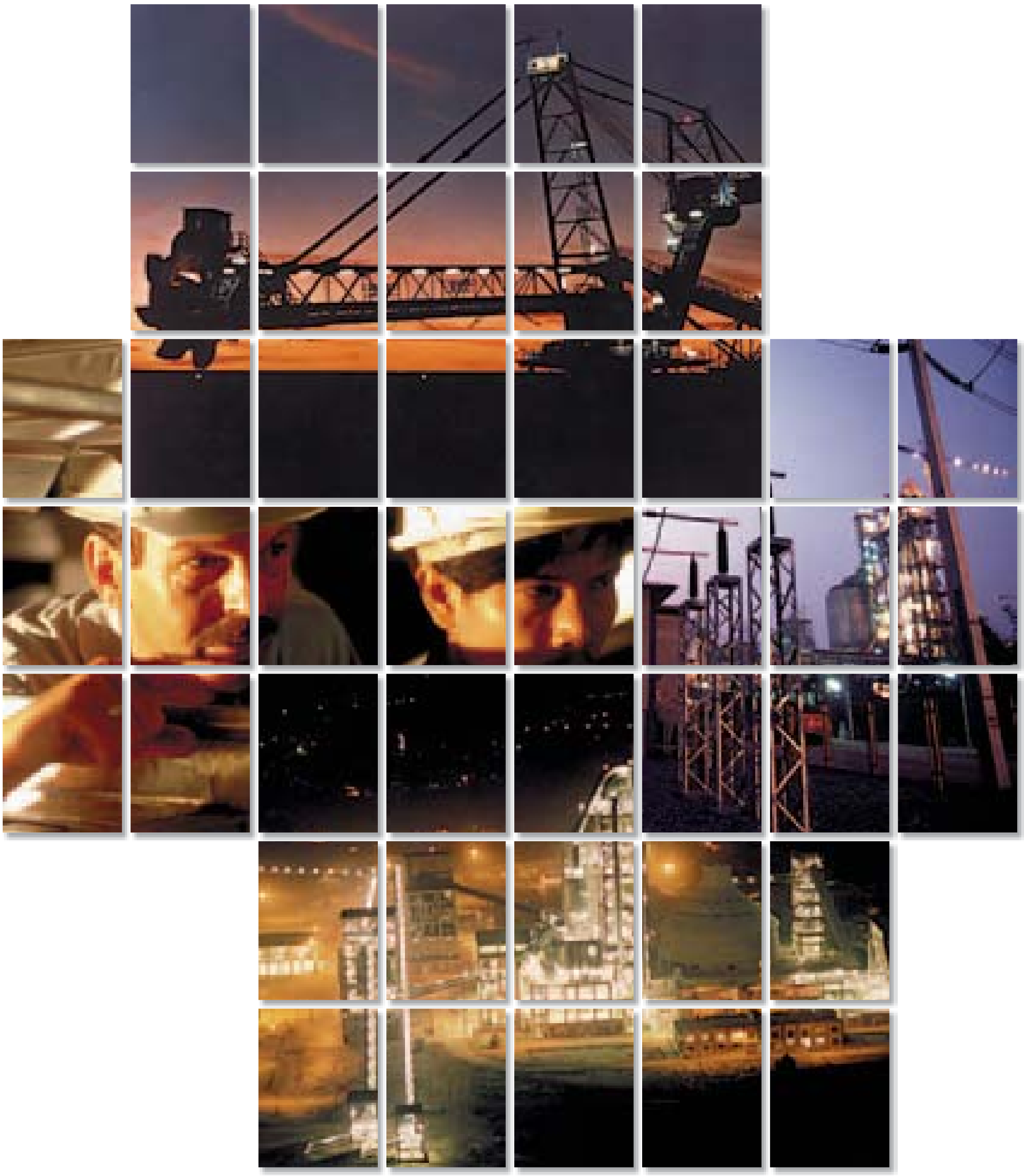
Plant Engineering

Electrical Infrastructure Systems

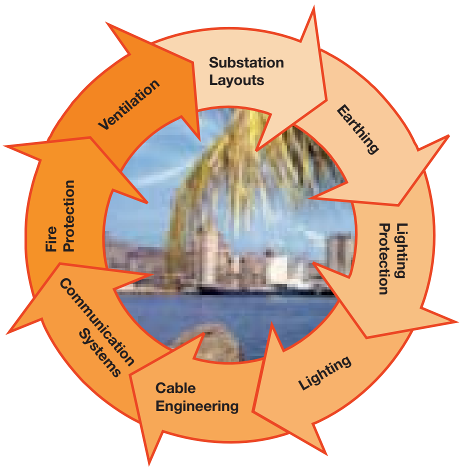


Infrastructure System in Industrial Plants

Efficiency of an industrial plant is not only influenced by the major mechanical and electrical installations, the appropriate infrastructure also plays an important role. The contribution of a reliable plant infrastructure consist of:

- Optimized substation and electric room layouts
- Cable engineering
- Installation engineering
- Earthing
- Lightning protection
- Process and street lighting
- Fire detection and protection
- Communication systems
- Air-conditioning and ventilation

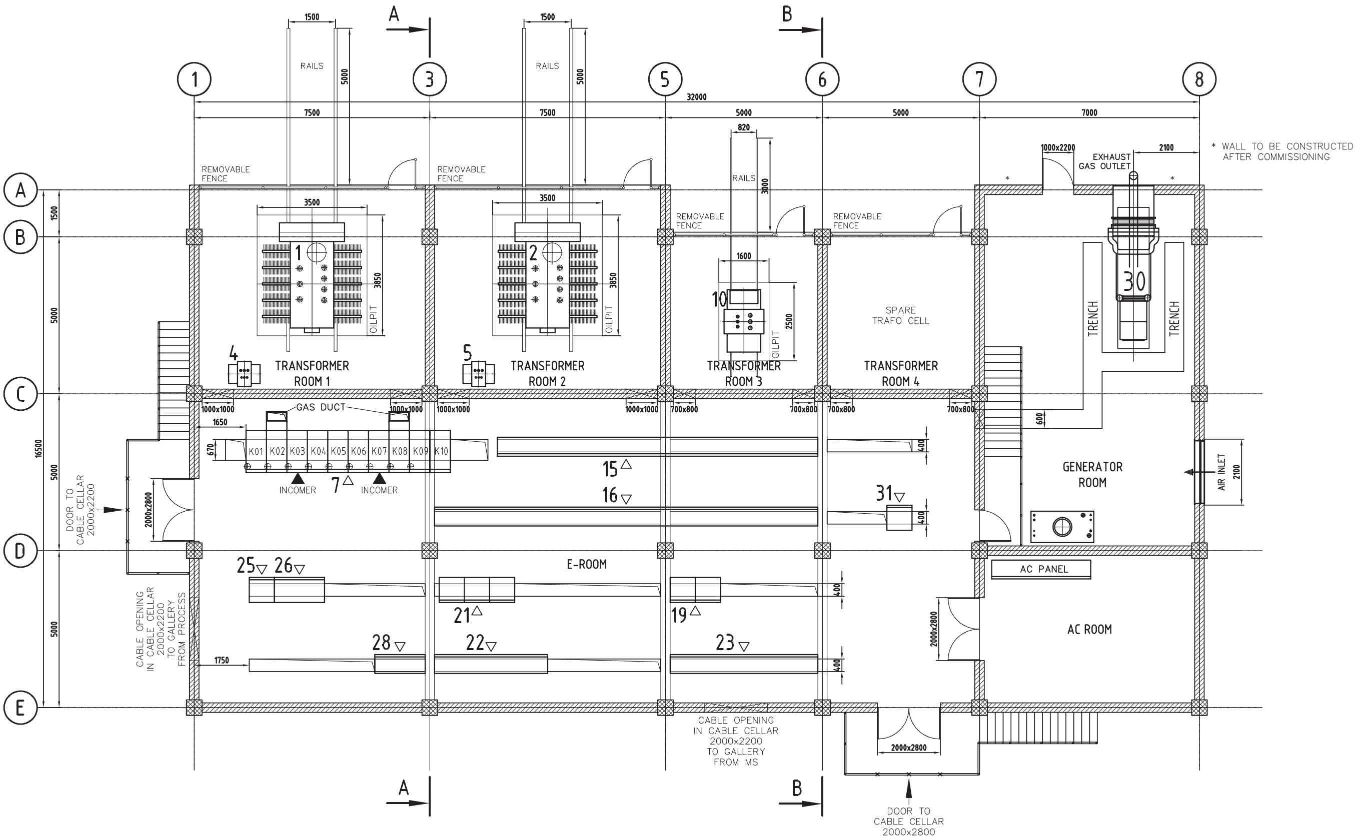
The correct dimensioning, smart positioning and adequate technology can help to save enormous sums of money not only in the investment but also in operating costs, where an apparently marginal saving adds up to a significant enhancement of plant economy over the lifecycle.

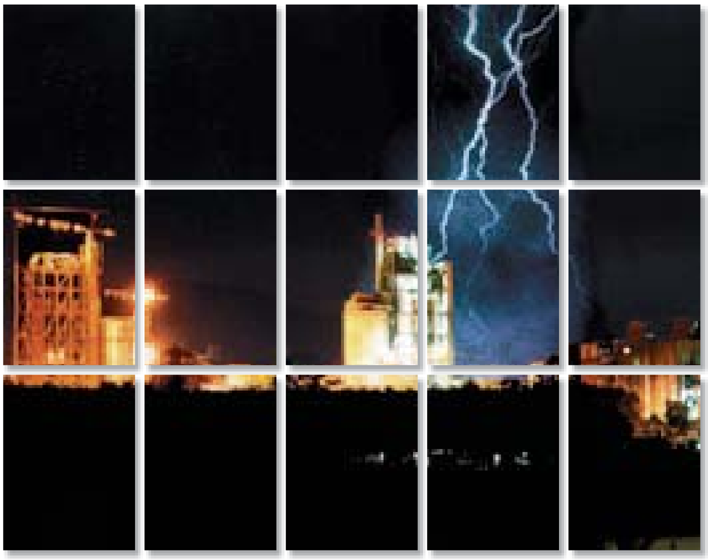


Substation and Electric Room Layout

Smart positioning saves money

The location of the electric rooms and substations is the first vital decision. Power losses equal operational costs and are determined by the average cable length between electric room and consumer. The shorter the distance to the consumer, the lower the losses. Timely consulting of an experienced infrastructure engineer will save investment and energy costs due to innovative design of the energy distribution and smart positioning of substations and electric rooms.





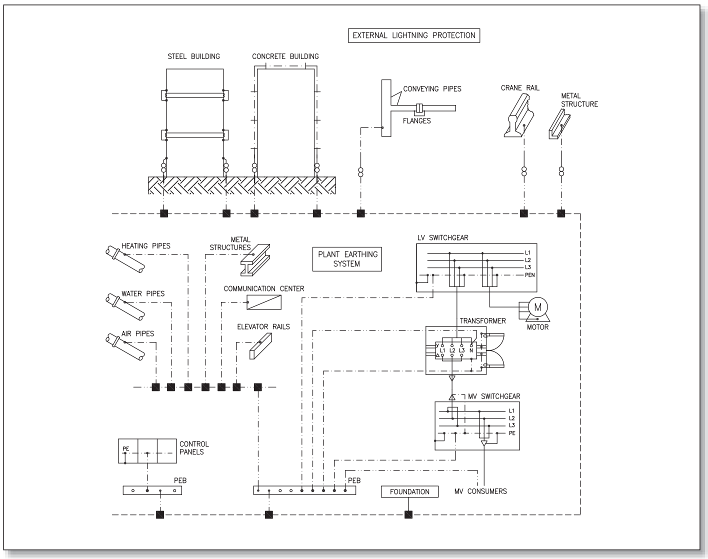
Earthing and Lightning Protection

Limiting the disruption, the fault and the damage

Maintaining high operational availability of electrical installations in any industry necessitates applying accepted rules concerning the design and implementation of earthing systems. Earth faults are the most common faults in an electrical network. Correct earthing therefore improves the technical performance and reduces the risk of disturbances, damages and injuries.

Here are the main purposes for earthing an electrical network:

- Preventing voltage to earth
- Protection of personnel and property
- Protection against transient overvoltages
- Protection against static discharges
- Protection against the effect of lightning strikes
- Protection against stray currents
- Creating defined network conditions for protection and metering purposes



The most common earthing practices in industrial plants are:

- Rigid earthing of HV-installations, e.g. switchyards, overhead lines
- Resistor or impedance (neutral earthing transformer) earthing of MV-installations
- Solid earthing of LV-installations (TN-C-S network according to IEC terminology)

For electronic systems and circuits, a separate electronic earthing grid is often an issue.
Investigations and practical tests have shown that separate grounding systems for electronics and electrical installations can lead to voltage differences in the respective equipment due to the resistance of the soil and/or the grounding system. These differences can cause uncontrolled switching as well as electronics defects. When protective and system grounding are interconnected, interference such as lightning can bring the entire electronics system to a higher voltage for a short time. No damage is caused to electronic equipment since there is no voltage difference between the protective grounding (electronic equipment housing) and the electronics earthing system.
A separate electronics grounding system can even result in additional risks and is therefore rarely used anymore.

Damage caused by lightning strokes cannot be completely prevented, either technically or on economic grounds, but the risk can be reduced to an acceptable level. Lightning protection always includes an earthing system.
A distinction is made between external and internal lightning protection.
External lightning protection comprises all devices located outside, at and in the protected installation, for the purpose of intercepting and diverting the lightning stroke to the grounding system, e.g. overhead protective wires, earthing of steel structures, etc.

Internal lightning protection comprises the measures taken to counteract the effects of the lightning stroke current and its electrical and magnetic fields on metal assemblies and electrical apparatus, e.g. surge arresters.
At present there are four methods of designing lightning protection systems:

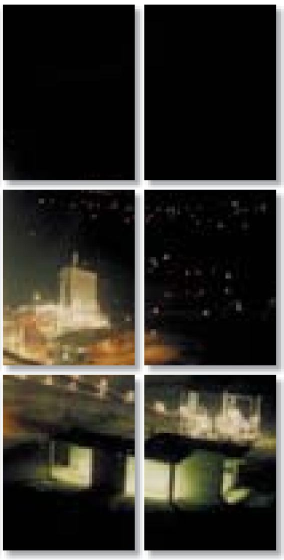
- The lightning sphere method (for highly inflammable areas, storages, e.g. oil, gas)
- The method according DIN/VDE 0185 (for all other buildings)
- The Linck Universal Method (lightning rods and overhead earth wires for overhead lines)
- The method according DIN/VDE 0101 (exclusively for outdoor switchyards)

Industrial Lighting

Wasting the profit

Depending on the location, lighting systems must fulfil a broad range of requirements.
In electric rooms, offices, workshops or laboratories for example, higher illumination levels are needed than in production areas, storage zones or roadways.
In production areas, it is necessary to differentiate between lighting for access and escape routes or for maintenance purposes. By establishing optimized illumination levels, the foundations for optimal energy savings can be laid at an extremely early stage of the project.
The responsibility for illumination standards is with ISO and CIE (International Commission on Lighting).
The demand in illumination levels has increased during recent years and some key figures are indicated in the table below.

Lighting systems today are often designed for the worst case, i.e. for trouble-shooting purposes. No account is taken of the fact that purely for lighting, a medium-sized cement or mineral processing plant requires an installed capacity of about 500 kW. During the night, lighting is switched on by an automatic system using, for example, photoelectric cells.
Installations of such dimension consume a considerable amount of energy. Since energy is a predominant cost factor, it is worth considering lighting installations in the perspective of an energy-saving concept. However, the correct design and layout of lighting installations in an industrial plant requires process know-how and experience.



Illuminance levels according to ISO 8995 (2002) Activity zones	LUX
Buildings:	
Entrances, corridors, restrooms, archives, storage	100
Stairways and escalators	150
Canteens	200
Conference rooms	500
Plant rooms, switch gear rooms	200
Workshop	300
Precision measuring rooms, laboratories	500
Control room	500
Process:	
Process area without manual intervention	50
Process area with occasional manual intervention	150
Process area with continuous manual intervention	200
Control platforms, local control rooms	300
Crushing, grinding	100
Preparation of materials, work on kilns and mixers	200
Packing and loading area	100
Aux. rooms, e.g. pumps, control station, switchboard	50
Stairways, escape routes	120
Walkways and walkways along conveyors	20
Platforms and passenger subways (underpasses)	50
Man sized under floor tunnels, cellars, etc.	50
Outdoor:	
Main roads	20
Secondary roads	10
Storage areas	20
Petrol station	50
Switchyards, oil & water tanks	30
Loading and unloading ramps	100

High-efficiency lighting

Illumination power requirement on average	500 kW
Possible savings	
• By choice of equipment: 10%	50 kW
• Optimising the lighting distribution and location of armatures	60 kW
• Optimizing the illumination levels	140 kW
Utilization factor	0.4*
Actual power saving	100 kW
Savings p.a. at 8.500 hours	850 000 kWh
Savings p.a. at Euro 0.10 / kWh	85 000 Euro

* The utilization factor can vary between 0.3 and 0.6 according to the plant.

Careful selection of lighting equipment is another step towards saving energy. Practical experience has shown that the use of high-efficiency lighting equipment can save a considerable percentage of the lighting energy costs.

Cable and Installation Engineering

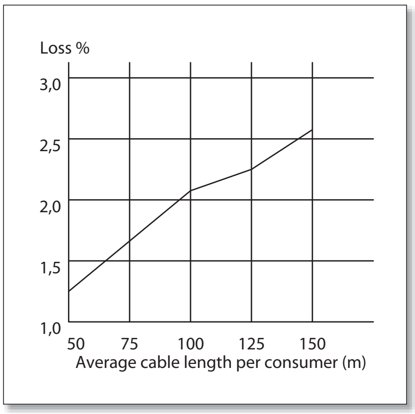
Reduced costs through optimized design

Cable and installation material costs account for a substantial part of the total plant electrification costs. In the vast area covered by an industrial plant, the energy distribution from high-, medium- and low voltage feeders down to the corresponding consumers, including the related process control, earthing and lightning, requires an extensive cable network.The overall length of power and control cables can easily reach a total of several hundred kilometres. Optimized infrastructure engineering, supported by modern network calculation tools, can therefore save energy and costs.

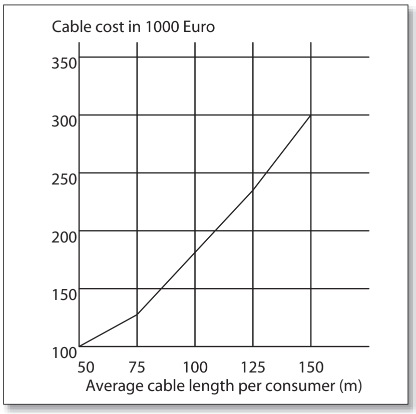
To select the appropriate cable type and cross-section, several factors have to be considered:

- Ambient temperature
- Cable laying method
- Permissible voltage drop
- Nominal current
- Cable length
- Short-circuit current
- Tripping times of protective devices
- Load flow calculations
- Harmonic distortion
- Network grounding

To keep the voltage drop within reasonable limits, longer cables require larger cross-sections, thus generating higher costs.A reduction of the average cable length of low voltage consumers by 10m can save approximately 5% of the total cable and installation costs. Modern cable and installation engineering software support the optimization of the design and, if combined with bar code readers, enables the monitoring of the cable and installation material during construction on site.

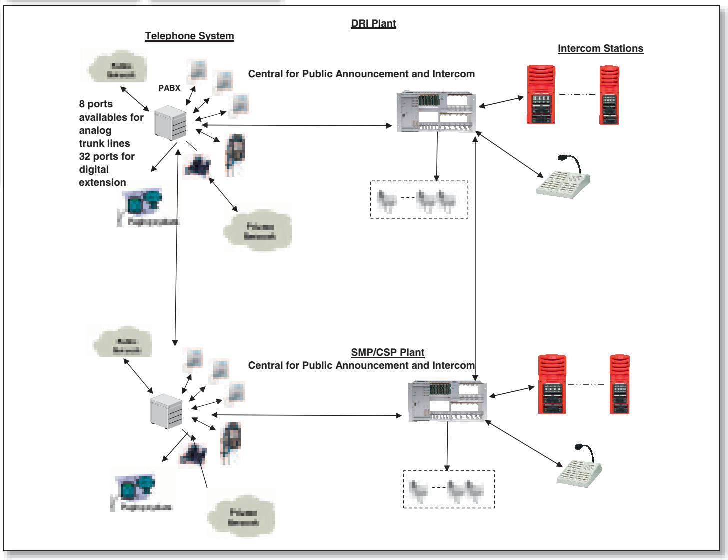


Graph 1:
Losses in low voltage power cables. Cables dimensioned for 15% voltage drop with ratio of start-up current to nominal operating current of 6.5



Graph 2:
Cable costs in relation to average cable length. Cables dimensioned for 15% voltage drop with ratio of start-up current to nominal operating current of 6.5

Plant Communication Systems

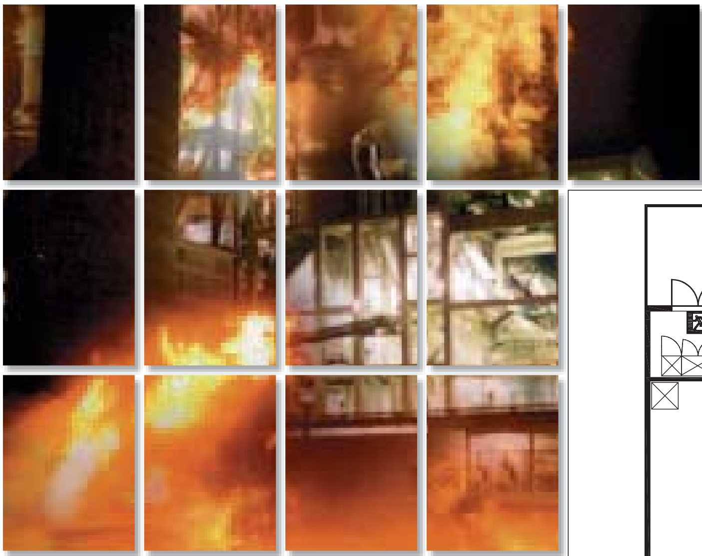


Who's there?

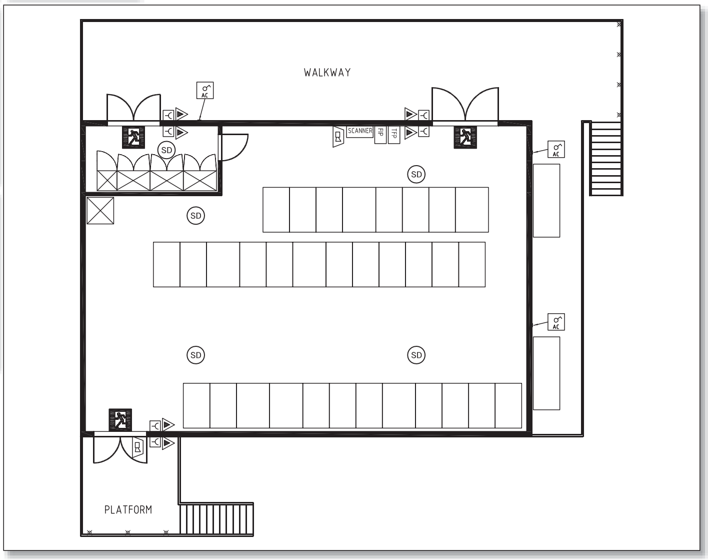
Plant communication, both internal and external, is extremely important in industrial plants. It is used for troubleshooting, maintenance or emergency situations and, if inter-connected with process control, even remote analysis of the plant is available. Therefore, the demand for high reliability and comfort of the plant communication system has been drastically increased during recent years.
With the latest communication technologies a lot of functionality has merged into smart telephone and communication systems, combining the advantages of the previously separated systems.

The following functionalities are in common use today:
- Phone, fax & mobiles
- Intercom (plant communication network)
- Paging

While telephone, fax and mobiles (analogue or digital, conventional or by satellite) serve mainly external communication, intercom and paging systems are for plant internal purposes only. The actual arrangement, location and number of the apparatuses depends strongly on the plant requirements. The system itself is modular, extendable and equipped with a programmable main unit.
Modern telephone and intercom systems offer optimized cost/benefit ratios for external and internal plant communications. By using modern field bus technology, the performance and comfort of these systems have tremendously increased at reduced cabling and installation costs. Not only functionality is a design criteria, but also the environmental conditions. Field telephones often require heavy duty design to cope with the mechanical stress of a particular location.
Noise and pollutions levels, generated by the machinery or the environment, is another factor to be considered during engineering.



Fire Protection



Don‘t play with fire

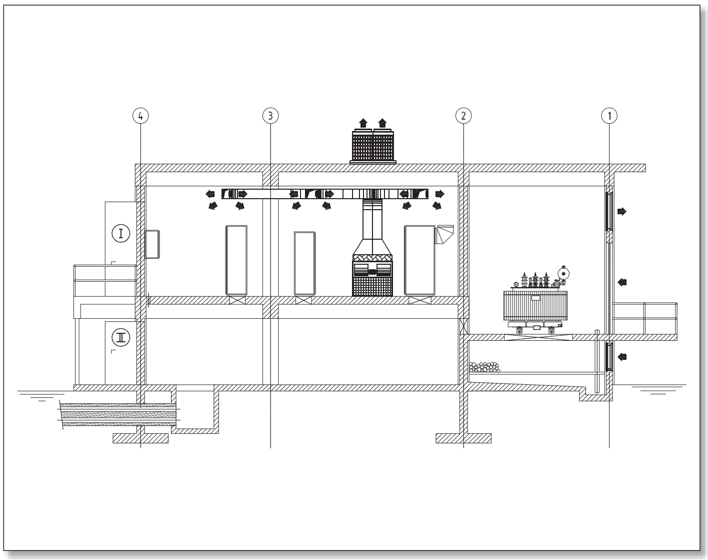
Fire protection is a very serious business and preventive measures are compulsory according to all major building codes and insurance companies. This includes:

- Separation of buildings into fire zones and other civil construction countermeasures
- Installation of fire-barriers, particularly where cables, conduits or pipes, etc. penetrate the walls
- Selection of appropriate fire retardant materials
- Installation of an integrated fire alarm system
- Installation of fire extinguishing systems
- Installation of fire fighting equipment

Fires of electrical origin are caused by arcing faults, excessive temperature rise due to operational overloads or short-circuit. Hence the main focus is on cable- and electric rooms, cable tunnels and transformers.

If a fire is detected early and actions to fight it are taken quickly and efficiently, the damage and the interference to the plant is reduced. An automatic fire alarm system provides this functionality.
The fire is indicated by smoke, temperature or flame detectors, which set off the alarm and trigger extinguishing systems if in place. The previously used radio-active isotope sensors have been replaced by electronic sensors for safety reasons. Additionally, electrical isolation and the shut down of ventilation systems of the affected area must be initiated by the system.

Ventilation & Cooling



Keep cool

Heat losses reduce the performance and insufficient cooling can result in overload or even damage of electrical equipment. Where most of the components are operated on natural air flow only, others such as power electronics require permanent forced cooling to protect critical components. Temporary forced cooling is also used to cover peak demands of equipment, e.g. forced cooling for transformers (ONAF). Ventilation and cooling systems ensure constant or even increased performance of electrical equipment and if combined with a heat exchanger and/or coolant, provides space saving and highly efficient solutions to meet even the highest operational demands.

Ventilation and cooling systems include:

- Ventilation of switchgear- and control rooms
- Air conditioning of switchgear- and control rooms
- Forced cooling of switchgear and other components
- Ventilation and cooling systems for motors
- Ventilation and cooling systems for power electronics

The semi-conductor elements of high current frequency converters generate enormous heat which has to be dissipated from the room. This can be done by water cooling units, which transport the heat losses via water-to-water and air-to-water heat exchangers to the exterior.

Commitment to Industrial Plants

ABB is committed to industrial plants. Since 1975, ABB has a dedicated Centre of Excellence, based in Switzerland, that develops standards for the minerals, mining & aluminium industries. In the last 20 years ABB has successfully delivered, electrification solutions, to over 500 installations worldwide.

ABB is leading global supplier of plant electrification systems. Its engineering departments with their industry specific validation procedures ensure a high quality in infrastructure technologies.

Contact us, use our experience.

ABB Switzerland Ltd
CH-5405 Baden 5 Dättwil
Switzerland
Phone: +41 58 586 84 44
Telefax: +41 58 586 73 33

E-Mail: process.industries@ch.abb.com
www.abb.com/cement

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