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Steel Plants
(Part two)

Loss Prevention Aspects

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Preface

Content of the report:

This report is part two of an IMIA paper dealing with steel plants. It is addressed primarily to risk surveyors and loss prevention engineers to assist in their risk assessment. Therefore the scope of the paper has been limited to loss prevention aspects.

The report was preceded by Part 1, which was addressed primarily to underwriters. That report described the processes and associated loss exposures. Some of the most important loss prevention issues were mentioned in Part 1 and these are described in Part 2 as well.

The loss prevention advice offered focuses on the blast furnace route only and no particular emphasis on new technologies are presented. However, much of the protection measures for buildings, energy supply, logistics and condition monitoring of critical machinery are of course applicable for metal production utilising other manufacturing technologies.

Structure of the report

The structure of this report follows the list of contents used for Steel Plants, Part 1 prepared by an IMIA working group in 2004. The paper presents major risk exposures and gives loss prevention recommendations. In addition to process specific issues, also general loss prevention aspects are presented in the beginning of the paper.

Acknowledgement

The working group is much indebted to the task force for Part 1, chaired by Mr. Günther Hoffmann, as the structure and a considerable amount of the technical content was devised by that group.

1 Common aspects of risk exposure and loss prevention affecting entire steel plants

1.1 Risks and loss prevention related to layout

Risk Exposure

Explosions and fires caused by gas and combustible liquids may spread from one production unit to another. Also smaller pieces of equipment like oil cooled transformers may represent considerable risks. The spread of molten steel to vital equipment is a major concern.

Loss Prevention

Tanks, containers and processes with a potential for big fires and explosions should be located at safe distances from each other. Examples of such equipment are gasometers, LPG tanks, electrical substations and transformers.

1.2 Risks and loss prevention related to buildings

Risk Exposure

Buildings housing steel manufacturing processes are often high and very large i.e. more than 1000 meter long. Therefore, fires might develop and spread very fast and can be very difficult to extinguish by fire brigades. Heavy rain and wind may cause extensive damage because of the size of the buildings.

Loss Prevention

Non-combustible building materials, including roof sealing materials, should be used. Large roof areas should be subdivided into smaller sections. Supporting arrangements to aid the fire brigade in its work “i.e. dry risers, fixed ladders” should be provided for.

The buildings should not allow the entry of water by wind-driven rain or snow. Roofs should be properly maintained and not allow any water leakage into buildings.

1.3 Risks and loss prevention related to the availability of electrical power

Risk Exposure

The availability of electrical power is crucial for maintaining heating and cooling of critical equipment (coke plant, walking beam furnace, etc.). A total blackout would lead to structural failures and prolonged start up times.

Loss Prevention

The supply lines to the site should be doubled as a minimum. Provisions should be made for separating the supplies from each other. Spares for important transformers should be available.

A ring-supply to substations on site should be built. Some key functions in the production need their own emergency generators. A best practice is often to use cooling pumps driven by diesel engines.

Transformers shall be a part of the in-service inspection program giving scheduled in-service inspection intervals. Inspection methods should include: visual control, oil analysis, infrared thermography, test of protection systems, like Bucholtz relays and differential relays. Transformers need fire resistant partition walls and may need sprinkler protection if nearby buildings or other equipment are exposed to fires.

Electrical substations should be built entirely of non-combustible material and designed to withstand external impact. Fire detection should always be installed. It is often a good practice to have electric arc protection. Critical substations should have extinguishing systems installed. If water as an extinguishing agent is a problem, gas systems should be considered. Cable rooms and cable ducts, particularly underground, should be protected by water sprinklers.

Cable penetrations should be sealed using tested and approved materials and methods. Fire doors should be self closing and latching.

Phase compensation units often demand fixed installed extinguishing systems.

1.4 Risks and loss prevention related to control rooms and electronic facilities

Risk Exposure

The type of equipment used in control rooms and electronic facilities is particularly sensitive to smoke, heat and moisture. Loss of production may be a consequence of failures in such equipment.

Loss Prevention

Delicate equipment should be accommodated in separate electric rooms or cabinets.

High sensitive smoke detection equipment should be installed. Gas extinguishing equipment may be required based on risk analysis. Moisture detection may be needed for identifying leaks.

Control rooms having cables below raised floors may need local fire protection.

1.5 Risks and loss prevention related to internal transport

Risk Exposures

Steel plants require large quantities of raw materials within the plant. Steel plants depend strongly on the smooth operation of internal infrastructures, especially such as belt conveyers, overhead cranes and railcars.

Loss Prevention

Conveyers should be made of non-combustible building materials. The conveyor belt material should also be non-combustible. Rotation controllers for slippage control on each driving roll and indicators for misalignment of the belt are necessary. Critical conveyors and their cross stations should be sprinkler protected.

Gas pipes and critical electrical supply cables should not be mounted in conveyor ducts.

Overhead cranes should have in-service inspection and condition monitoring to prevent structural damage. Critical spare-parts should be available preferably on site.

Cranes should have emergency brakes operating directly on the supporting wires.
An advantage is to have redundant cranes in critical areas.

1.6 Risks and loss prevention related to the gas and fuel gas systems

Risk Exposure

Steel plants are large consumers of fuel gases and have extensive gas grids comprising large compressors and their drives. Some of the fuel gases are a by-product of various processes such as coking or the blast furnace process. Gases are stored in large gasometers where the risk of explosion is high.

Liquid petroleum gas is used in large quantities at plants where natural gas is not available. Fire and explosion are risks during unloading. An additional risk prevails when above ground storage tanks are used.

Oxygen is produced and stored in considerable amounts on steel production sites. It is brought to the places of consumption by large pipes.

Loss Prevention

Oxygen detection devices should be provided for the coke gas pipes. In case of oxygen detection, plant emergency procedure should include: stop of electrostatic tar de-sprayer and extraction of exhaust coke gas using hoods and by burning it in candelabras.

Gas pipes should be provided with low and high gas pressure safety devices and explosion-venting devices. Grounding and bounding of gas piping should be provided.

Emergency shut-off valves should be installed. Candelabras should be used as hydrostatic pressure relief valves.

The gasometer should be provided with high level alarms and pressure relief valves. Pressure relief valves should be protected by horned spark gap devises (''Faraday casings'').

Hydrogen detection devices should be installed at the bottom of the gasometer (four hydrogen detection devices located at 90° intervals).

The gasometer should have lightning protection.

LPG storage tanks should preferably be installed underground. Unloading areas and above ground tanks should have automatic water spray protection.

Oxygen production units should be at safe distances from production areas with furnaces and hot surfaces. Pipes and particularly their valves should be in easily accessible locations to allow controlled maintenance and testing.

1.7 Risks and loss prevention related to various forms of corrosion and cracking

Risk Exposure

Various forms of corrosion and cracking occur in different sections of steel plants. Corrosion will ultimately result in the weakening of materials, cracking and breakdown of equipment or machinery. Key production machinery like rolling mills, cranes, large electric motors and wind machines are unique and have very long replacement times.

Loss Prevention

Regular monitoring of corrosion and material stresses by experts using established methods such as Non Destructive Testing (NDT) or Non Destructive Characterization (NDC) is a vital requirement.

Steel plant operators should have access to corrosion related know-how either in their own metallurgical departments or through external institutes in order to prevent serious losses.

Various appropriate condition monitoring methods have to be utilised. Pro-active maintenance philosophies shall be used whereby the ideas are based on an established maintenance system like RBM (Risk Based Management), RCM (Risk Centered Maintenance) and RBMI (Risk Based Maintenance and Inspection). Pro-activity implies the selection of method, applied technique and above all the inspection interval. The interval is hereby chosen in such a way, that discontinuities and thinning not found in the previous inspection, do not have time to lead to catastrophic failure.

The most utilised NDT and NDC methods are: visual inspection, ultrasonic inspection, magnetic particle testing, penetrant testing, radiography and eddy current testing and hardness measurement. For NDT-methods see IMIA WGP 22(02) on www.imia.com

The most applied condition monitoring methods are vibration measurements, oil analysis, thermography, on-line monitoring of electrical motors (current, power, partial discharge etc.), acoustic emission, pressure and flow measurements.

The measurement methods can be applied as spot measurements, as predetermined route measurements or as on-line measurements. The measurement results, e.g. vibration measurements, are being stored, analysed and diagnosed utilising various techniques like vibration severity (ISO 10816-3) classification, time domain analysis and envelope analysis. The results of the diagnosis give the user of the machine or the component a possibility of performing prognostic evaluation. This evaluation is crucial for determining the inspection intervals.

In addition to utilising machine diagnostic methods mentioned above, which primarily are used for detecting discontinuities and material thinning, some methods are also used for process control. An example of this would be the use of acoustic emission for monitoring low speed bearings, lubricating films, stresses on crane structures, trunnion bearings in the blast furnace and friction induced acoustic activity of the continuous casting machine. For this type of application the threshold levels for alarms and tripping for different condition monitoring methods are highly dependent on the production parameters and very cumbersome to set. In order to set them a neural network system can be advantageously applied.

1.8 Risk and loss prevention related to refractory linings

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Risk Exposure

Consequential damage to production equipment and personnel due to outbreak of molten materials from blast furnaces, electric arc furnaces, converters and ladles.

Loss Prevention

Careful monitoring of operating parameters and regular inspections are very important in order detect possible hot spots and to avoid outbreak of molten metal. Temperature monitoring of the blast furnace shell is a vital design feature.

Regular inspections and maintenance of linings in furnaces and ladles are important. Spare tiles should be available on site.

1.9 Risks and loss prevention related to natural and environmental hazards

Risk Exposure

Steel plants are in many cases located on river banks or at the seashore because of their large cooling water requirements and logistic aspects. Depending on the site, steel plants and the related infrastructure such as access roads and railways may be exposed to flood and inundation.

Steel plants include very heavy equipment which requires solid foundations. Soil conditions and solid foundations are very important in order to assure that the substantial weights are properly carried and damage by settlement is avoided.

Steel plants have also been constructed even at sites which are substantially exposed to earthquakes. In case of earthquakes the infrastructure such as access roads, railways and shipping facilities may be damaged.

Loss Prevention

The risk of inundation, foundation settlement and earthquakes should be carefully analyzed when the site is selected. Solid safety margins must be included in the design of such steel plants.

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2 Risk exposure and losses related to specific units

2.1 Raw materials, stockyards

Risk Exposure

The potential of self ignition is always present in coke or coal in the stockyards.

Loss Prevention

Important loss prevention methods are the following:

- measurement of the pile temperature with associated alarms in case of unusual temperature increase,
- the availability of front loaders for opening piles on fire,
- provisions for sufficient fire hydrants,
- prevention of air movement in the pile. Coal should not be piled over covered trenches,
- limiting coke and coal piles to the strict minimum,
- low-grade coal should not be piled more than 3 m high,
- locating coal piles at a minimum of 15 m from important buildings,
- a proper extinguishment of the coke after the coke production process and
- reduction of fire risks by moving the coal/coke frequently (e.g.15 days turnaround time).

2.2 Sinter plants for fine ores

Risk Exposure

Dust explosion of the various pulverized raw materials.

Loss Prevention

The following loss prevention measures are advised:

- the use of magnetic detection before the pulverisers in order to trap metallic parts that could create sparks,
- the pulveriser should be protected (water, CO_2, nitrogen),
- in order to prevent dust explosions in buildings, the areas should be evaluated according to the ATEX-directive or similar, and electrical equipment should be chosen accordingly,
- the building should be sprinkler protected,
- the transport of pulverised coal to the blast furnace should be done under nitrogen blanket,
- explosion relief panels should be provided on the grinders and on any filter of the dust extraction system,
- there should be a possibility to blanket the entire installation with nitrogen and
- pulverised coal silos should be blanketed.

2.3 Coking plants

2.3.1 Coking plant, raw material

Risk Exposure

Inappropriate piling of coal or coke, particularly with excessive pile heights, may self-ignite.

Coal represents a fire risk above a 12 % content of oxygen. This risk is higher when coal is finely sized having a size distribution with 80% of the coal grains being smaller than 2 mm in diameter.

The explosion risk is slightly lower at high humidities (above 10%) of the coal.

Generally, coke oven plants have a safety stock of coals: 1 month of production. The storage is not highly hazardous and the handling of coal is based on first in/first out principle.

Loss Prevention

The piles should be stored at least 15 m from all important building structures and sufficient hydrant installation should be provided.

Clean coal bins should be provided with a sprinkler protection system.

2.3.2 Coke oven area

Risk Exposure

The brickwork of the coke oven can occasionally get damaged due to thermal fatigue and overstressing.

Overpressure by released gases may lead to mechanical deformation of coke ovens.

The main gas supply is coke gas or a mixture of coke gas and blast furnace gas. The gas supply is very important for coke ovens to avoid the destruction of refractory bricks (silicon dioxide).

Other risks are the loss of cooling in the gas collection main (barillet), and fires in electrical rooms or hydraulics rooms (for the Larry Car and for reversal of the coking flue).

Loss Prevention

In case of a loss of fuel gas, an automatic inert gas injection (N_2) should feed the gas pipes.

If the gas pipes are running inside rooms or under the coke battery, CO and H_2 explosion detection devices should be provided.

A back-up supply with natural gas or LPG for the oven should be available.

2.4 The blast furnace

Risk Exposure

The presence of liquid hot metal at 1.600 °C and water circulating in cooling elements implies that the BF must be considered as highly exposed equipment. When water comes into contact with hot metal a violent explosion will occur.

Wear and tear of the refractory lining in the lower sections of the BF zones is considerable. Recent trends to extending BF campaign periods represent an enhanced risk factor.

Very serious accidents have happened with spillage of hot metal or release of hot gas. Whilst tapping the BF is a standard procedure, problems do still occur resulting in damage from spilled hot metal and radiant heat.

The loss of sufficient wind machine capacity leads to loss of BF operation.

Coal milling may cause a dust explosion in BFs having coal injection systems.

Excessive pressure in the gas treatment equipment could be caused by a blocking of the precipitators or the washers.

The gas ducts are usually of a large diameter and above ground, in case of a pipe collapse by mechanical impact or overpressure and a subsequent release of gas could occur. This gas could explode in a similar way as vapour clouds explode in refineries.

Loss Prevention

It is of utmost importance to monitor all operating parameters of a BF such as temperatures, pressures, top gas composition, heat fluxes, refractory cooling conditions etc., and to survey them by experienced operators to avoid very serious problems including hot spots and breakthrough of the furnace shell with a related spillage of hot metal or release of hot gas. Once critical parameters are exceeded, automatic alarms should be given or fail-safe positions activated. For instance, the composition of the BF top gas is used as an indicator of a cooling water leakage in the staves to which immediate attention must be given.

BF campaign extensions require very careful engineering studies of the whole BF system including all ancillary BF equipment such as air pre-heaters, top gas piping, top gas cleaning etc. These extensions have an impact on the general risk exposure. The installation of a fourth hot blast stove could be required when BF campaign times in excess of 20 years at constantly high production level are aimed for.

There should always be spare capacity for wind machines. If an electrical motor driven pump is used, the spare unit should have 100 % capacity and should use another driver (diesel engine or steam turbine).

Coal mills should be located in own buildings at a safe distance (for instance 40 m) from other important areas. Coal dust handling may require installation of extinguishing apparatus, such as open sprinklers.

Adequate control of the cooling circuit flow utilising differential flow meters and temperature controls should be provided for in each section of the furnace.

Thermocouples should be installed at several levels in the refractory.

There should be a means to granulate the crude iron or to dump it in an open area in case of problem with the normal emptying process.

There should be a means to quickly plug the blast furnace. Adequate emptying procedures of hot metal from the BF are also needed.

In crude iron granulating installations, the water supply should be reliable (double supply).

In case of problems with the gas treatment unit, there should be flares to burn the exhaust gas produced. Pressure relief bleeders should be provided to prevent excessive pressure in the system.

Impact protection should be provided on duct supports in areas with heavy truck operations.

2.5 Air pre-heaters (hot - blast stoves/cowpers)

Risk Exposure

The cyclical operating mode of hot blast stoves results in constant variations of material stresses which are aggravated by the formation of acids as a result of fuel gas combustion. Hot blast stoves are highly exposed to a combination of mechanical stress and chemical attack mainly leading to a phenomenon called stress corrosion cracking (SCC).

When operating conditions in the BF are seriously disturbed, a backflow from the blast furnace to the hot blast stoves can cause severe gas explosions in hot blast stoves.

Loss Prevention

Hot blast stoves must be inspected and surveyed regularly by experts applying established machine diagnostic methods in order to avoid serious explosions.

On cowpers there should be a system to prevent hot air back flow into the heating gas system.

Due to the presence of hydraulic units, the building containing these, should be sprinkler protected or water spray systems should be provided above the hydraulic units.

2.6 Converting hot metal into steel

2.6.1 Basic oxygen furnaces (BOF)

Risk Exposure

The presence of liquid steel and cooling water circulating in some furnace components, such as oxygen lances, implies that BOF's must be considered as highly exposed equipment. When water comes into contact with hot steel a violent explosion will occur. Important accidents have happened with spillage of hot metal and losses due to radiant heat.

Due to the cyclical mode of operation, the off-gas steam boiler above the BOF is exposed to cyclical mechanical stress. This can result in cracks and mechanical damage.

The BOF off-gas cleaning system is vital to maintain the operation of the furnace. For dust separation, very large bag filters are used. They represent a fire and machinery breakdown risk. Dust recovery plants are tailor-made constructions and replacement times may be extended.

The refractory lining is subject to wear and tear. Outbreak of hot steel may occur in case of inadequate maintenance.

A molten metal spill caused by the tapping operation or by failure of the refractory can damage fuel gas piping, oxygen piping, hydraulic oil piping, unprotected electrical cables or equipment, control rooms and structural members.

Serious fires may occur in case the oxygen supply and distribution system is not adequately maintained.

If water falls on the surface of a molten metal bath it is rapidly transformed into steam normally without any major problem to the equipment. Major problems can be caused by the inclusion of the water inside the bath. In this case the water trapped into the bath is immediately vaporised and partially dissociated into H_2 and O_2 with consequent "steam explosion" inside the molten metal bath.

The inclusion of water inside the molten metal bath is normally caused by:

- the water cooled oxygen lance falling into the bath,
- a water leakage of the cooling system wetting the refractory and reaching the bath below its surface,
- a water leakage in the hood cooling system (above the surface of the bath) when the BOF is tilted to pour the metal,
- a molten metal that spills into a wet containment basin (e.g. safety containment pit below the furnace) or
- by water or especially ice, trapped in the scrap metal.

Since the BOFs produce large quantities of dust and gas (CO, CO_2 etc), waste cleaning facilities are essential to the process, and most losses associated with these pieces of equipment have been fires or explosions in the waste cleaning system.

A fire in the hydraulic system, that provides power for almost all BOF-movements, may seriously interrupt the operation.

Calcium carbide and magnesium are often used as additives for the desulphurization of the bath. These materials can in humid or wet atmospheres produce explosive gases (acetylene, hydrogen).

<u>Loss Prevention</u>

The oxygen lance should be provided with an emergency extraction device and a dedicated power supply e.g. mechanical counterweight, pressurised N_2 system.

The breaking system of the oxygen lances should operate at the end of the drive, which controls the lance movement. Alternatively, the lance can be provided with a fixed, reliable mechanical stopper (to ensure that it cannot fall inside the molten bath in case of a failure).

The cooling system should be provided with reliable water flow control devices (preferably differential flow meters monitoring the inlet and outlet flows of the cooling system).

The oxygen lance should be inspected with established non destructive testing methods (preferably at each replacement of the nozzles).

The emergency procedure should clearly indicate that no tilting operations of the BOF should be performed in case of a surface water leakage.

There should be an adequate basin below the furnace to contain molten metal spills. The containment basin should be regularly inspected to confirm the absence of water (e.g. surface run-off water accumulation).

It is critical not to expose scrap metal storage to water or ice. The scrap metal components should be cut in pieces to avoid entrapments of water and be visually inspected before use. The prepared scrap has to remain in a covered area for a few days before being introduced in the furnace (the area should be protected from rain, snow or surface water).

Filter systems should have provision for fire extinguishment and for explosion pressure relief.

Calcium carbide and magnesium require proper storage and handling procedures (cut-off room, humidity control etc.) and fire protection should be provided with dry chemical powder type extinguishers.

2.6.2 Electric arc furnaces (EAF)

Note: This chapter primarily applies to EAFs for mini mills, several features are common for furnaces used for secondary metallurgy.

<u>Risk Exposure</u>

Due to the presence of liquid steel and cooling water circulating in various furnace components, EAFs must be considered as highly exposed equipment. When water comes into contact with hot steel a violent explosion will occur.

Recycled scrap from various sources such as cars, household appliances, building material is frequently processed in EAFs. It may contain undesired components such as gas bottles, oil or gas filled shock absorbers and military material including explosives.

Water or ice may be trapped in scrap. When loaded to the EAF, this will result in explosions.

Radioactive material in the scrap may contaminate batches of metal.

Furnace transformers using very high currents are subject to high mechanical and thermal stress which may result in breakdown.

Due to the batch type operation of EAFs, the off-gas steam cooling system is exposed to cyclical mechanical stress which can result in cracks and mechanical damage.

For dust separation, very large bag filters as well as drives / blowers are used. Dust recovery plants may be unique pilot constructions and therefore hard to replace. Damage to the off gas cleaning system may cause serious loss of production.

The refractory lining is subject to wear and tear and requires proper maintenance.

Spillage of liquid steel may occur when the content of an EAF is tapped into ladles to be transported by overhead cranes.

Loss Prevention

Scrap should be cut in small pieces and carefully investigated.

Scrap pre-heating in pre-heating furnaces (sometimes using EAF off-gases) is an important measure to avoid problems and to increase operational safety.

All scrap should pass via gates for radioactive screening before entering furnaces.

There should always be a spare furnace transformer on site. Transformers should have fixed sprinkler systems installed and should be installed in fire cells of their own.

Provisions for extinguishing dust filter units should be made. Fans and drives for filter units should have spares or be carefully monitored.

It must be assured that the brick lining is periodically renewed in order to avoid outbreak of hot steel. Spare bricks should be kept on site.

Electrical supply systems and hydraulic systems should be installed in areas protected from spill of hot metal. The control and supervision of hoisting equipment is important.

2.6.3 Continuous casting

Risk Exposure

Casting the steel is a delicate operation since the strand is initially only hardened at the surface and is still liquid inside. Spillages of molten steel can occur with damage by radiant heat to mechanical or civil structures, electric cables and hydraulic equipment etc.

Problems with the overhead handling of the ladle and its slide gate may lead to spills.

Loss Prevention

The platform by the caster should be leak tight allowing smaller spills from ladles or the thundish, without consequential damage to any equipment. All sensitive pieces of equipment (electronic, electrical, hydraulic, etc.), especially on lower levels, should be located in fire resistive cells to prevent inflow of hot metal.

An emergency dumping arrangement should be prearranged to secure that the hot metal does not come in contact with water.

Provisions for effective service of slide gates should be made to secure a safe operation.

2.6.4 Hot rolling mills

Risk Exposure

Loss of cooling and explosion of firing gas for walking beam furnaces may lead to damage of the furnace.

The presence of steel at high temperature and large amounts of combustibles such as cables, lubricating oil and hydraulic oil under very high operating pressure, mostly installed in the basement of the mill, constitute an added fire hazard. Furthermore, leakages in oil systems are frequent.

Substantial risks of fires spreading in the large buildings or their basements exist. Without appropriate measures, such as partitioning of basements or separate rooms, vital equipment like large motors or electrical cabinets may be damaged.

Loss Prevention

There should be back-up pumps for furnace cooling systems, installed in a safe location.

Gas fired furnaces should be provided with the following features:

- have safety devices on the burners: flame control, monitoring of combustion gas and air pressure,
- have safety devices on the piping (main and pilot) including vent lines operating automatically and manually triggered by high and low pressure,
- have start-up and stop procedures that include automated purge with air (or inert gas),
- have permanent monitoring of furnace atmosphere composition and temperature, interlocked with safety devices and
- have a gas pipe arrangement designed to prevent any exposure from adjacent explosion and fire hazard.

The hydraulic systems should use non-combustible fluids if possible.

Hydraulic systems, using combustible fluids, should have automatic sprinkler protection.

Lubrication systems should have automatic sprinkler protection.

Electrical cable tunnels and cable rooms, particularly underground, should have automatic sprinkler protection.

The maintenance of oil containing systems should be effective enough to avoid uncontrolled leakages.

Electrical rooms, lubrication equipment, hydraulic equipment, control equipment and motor rooms should all be located in separate fire compartments.

Rolling mills and down coilers should have automatic sprinkler protection.

2.6.5 Pickling plants

Risk Exposure

Fire risk is present due to the fact that the tanks are made of combustible material. Ignition of the tanks is often caused by malfunctioning of electric heating elements.

The pickling process requires corrosive fluids and they represent an environmental pollution risk in case of spills.

Loss Prevention

Areas containing large amounts of combustible materials should have sprinkler protection.

Fluid levels should be monitored and a safe function of heating elements secured.

Curbing should be installed to prevent the spread of spills and the release of waste water should be controlled.

2.6.6 Cold rolling mills

Risk Exposure

Fire from large hydraulic units and lubrication systems, usually housed in basement below the mill, represents an essential fire risk.

Old technology roll drives utilising large electrical motors, generally DC, represent a risk factor because the DC current is generated from AC power using generators (Illgner-type) and thyristors. These have replacement times up to and above 12 months. Most recent mills have modern frequency controlled AC motors with shorter replacement times.

Other essential fire risks are for instance: hoods located above housing of the mill, timber used for piling of steel products and auxiliary systems for roll rectifying shops.

Loss Prevention

The cold rolling mill itself should be protected with deluge or water spray system.

The lubrication and hydraulic systems below ground should have sprinkler protection.

Vapour exhaust hoods, or ducts leading to filter systems, should have CO_2 protection.

Electrical systems and electronic control systems should be situated in separate fire compartments. Water sprinkler or total flooding gas suppression systems may be needed based on risk analysis.

Motors and gear boxes should be located in separate fire compartments.

The amount of timber inside the mill should be minimised.

The fire load in rectifying shops should be kept at a minimum. Electrical rooms should have fire detection and/or automatic extinguishing systems.

2.6.7 Annealing plants

Risk Exposure

The presence of hydrogen represents a risk of explosion and fire.

For continuous furnaces, hydraulic systems used for upstream (unwinding machines, shears, welding machine) and downstream (winding machines) equipment represent a fire risk.

Gas used to heat the furnace represents an explosion hazard. The release of oxygen, used for improving furnace heating, represents an enhanced fire risk.

Loss Prevention

Areas containing hydraulic equipment are to be protected by sprinklers, as they can stop the whole annealing process. Non-combustible hydraulic fluids are recommended.

See loss prevention recommendations in 2.6.4: Hot rolling mills!

Should the N_2/H_2-mixture be obtained from ammonia, then the cracking units and ammonia tanks are to be located outside.

2.6.8 Hot galvanising

Risk Exposure

Heavy hydraulic units are used for winding and unwinding of the strip and these constitute a potential for fires.

Release of molten metal in ponds below the rolls may lead to damage of surrounding equipment.

Damage to electrical supply and heating units represent similar risks as those described for the annealing plants.

Loss Prevention

Areas containing hydraulic equipment should be protected by sprinklers, because if these pieces of equipment are damaged, the hot galvanising process may be interrupted. Non-combustible hydraulic fluids are recommended.

Retention arrangements below molten metal pots should be designed to prevent spill from reaching critical elements.

Fire detectors and appropriate protection should be installed for electrical systems and furnaces as recommended for annealing plants.

2.6.9 Electro galvanising

Risk Exposure

The release of gaseous hydrogen in the electro galvanising cells may cause fire or explosion.

Explosions and fires may be caused by strong oxidisers used in the process.

Fires may occur in equipment or components made of plastic material.

Heavy hydraulic units are used for winding and unwinding of the strip and these constitute a potential for fires.

Loss Prevention

Forced ventilation should be installed and controlled by hydrogen detectors.

The presence of organic material should be controlled in areas containing oxidisers.

Automatic sprinklers should be installed to protect hydraulic units, electrical rooms and cable rooms. Total flooding gas systems may be effective for some electrical rooms

General sprinkler protection should be installed in areas containing large amounts of plastic containers and other combustibles.

2.6.10 Colour coating

Risk Exposure

Paints and combustible solvents in storage facilities and pump rooms represent a serous fire hazard.

Fires or explosions may occur in the coating hood and in the incinerator for fumes.

Loss Prevention

The storage of paints and solvents should be in a separated fire compartment. Bulk storage of combustible liquids should be in a separate building. Storages inside the mill need fixed fire extinguishing systems.

Pump and mixing rooms should be in separate compartments and protected by automatic water sprinkler or foam systems. The type of foam should be chosen to comply with the type of solvents used.

Coating hoods and incinerators should be designed for explosions or provided with suitable pressure relief arrangements.

The use of water-based coatings is recommended.

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