RiskFix

Balanced Risk Engineering Solutions

Transient Overvoltage Protection

Understanding the Risk

Transient overvoltages (widely termed ‘surges’) is a short (micro/milli-sec) duration increase in voltage between two or more conductors. The two main causes of this phenomenon are lightning and electrical switching.

Direct lightning strikes to HV/LV power cables or telephone lines result in discharge flashovers to earth causing line-to-line overvoltage transients and a flow of part of the lightning current along the line to electrical/electronic equipment.

Indirect strikes, coupled into electrical services, through resistive, inductive and capacitive effects can cause transients as discharge currents attempt to flow through conductors/circuits and other electrical equipment.

Electrical switching interrupts established magnetic fields, releasing stored energy from those fields, causing transient overvoltages as this charge attempts to flow. The extent and magnitude of this effect is a function of the switch current flow and length/capacity of the attached conductor.

The problems caused by transient overvoltages, whether lightning or electrical switching induced, range in consequence level and can be broadly classified into disruptions, degradation, damage and downtime.

Disruptions result in no physical damage, but nuisance upset to electronic systems is caused, involving data loss, software corruption, system crashes/lock-ups and spurious tripping.

Degradation is the gradual deterioration of components due to long-term lower level transient overvoltages reducing the life of components and susceptibility to premature failure.

Damage manifests in burnt-out circuit boards through overheating and insulation failure and exacerbated by the subsequent power follow-on. Damage can also occur due to mal-operation/ short-circuit caused by the transient overvoltage.

Downtime is the interruption to work/ operations resulting in lost business and increased costs.

Related Loss Statistics

Accurate data on transient overvoltage loss statistics is elusive, however it is suggested and admitted that 30% of all power outages are lightning transient related.

Source www.lightningsafety.com

There was an average of 170 lightning strikes per annum on UK ground between 2004 and 2014, ranging between 50 in 2010 and 350 in 2006.

Controlling the Hazard

Decision criteria governing the risk rating of transients and the protection against them are documented in technical standards risk assessment procedures, based on lightning/switching exposures (magnitude/frequency), sensitivity of equipment/circuitry and economic/ human/environmental consequential loss factors. Primarily protection is provided by building Lightning Protection System (LPS) and supplemented by transient overvoltage protectors/devices.

Building LPS and installation techniques reduce the severity of transients from lightning sources. Important features include:

- A large number of down conductors around the sides of buildings housing important electronic equipment, reducing magnetic fields within the building.
- Electrical/electronic equipment appurtenances (e.g. CCTV cameras, antennae) installed within the shielding angle of LPS and/or bonded to earth.
- Exposed wiring in bonded metallic conduit.
- All incoming services (e.g. Pipes, power/data cables) bonded to a single earth reference point.
- All services entering/leaving building at a single point, unless there are dual sourced supplies in which case, separate entry points are preferred to maintain resilience.
- Earthing systems interconnected between adjacent buildings where services pass between these buildings.
- Power/data cables between adjacent buildings enclosed in metal conduits and bonded at both ends.
- Electronic equipment not located on top floors or adjacent to outside walls/corners where the greatest lightning current flow and hence magnetic field is present.
- Electronic equipment not installed near lightning attractive structures (e.g. towers).
- Cable routing avoiding proximity to lightning conductors.
- Minimal looping; segregated/ shielded, side-by-side runs of power, data and telephone cables.
- Use of fibre optic cable for data links

Inspection and maintenance of LPS is critical and technical standards make provision for the issue of a certificate of compliance for new installations and maintenance inspections. Certification governs fit-for-purpose condition of LPS and considers design integrity, corrosion and building additions/extensions. Testing/certification is recommended annually and required after alterations/repair or lightning strike.

Transient overvoltage protectors supplement/support the building LPS and provide specific solution to electrical switching sources of transients. These devices are installed on:

- Mains power supply entering the building at the LV incomer/distribution board.
- Mains power supply leaving the building.
- Power supplies between buildings at both ends.
- Power supplies within buildings locally at important pieces of equipment.
- Power supplies at electrical switching sources of transients (e.g. air conditioning, motors, lifts).
- Power supplies at UPS.
- All incoming/outgoing data/signal/ telephone lines.
- PBX telephone exchanges.

The specification, selection and installation of transient protectors are critical factors in the reliability of the protection. The rating of a protector is a function of protector location (location category) and exposure level which is defined in terms of peak voltage/current expected and maximum let-through voltage. Exposure level is obtained from the risk assessment procedure referred to above.

The specification and testing of protectors is made in accordance with various technical standards to assure quality and reliability. Protectors must have continuous indication of condition status and fault/failure indication between all combinations of conductors/lines they are protecting.

References:

NFPA 780 – Standard for the Installation of Lightning Protection Systems
NFPA 70 – National Electrical Code
BS7671: 2008 + A3: 2015 – Requirements for Electrical Installation IET Wiring Regulations

BS EN 62305 - Protection Against Lightning

BS EN 61643 - Low Voltage Surge Protective Devices

For further information, contact your local AIG risk engineer.

www.aig.co.uk

BELFAST
Forsyth House
Cromac Square
Belfast BT2 8LA
Tel: 02890 726002
Fax: 02890 726085

BIRMINGHAM
Embassy House
60 Church Street
Birmingham B3 2DJ
Tel: 0121 236 9471
Fax: 0121 233 3597

CROYDON
2-8 Altyre Road
Croydon, Surrey CR9 2LG
Tel: 020 8681 2556
Fax: 020 8680 7158

GLASGOW
Centenary House
69 Wellington Street
Glasgow G2 6HJ
Tel: 0141 303 4400
Fax: 0141 303 4440

LEEDS
5th Floor Gallery House
123-131 The Headrow
Leeds LS1 5RD
Tel: 0113 242 1177
Fax: 0113 242 1746

LONDON
58 Fenchurch Street
London EC3M 4AB
Tel: 020 7954 7000
Fax: 020 7954 7001

MANCHESTER
4th Floor, 201 Deansgate
Manchester M3 3NW
Tel: 0161 832 8521
Fax: 0161 832 0149