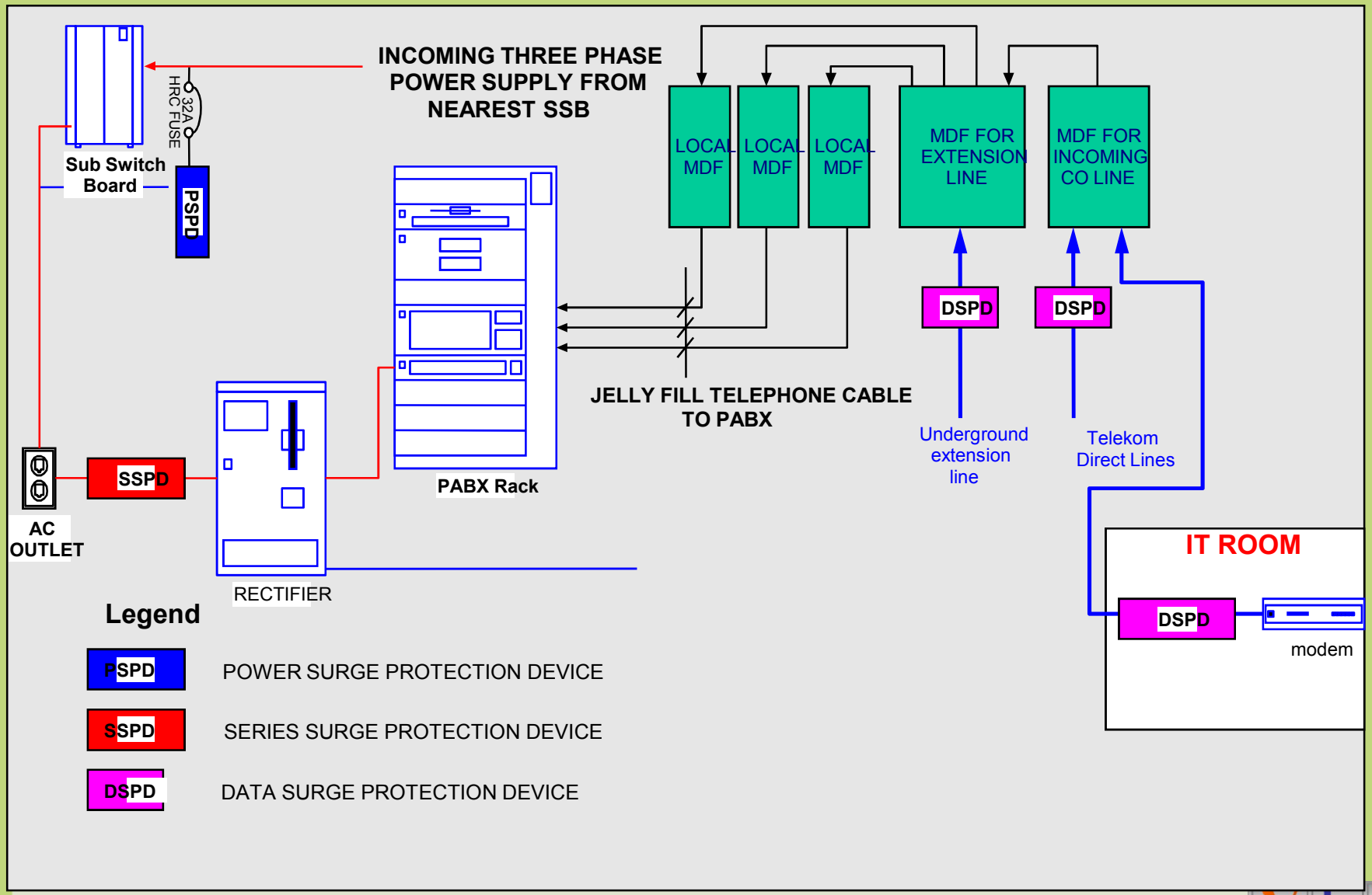
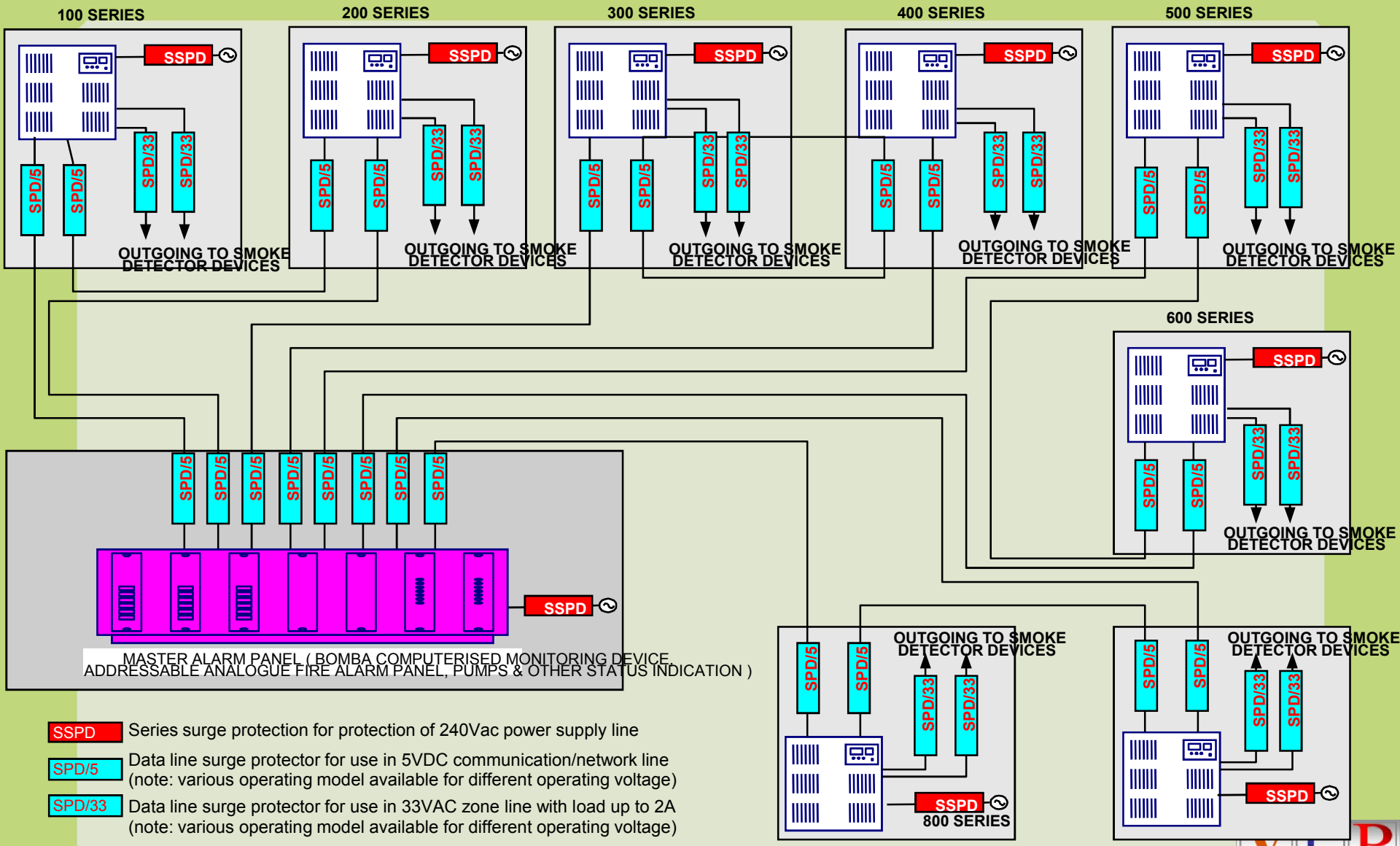
TYPICAL SURGE PROTECTION FOR PABX SYSTEM



TYPICAL SURGE PROTECTION FOR FIRE ALARM SYSTEM



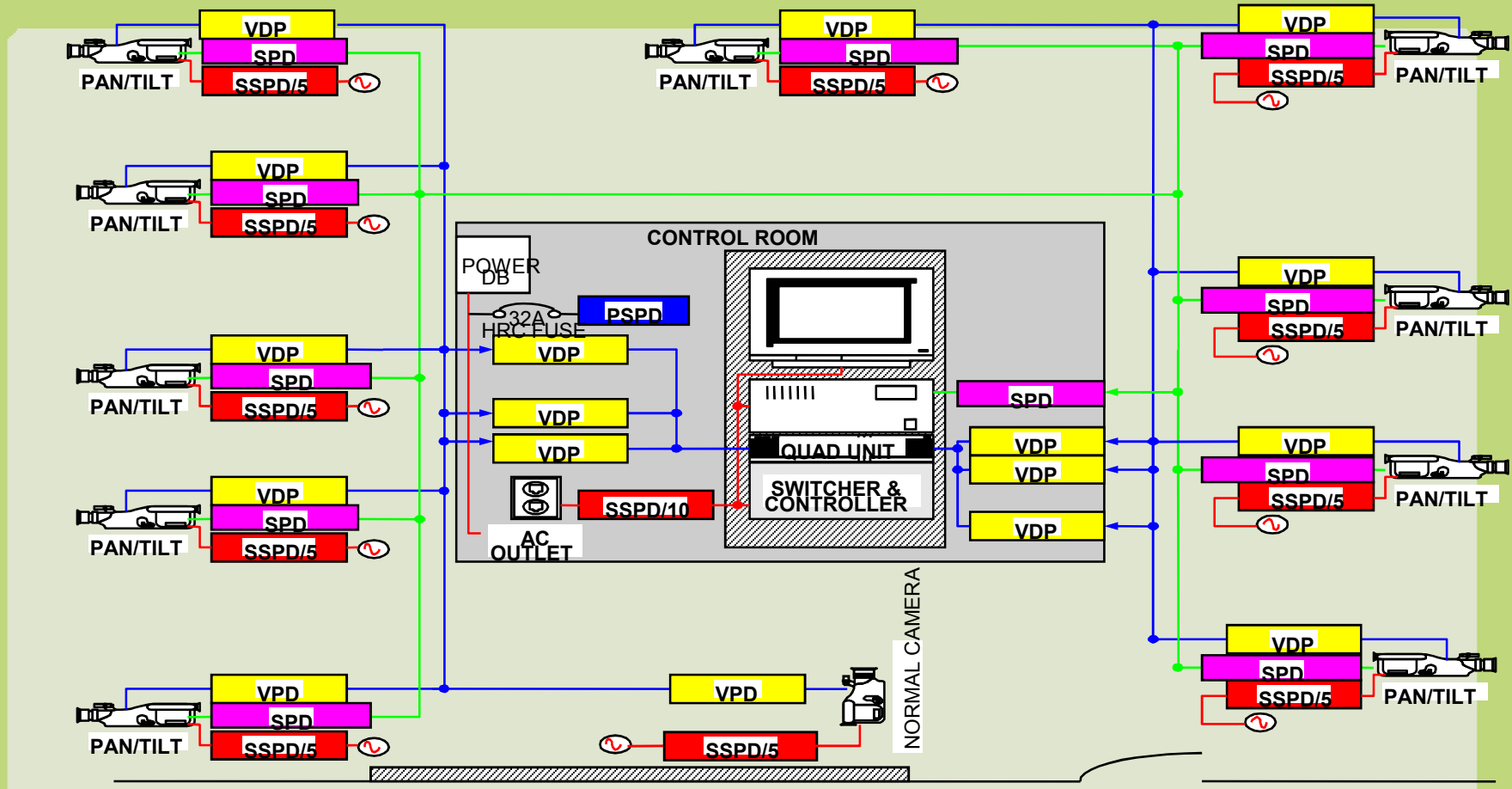
SSPD — Series surge protection for protection of 240Vac power supply line

SPD/5 — Data line surge protector for use in 5VDC communication/network line (note: various operating model available for different operating voltage)

SPD/33 — Data line surge protector for use in 33VAC zone line with load up to 2A (note: various operating model available for different operating voltage)

VLP ENGINEERING SDN BHD

TYPICAL SURGE PROTECTION FOR CCTV SYSTEM

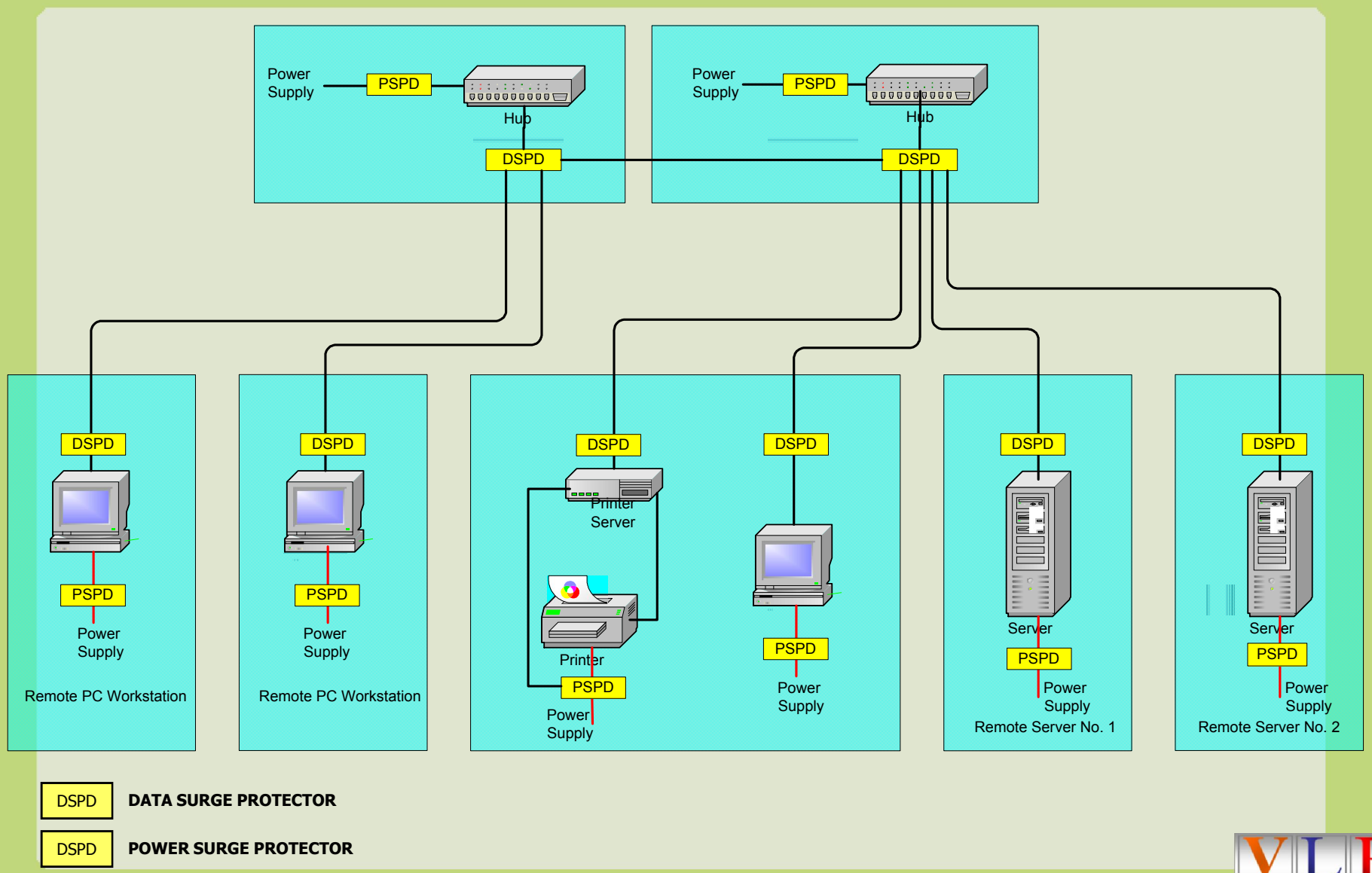


Legend

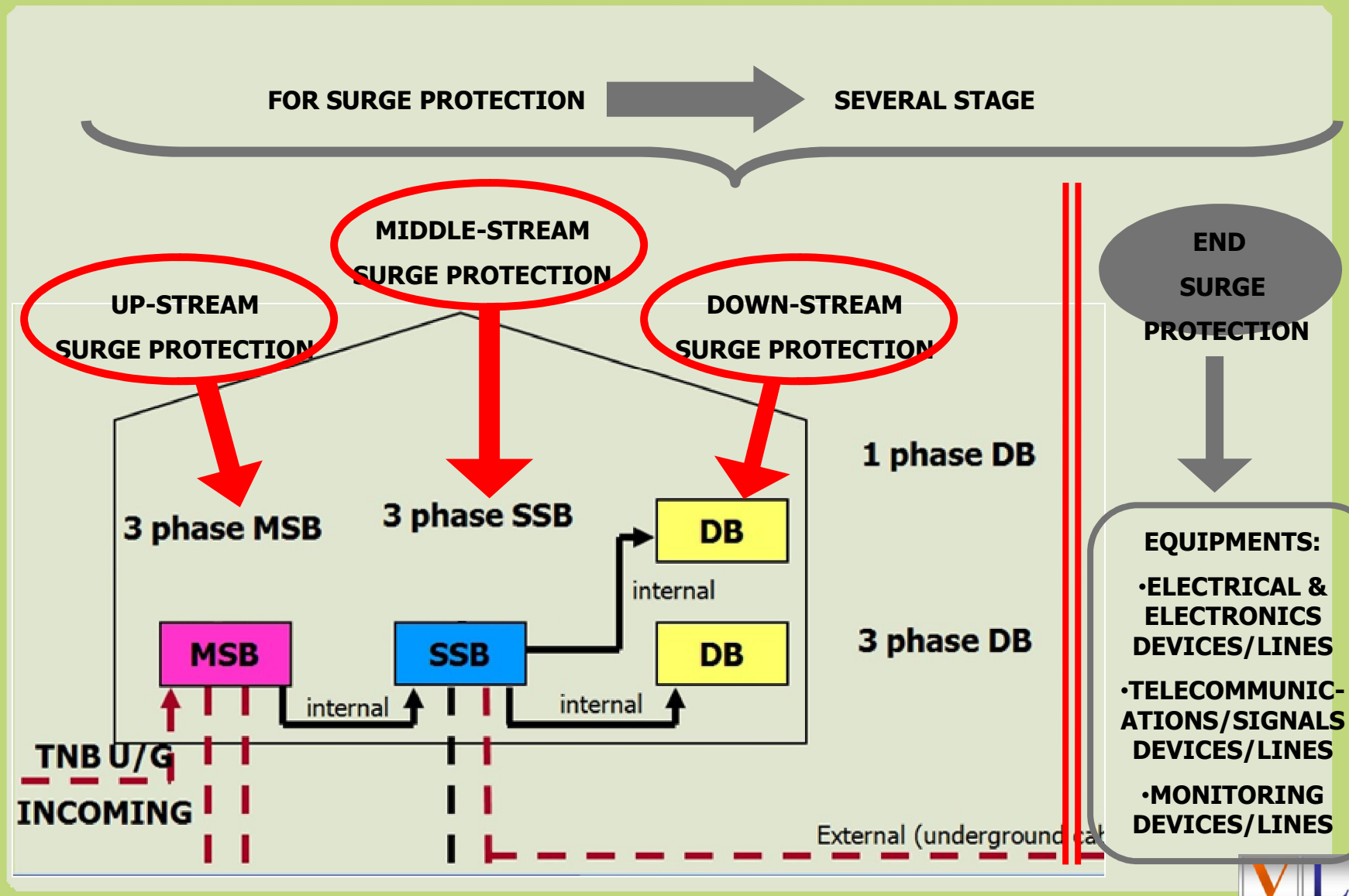
PSPD	POWER SURGE PROTECTION DEVICE
SSPD/10	SERIES SURGE PROTECTION DEVICE FOR LOAD RATED 10A,
SSPD/5	SERIES SURGE PROTECTION DEVICE LOAD RATED 5A,
VDP	VIDEO LINE SURGE PROTECTOR,
SPD	SIGNAL LINE PROTECTOR

VLP ENGINEERING SDN BHD

TYPICAL SURGE PROTECTION FOR NETWORKING SYSTEM



GENERAL REVIEW OF SURGE PROTECTION



VLP ENGINEERING SDN BHD

PROTECTION FOR POWER SUPPLY (ELECTRICAL)

UP-STREAM SURGE PROTECTION

For the up-stream surge protection which attached to the main **MSB or incoming supply** with Higher Rated SPD – 80kA.

Descriptions:
- Three Phase – Power Surge Protector Device (SPD)
- Withstand Surge Current of 80kA per phase (L-N),(L-E),(N-E)
- Model: **PSP1-80415**

- **LED Indicator** – for condition/indication of SPD operation.
- Specification:
  - ✓L1 (Red)
  - ✓L2 (Yellow)
  - ✓L3 (Blue)

  } 3 Phase indicator

MCCB with current rating (100A or 60A) being used for maintenance services.

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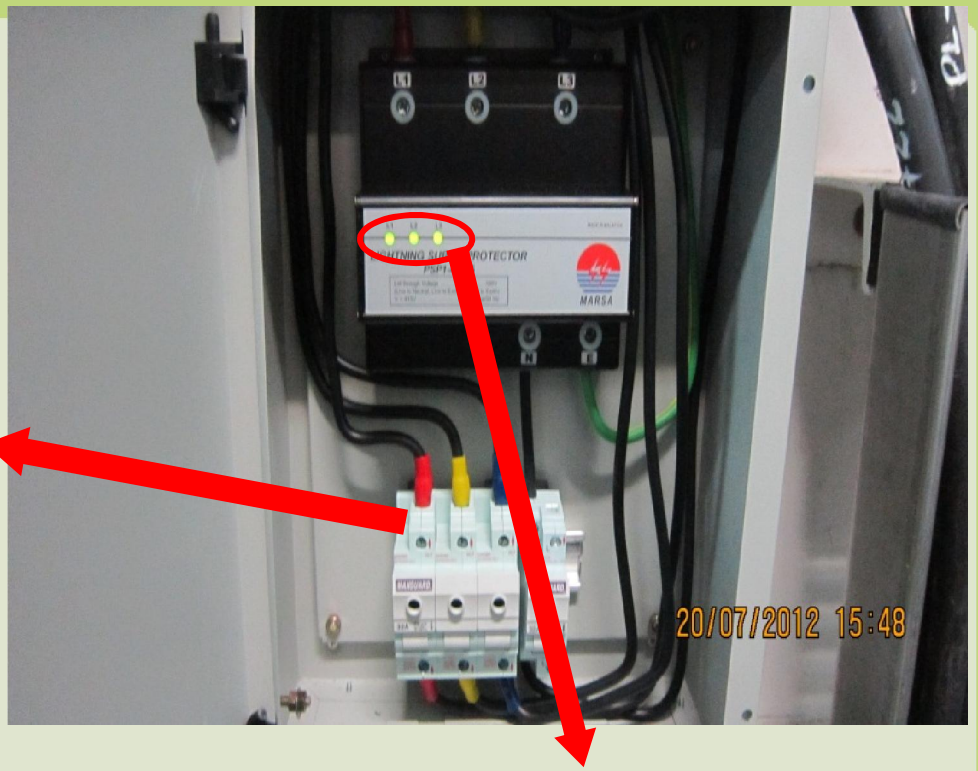
PROTECTION FOR POWER SUPPLY (ELECTRICAL)

MIDDLE-STREAM SURGE PROTECTION



MCCB with current rating (100A or 60A) being used for maintenance services.

For the up-stream surge protection which attached to the main **SSB** with Higher Rated SPD – 40kA @ 20kA.

Descriptions:
- Three Phase – Power Surge Protector Device (SPD)
- Withstand Surge Current of 40kA per phase (L-N),(L-E),(N-E)
- Model: **PSP1-40415 @ PSP1-20415**

- **LED Indicator** – for condition/indication of SPD operation.
- Specification:
  - ✓L1 (Red)
  - ✓L2 (Yellow)
  - ✓L3 (Blue)

} 3 Phase indicator

VLP ENGINEERING SDN BHD

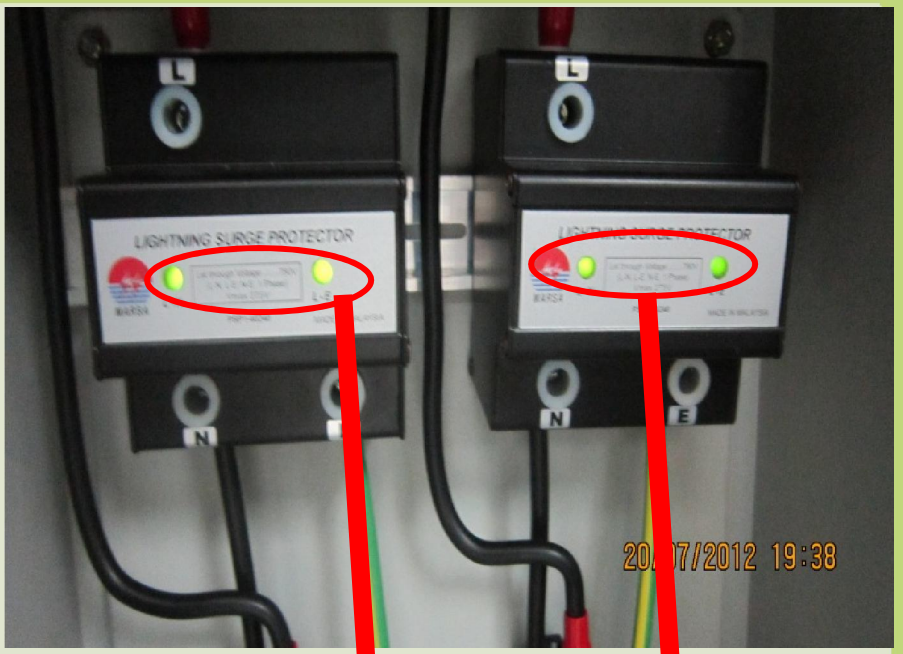
PROTECTION FOR POWER SUPPLY (ELECTRICAL)

DOWN-STREAM SURGE PROTECTION

MCCB with current rating (60A) being used for maintenance services.

For the up-stream surge protection which attached to the main **DB** with Higher Rated SPD – 40kA @ 20kA.

Descriptions:
- Three Phase – Power Surge Protector Device (SPD)
- Withstand Surge Current of 40kA per phase (L-N),(L-E),(N-E)
- Model: **PSP1-40240@ PSP1-20240**



- **LED Indicator** – for condition/indication of SPD operation.
- Specification:
  - ✓Live (L)
  - ✓Neutral (N)

Single (1)-Phase indicator

VLP ENGINEERING SDN BHD

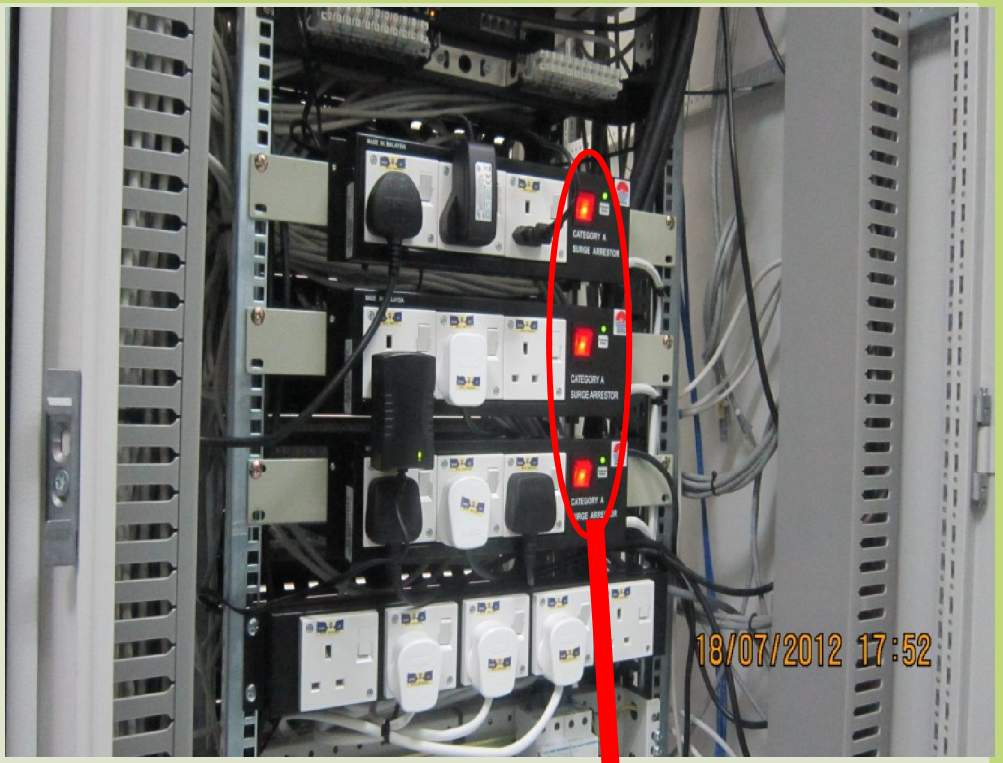
PROTECTION FOR POWER SUPPLY (ELECTRICAL)

END SURGE PROTECTION

- **Power Outlet Surge Protector Device.**
- **Model:**
  - ✓**POSP1-01 (Single outlet)**
  - ✓**POSP1-03 (Three outlet)**

Install to attach protection for most of the server incoming supply socket.

This can be considered as the protection in term of the electrical connection protection of the equipment.



- **LED Indicator** – for condition/indication of SPD operation.

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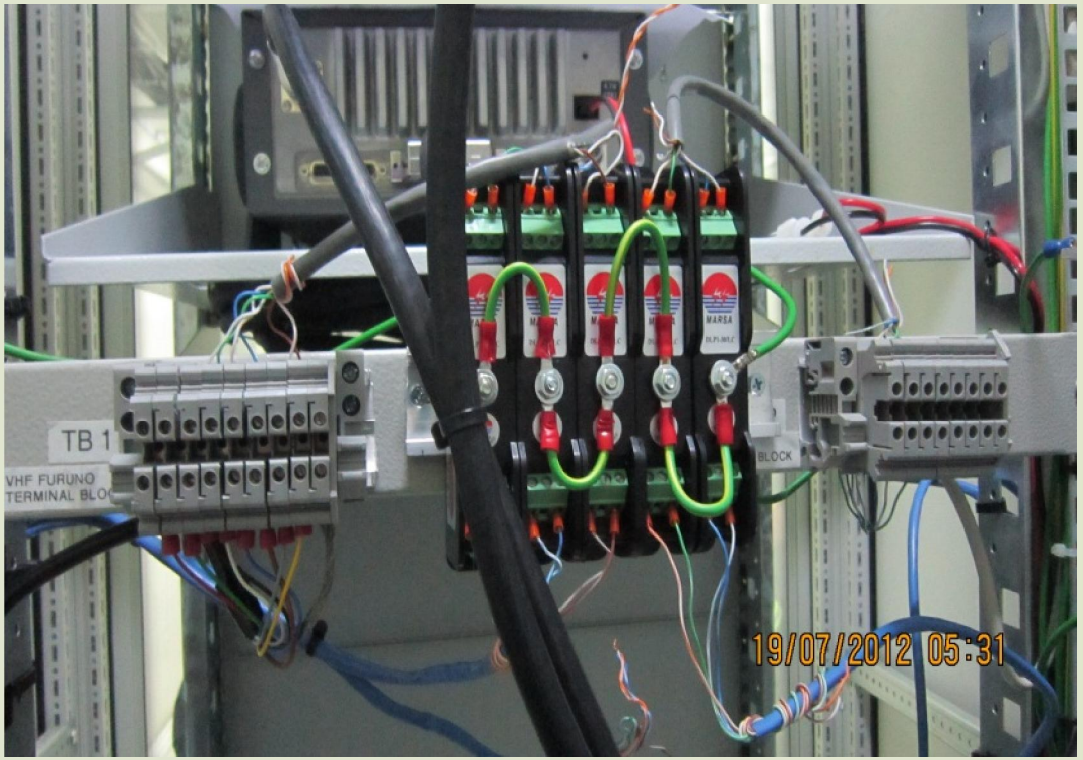
PROTECTION FOR POWER SUPPLY (ELECTRICAL)

LOW VOLTAGE DEVICE

Power Line Protector Device (240V):

•PLP1 - 240

Install to attach protection for most of the electrical and electronics equipment that operate in a lower voltage level (below 240V).



This can be considered as the protection in term of protecting the equipment itself which may be exposed directly or indirectly to the lightning attack. This usually the equipment that related to the Fire Alarm System, CCTVs system, Electronic Device for Signaling System in BORF.

MURPHY OIL BINTULU ONSHORE RECEIVING FACILTIES (BORF)

VLP ENGINEERING SDN BHD

SUPPLY, DELIVER, INSTALL,TEST AND COMMISIONING OF EARTHING, LIGHTNING AND SURGE PROTECTION SYSTEM AT BINTULU ONSHORE RECEIVING FACILITY (BORF), SARAWAK.

VLP ENGINEERING SDN BHD

PROTECTION FOR TELECOMMUNICATION

SIGNALING SYSTEM

Lightning Surge Protector Device for Data Line Networking System :

- **DLNS1- 1 8/8 (RJ 45)**

Install to attach protection for most of the server incoming lines and LAN that may exposed to the lightning attack.

This can be considered as the protection in term of the telecommunication protection of the signaling systems which mostly important in this BORF. This **must be done** because, BORF is totally having telecommunication with the Central Control Room (CCR) on Platform(Offshore base) for operation in their field (oil and gas).

VLP ENGINEERING SDN BHD

PROTECTION FOR TELECOMMUNICATION

TELEPHONE LINES SYSTEM

Telephone Line Surge Protector Device:

- **TLSP1- 10**
- **TLSP1- 01**

Install to attach protection for most of the telephone lines that may exposed to the lightning attack.

This can be considered as the protection in term of the telephone lines protection of the telephone systems which mostly important in this BORF. This **must be done** because, BORF is totally having telecommunication with the Central Control Room (CCR) on Platform(Offshore base) for operation in their field (oil and gas).

VLP ENGINEERING SDN BHD

PROTECTION FOR TELECOMMUNICATION

CCTVs SYSTEM

PAGA SYSTEM

Coaxial Cable Surge Protector Device:

•CXP1- 103

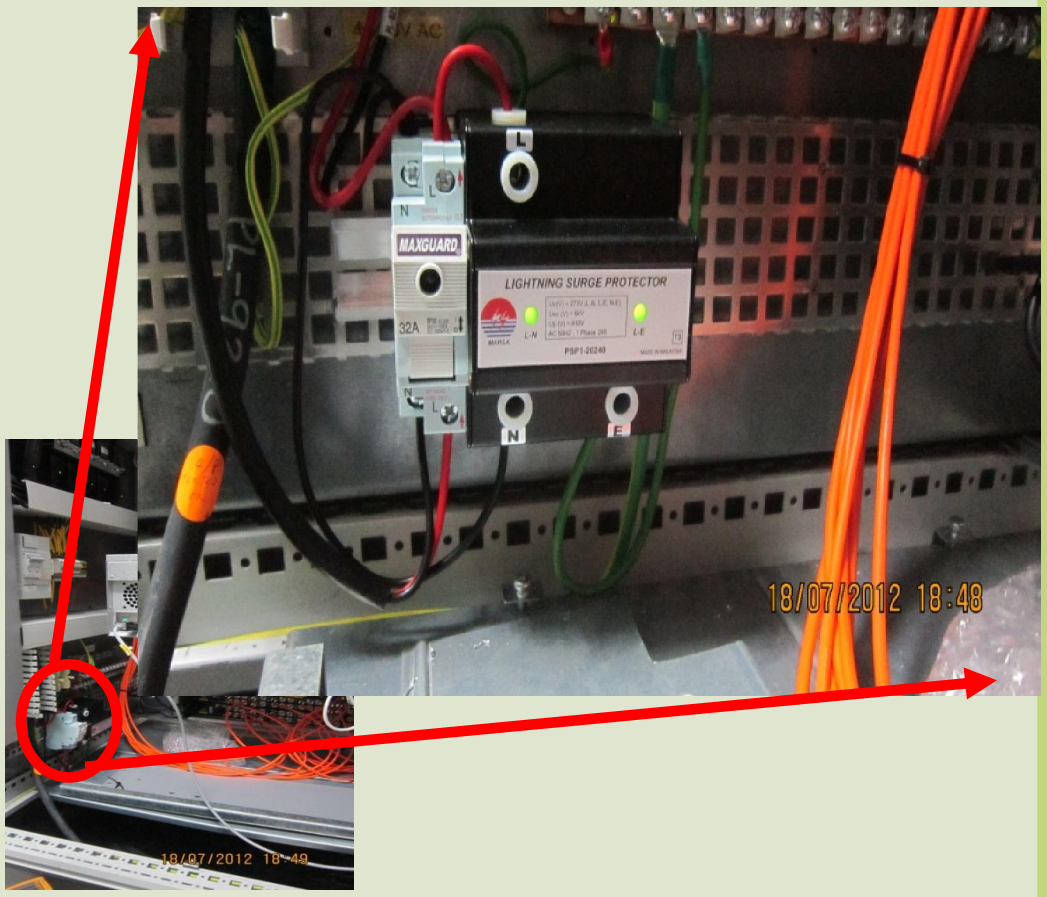
Install to attach protection for most of the monitoring and visual systems that control the CCTVs which placed either in the Onshore base or Platform (Offshore base).

This can be considered as the protection in term of the safety and monitoring for service/operation/maintenance controls.

VLP ENGINEERING SDN BHD

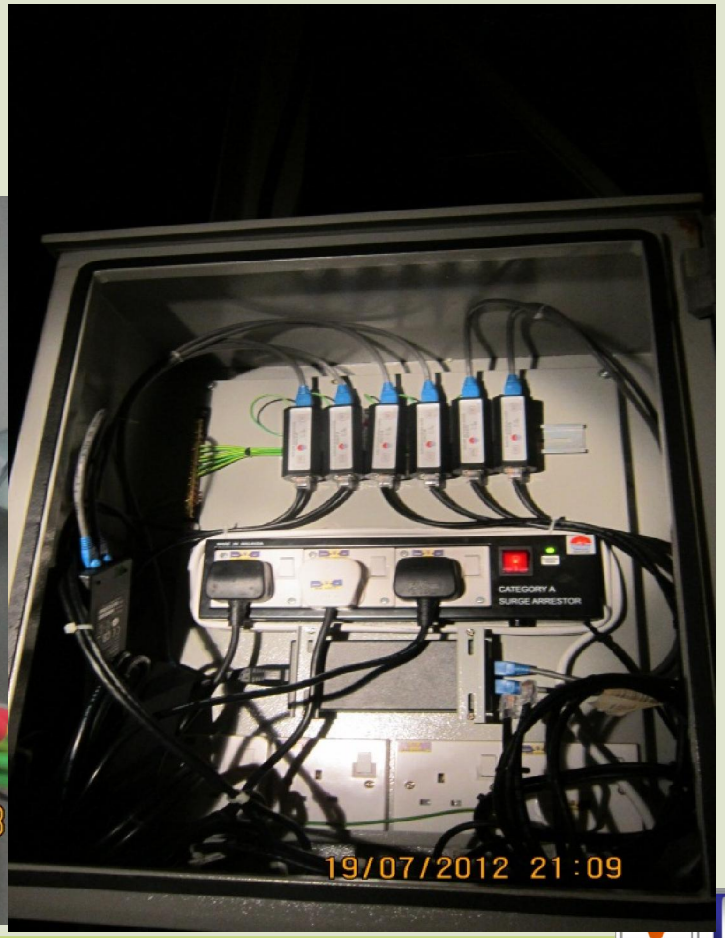
MURPHY OIL BINTULU ONSHORE RECEIVING FACILTIES (BORF)

Other Installation that had been done in Bintulu Onshore Receiving Facilities (BORF)



MURPHY OIL BINTULU ONSHORE RECEIVING FACILTIES (BORF)

Other Installation that had been done in Bintulu Onshore Receiving Facilities (BORF)



ENGINEERING SDN BHD

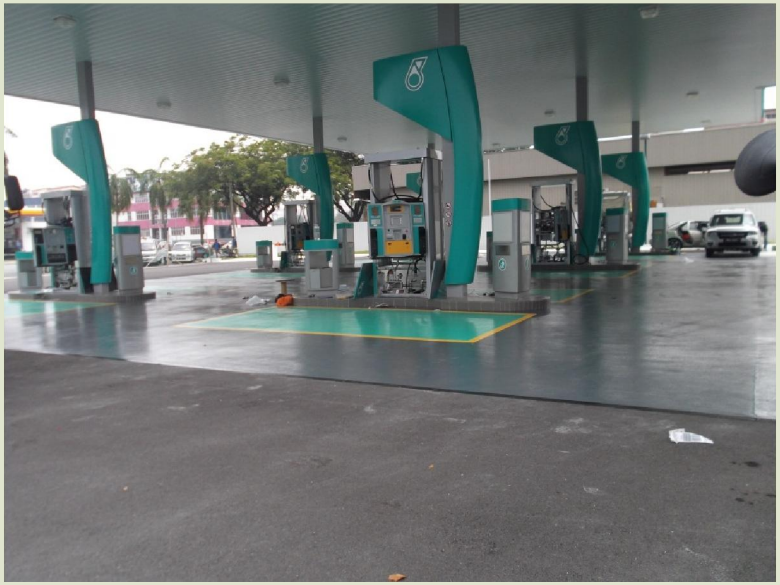
PETRONAS SERVICE STATION (PSS)

@

PETRONAS PETROL PUMP STATION

VLP ENGINEERING SDN BHD

SUPPLY, DELIVER, INSTALL,TEST AND COMMISIONING OF SURGE PROTECTION SYSTEM AT PETRONAS PETROL PUMP, MALAYSIA



SUPPLY, DELIVER, INSTALL,TEST AND COMMISIONING OF SURGE PROTECTION SYSTEM AT PETRONAS PETROL PUMP, MALAYSIA

VLP ENGINEERING SDN BHD

SUPPLY, DELIVER, INSTALL,TEST AND COMMISIONING OF SURGE PROTECTION SYSTEM AT PETRONAS PETROL PUMP, MALAYSIA

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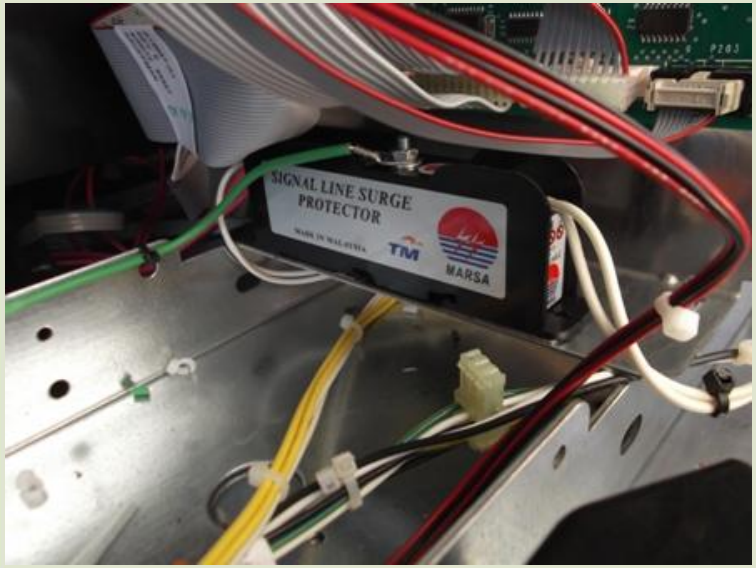
PROTECTION FOR POWER SUPPLY (ELECTRICAL)

For PSS, the first protection being attached is the power supply @ incoming supply.



Protection for the power of the lower voltage for electrical and electronic devices.

Examples: Petrol Pump Machine

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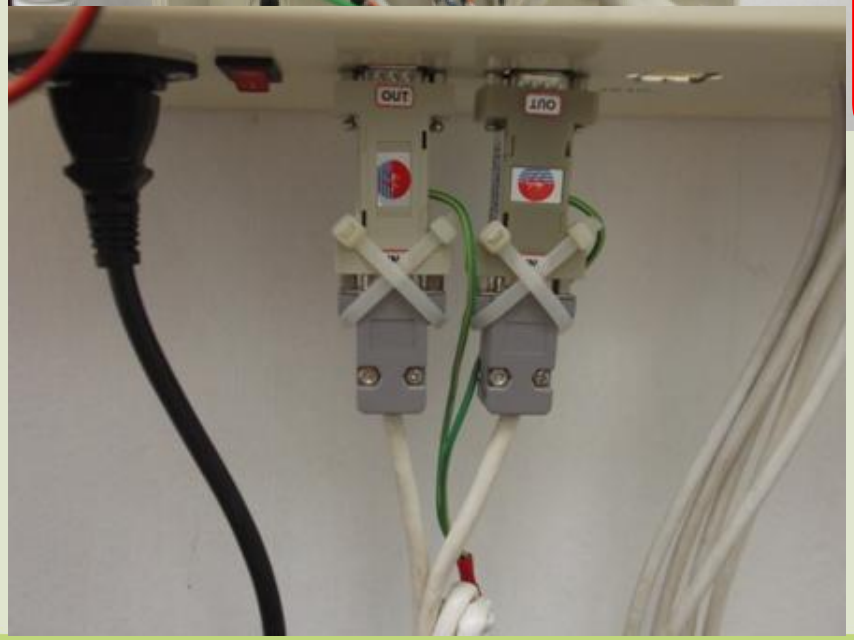
PROTECTION FOR TELECOMMUNICATION



SIGNALING SYSTEM

Protection for the signaling system that control the petrol pump which connected through the control system in the counter post and also the Pump Controller.

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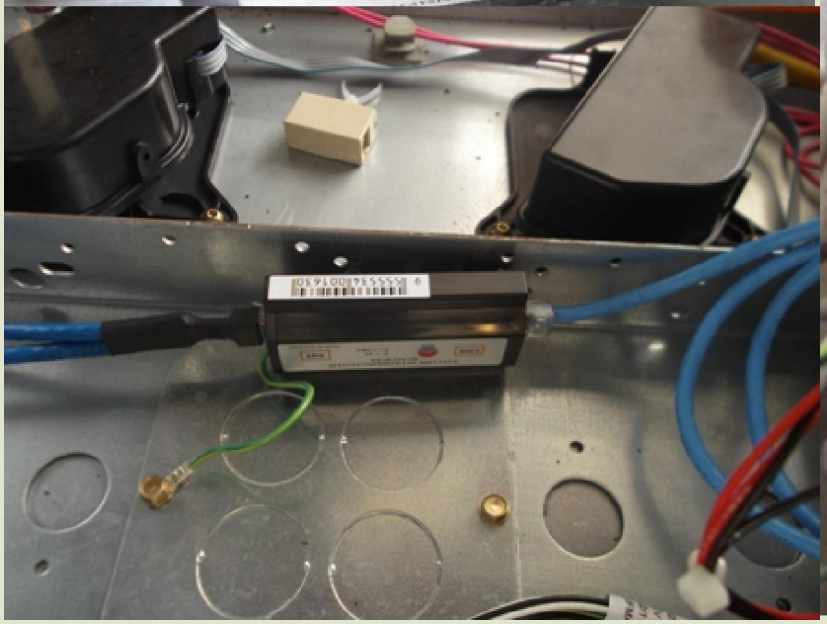
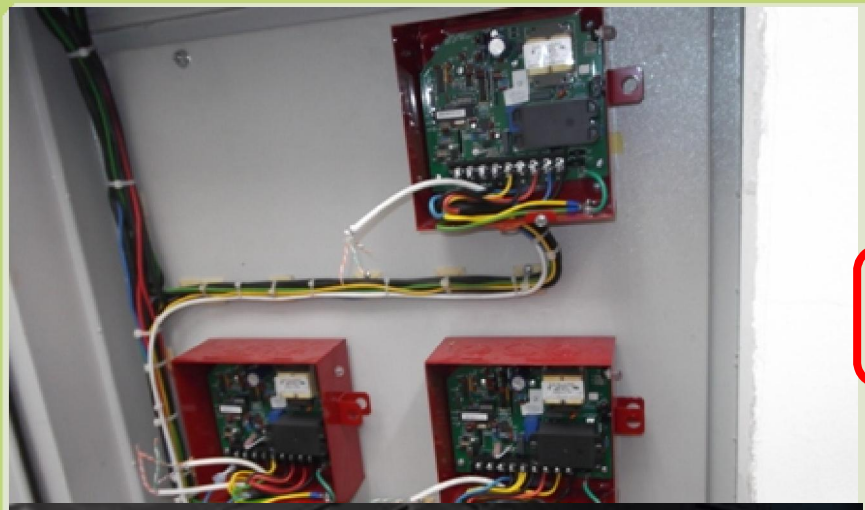
PROTECTION FOR TELECOMMUNICATION



SIGNALING SYSTEM

Protection for the signaling system that control the petrol pump which connected through the control system in the counter post.

PROTECTION FOR TELECOMMUNICATION



FIRE ALARM SYSTEM

Protection for the signaling system that control fire alarm system.

CCTVs SYSTEM

Protection for the signaling system that control CCTVs system.

VLP ENGINEERING SDN BHD

RAPID KL

LRT

PROTECTION FOR POWER SUPPLY (ELECTRICAL)

The first protection being attached is the power supply @ incoming supply.

ENGINEERING SDN BHD

PROTECTION FOR POWER SUPPLY (ELECTRICAL)

Second protection being attached is the power supply socket oulet for the GPS Track Supply Power.

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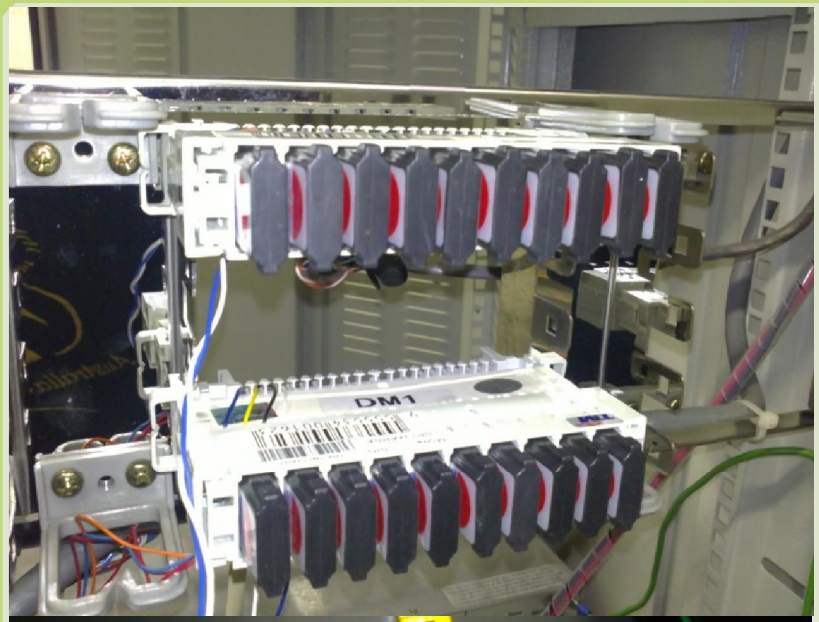
PROTECTION FOR TELECOMMUNICATION

SIGNALING SYSTEM

Protection for the signaling system which control the train system that lead the command for the train to stop or move.

PROTECTION FOR TELECOMMUNICATION

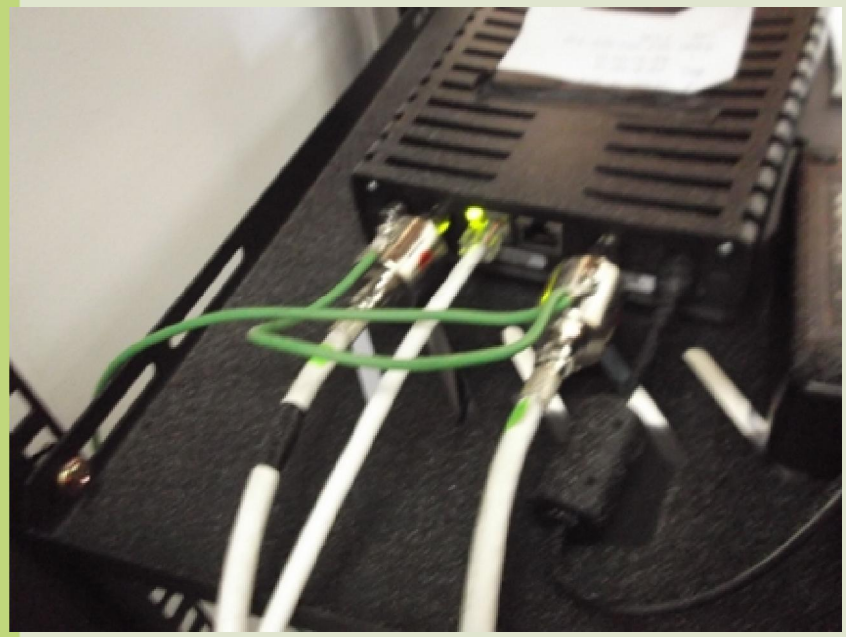


COMMUNICATION SYSTEM

Protection for the communication system that control the train which lead the main train system.

Especially for the TM system.

PROTECTION FOR TELECOMMUNICATION



CCTVs

SYSTEM

Protection for the monitoring system that lead for safety and security system.

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PROTECTION FOR TELECOMMUNICATION

RADIO AND TRACK SYSTEM

Protection for the radio and track system which control the track system which giving command on where the train should be.

LANGKAWI CABLE CAR

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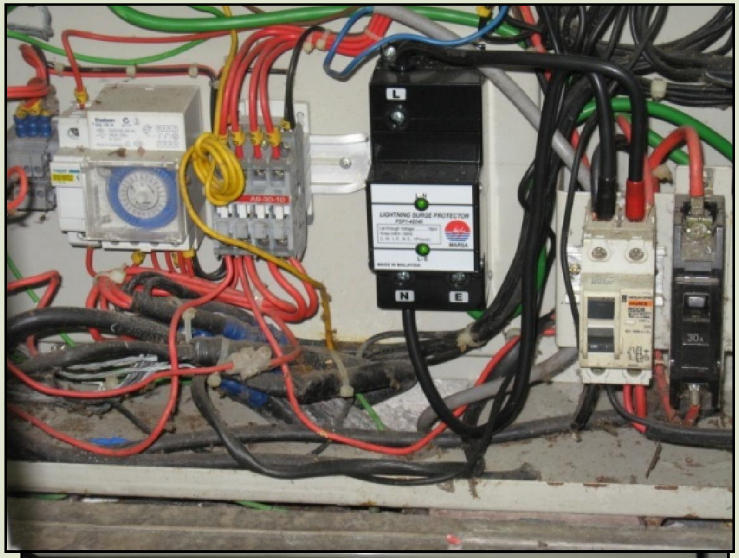
PROTECTION FOR POWER SUPPLY (ELECTRICAL)



For LANGKAWI Cable Car, the first protection being attached is the power supply @ incoming supply.

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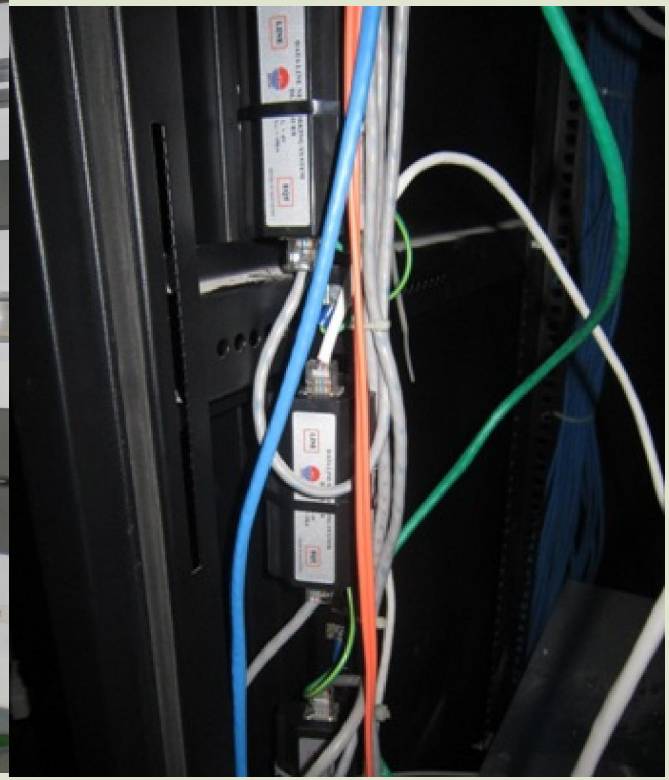
PROTECTION FOR TELECOMMUNICATION

SIGNALING SYSTEM

Protection for the signaling system which control the cable car system that lead the command for the cable car to stop or move.



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PROTECTION FOR TELECOMMUNICATION

SIGNALING SYSTEM

Protection for the signaling system which control the cable car system that lead the command for the cable car to stop or move.

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LAPANGAN TERBANG SULTAN ZAINAL ABIDIN, TERENGGANU

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PROTECTION FOR POWER SUPPLY (ELECTRICAL)

For system, the first protection being attached is the power supply for Distribution Board (DB).

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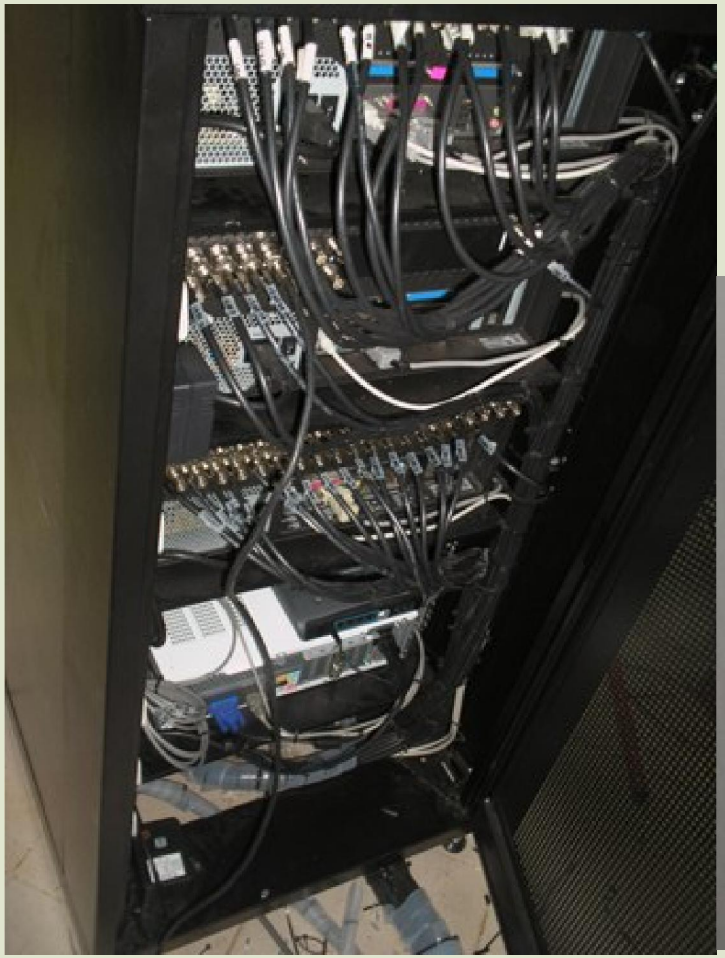
PROTECTION FOR POWER SUPPLY (ELECTRICAL)

For monitoring and display screen, the protection being attached is the power supply socket outlet for incoming power socket.

PROTECTION FOR TELECOMMUNICATION



CCTVs

SYSTEM

Protection for the monitoring system that lead for safety and security system.

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Q & A SESSION

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