GUIDELINES FOR DETERMINATION OF THE SURGE PROTECTION TYPE MOUNTED ON DISTRIBUTION FRAMES

To determine the right type of surge protection on the distribution frames, certain principles have to be applied, such as quality of service, expenses and safety of the personnel. Causes of dangerous overvoltages and overcurrents can be:

- atmospheric discharges (direct or near lightning strikes)
- inductive influence as a result of proximity of high voltage plants
- cross-contact between the power line and the telecommunication line
- rise of earth potential.

Also the risks of telecommunication equipment exposure to surges have to be estimated as correctly as possible. They can be estimated knowing:

- external factors i.e. the environment such as:
  1. keraunic level i.e. number of days with lightning (higher levels mean higher risks)
  2. earthing resistance (higher earthing resistance means a higher risk of direct or near lightning strike)
  3. proximity of high voltage plants (make the risk higher)
  4. rise of earth potential (higher risk)
- used construction methods in laying out the telecommunication network (adherence to standards, separation, isolation and using shielded cable decreases the risk)
- resistance to surges of telecommunication equipment (with the development of electronics, capabilities of modern digital exchanges have advanced features, but the vulnerability to surges has increased several million times compared to mechanical telephone exchanges)
- quality of earthing for surge protection.

Surge protection on the distribution frame has to ensure that only harmless overvoltage levels or overcurrents could reach the telecommunication equipment. There are several types of surge protection modules with different elements, levels of protection, response time and resistivity to interference.

Five basic configurations of protection devices are used to provide surge protection on the distribution frames :

1. Gas discharge tubes (GDT) – this is basic and cheapest one-stage overvoltage protection. Drawbacks are slow response (around 500 ns), no thermal protection and no protection against short circuit between power line and telecommunication line. After several strikes the conductance of the gas discharge tube drops and surges with fast-rise time pass through without activating the tube. There are two types of gas discharge tubes used on distribution frames – two-pole for protecting one wire and three-pole for protecting one cable pair (two wires). Two-pole gas discharge tubes have another drawback because tolerances of the two different tubes, protecting one cable pair, do not spark over at the same time and the whole overvoltage (reaching several thousand volts) becomes transverse voltage between conductors a and b of this cable pair. Therefore it is recommended that three-pole gas discharge tubes with fail-safe clips are used. Fail-safe clip is providing thermal protection in the case of contact between telecommunication and power line. If this contact persists and gas discharge tube absorbes enough energy, its heat activates fail-safe clip and connects a and b line direct to the grounded pole.
   Protection with gas discharge tubes is recommended for high quality telecommunication networks with underground shielded cables. It can be applied for analog lines and for regions with keraunic levels $K < 30$.

2. Gas discharge tubes and varistors – this is two-stage overvoltage protection with three-pole gas discharge tube with fail-safe clip and varistors. Response time is less than 25 ns.
   This protection is recommended for telecommunication networks with underground unshielded cables and for regions with keraunic levels $K < 30$ and also for high quality telecommunication networks with shielded cables and regions with keraunic levels $K < 50$.
   It can be applied for analog lines and lower rate digital transmission.

3. Gas discharge tubes and diodes – this is fast two-stage overvoltage protection with three-pole gas discharge tube with fail-safe clip and thyristor diodes. Response time is less than 1 ns.
   This protection is recommended for telecommunication networks with underground unshielded cables and for regions with keraunic levels $30 < K < 50$, as well as for high quality telecommunication networks with shielded cables and regions with keraunic levels $50 < K < 60$.
   It can be applied for analog lines and digital transmission.

4. Gas discharge tubes, varistors and inductive elements - two-stage overvoltage protection with three-pole gas discharge tube with fail-safe clip and varistors and overcurrent protection with chokes. There is also thermal fuse protection for physical separation of the telecommunication equipment and the line, eliminating fire hazard in case of contact between telecommunication and power line. Response time is less than 25 ns.
   This protection is recommended for overhead and underground telecommunication networks with unshielded cables in the regions with keraunic levels $30 < K < 50$ and also for high quality telecommunication networks with shielded cables in the regions with keraunic levels $50 < K < 60$.
   This protection can be applied for analog lines and digital transmission. It is highly recommended for telecommunication lines with interference (near high–voltage transformers and railway lines) as it has filtering characteristics.

5. Complex protection devices with thyristor diodes – two-stage overvoltage protection with three-pole gas discharge tube and thyristor diodes and overcurrent protection with PTC thermistors. Response time is less than 1 ns.
   This protection is recommended for overhead and underground unshielded cables in the regions with keraunic levels $K > 50$ and for high quality telecommunication networks with underground shielded cables in the regions with keraunic levels $K > 60$.
   This protection can be applied for highest speed digital transmissions, LAN networks etc.

Gas discharge tube filled with radioactive gas should not be used as their large numbers in one location can represent an ecological risk.

These guidelines are meant to help in determination of optimal protection on the distribution frame, providing minimal cummulative expenses of protection devices and maintenance of telecommunication equipment. Adherence to these guidelines will also guarantee staff safety.

GUIDELINES FOR DETERMINATION OF THE SURGE PROTECTION TYPE ON DISTRIBUTION FRAMES - TABLE

PROTECTION CONFIGURATION	CABLE NETWORK	KERAUNIC LEVEL - K	NOTE
GAS DISCHARGE TUBE	UNDERGROUND SHIELDED CABLE	K<30	USED FOR ANALOG LINES (f=3,4 Khz), NOT EXPOSED TO INTERFERENCES
GAS DISCHARGE TUBE AND VARISTORS	UNDERGROUND UNSHIELDED CABLE	K<30	USED FOR ANALOG LINES AND LOWER RATE DIGITAL TRANSMISSION
	UNDERGROUND SHIELDED CABLE	K<50	
GAS DISCHARGE TUBE AND DIODES	UNDERGROUND UNSHIELDED CABLE	30<K<50	USED FOR ANALOG LINES AND DIGITAL TRANSMISSION
	UNDERGROUND SHIELDED CABLE	50<K<60	
GAS DISCHARGE TUBE, VARISTORS AND INDUCTIVE ELEMENTS	OVERHEAD OR UNDERGROUND UNSHIELDED CABLE	30<K<50	USED FOR ANALOG LINES AND DIGITAL TRANSMISSION, RECOMMENDED FOR LINES EXPOSED TO INTERFERENCES
	UNDERGROUND SHIELDED CABLE	50<K<60	
COMPLEX PROTECTION DEVICES WITH THYRISTOR DIODES	OVERHEAD OR UNDERGROUND UNSHIELDED CABLE	K>50	USED FOR HIGHEST SPEED DIGITAL TRANSMISSION, LAN NETWORKS ETC.
	UNDERGROUND SHIELDED CABLE	K>60	