PHARMACEUTICAL PLANTS

INTRODUCTION

The pharmaceutical industry, a high technology industry with a rapidly growing market for high value-added products, now poses a significant property and possibly a greater business interruption loss potential.

Pharmaceutical plants make two main types of product, over-the-counter (OTC) and prescription (Rx) products. Both types are generally patented; however, national medical authorities may more strictly regulate the latter.

A number of areas found in pharmaceutical plants such as clean rooms and warehouses are as susceptible to contamination as similar areas in semiconductor facilities. However, pharmaceuticals pose additional hazards, especially from the use and transfer of solvents.

Hazards in this industry include fires or explosions in solvents or dusts and the resulting smoke contamination of production and storage areas, particularly cleanrooms. These can lead to the loss of high value equipment and more importantly severe business interruption. Due to the medical nature of these products, they may only be licensed for manufacture in specific locations and/or certified production equipment. Many facilities require Federal Drug Agency (FDA) or similar national regulatory body approval. Recertification following contamination of production areas can be a lengthy procedure and can lead to the loss of market share.

Utility and mechanical service rooms pose a specific hazard, as there is often little or no redundancy in utilities. Laboratories are also common in pharmaceutical facilities because they act as both general research laboratories and as pilot plants. These areas are usually of high value, with unknown time element loss potentials due to their research nature.

PROCESSES AND HAZARDS

Several areas in this occupancy present special hazards. The following discussion describes the hazards in these areas:

- Cleanrooms
- Laboratories
- Warehouses
- Utility/mechanical service rooms
- Chemical rooms
- Production areas

Cleanrooms

Cleanrooms can be found in areas where the product is exposed to atmosphere. These areas include drying, milling and blending (DMB) plants, tableting plants and packing facilities. These rooms are generally Class 10,000 cleanrooms. However, some might be Class 1000. Therefore, even a small fire in one of these rooms would lead to widespread contamination. Since the majority of pharmaceutical products are of sufficiently low volume to be produced on a single process line, such an incident would lead to the total loss of production of a product until the room or building could be cleaned or rebuilt and recertified by appropriate government authorities. This can involve significant downtime leading to business interruption losses greater than one year. Even when the product can be produced by a subcontractor (tolled), this can involve significant extra expense.

Laboratories

Pharmaceutical laboratory areas are generally either research laboratories or pilot plants. The main hazards in research laboratories are storage and handling of flammable and combustible liquids. The main hazards in pilot plants can include exothermic or high pressure reactions, large flammable and combustible liquid holdups, and congested areas limiting the effectiveness of manual firefighting.

Adjoining service areas might support laboratories. Certain laboratories can also be classified as clean areas.

Warehouses

Pharmaceutical warehouses may have bonded stores which are customs and excise-free areas where finished product is stored.

Pharmaceutical products have varying shelf lives and, therefore, storage practices incorporated in stock turnover vary significantly. Pharmaceutical storage occupancies are generally regulated by government agencies.

The finished pharmaceutical products and the packaging associated with these products constitute combustible storage. The commodity classification depends upon the type of packaging for this material. Pharmaceutical warehouse occupancies may also have significant solvent storage, usually in small glass or plastic containers.

Pharmaceutical products may be fragile and require specific handling practices. In some cases Automated Storage and Retrieval Systems (ASRS) are used for large warehouses.

Pharmaceutical warehouses are highly susceptible to losses. Even a small fire can cause the entire stored product to be condemned due to contamination by smoke, heat, or water damage.

Pharmaceutical products have high value to weight ratios and are, therefore, susceptible to large value losses even in small areas. Many building owners do not recognize the magnitude of the loss exposures in their warehouses. They are more concerned with the amount of inventory moving through the warehouse than with its loss potential.

Utility And Mechanical Service Rooms

Utility rooms in these occupancies adjoin the areas of use. These areas of use are cleanrooms, tableting areas and packing areas. Equipment in service rooms can consist of ventilation, exhaust, water treatment, and smoke removal equipment; hydraulic packs associated with specific equipment; and chillers associated with climate control systems.

Utility rooms in a pharmaceutical occupancy are usually in unoccupied fire separated areas from the production area. In some cases a suspended ceiling separates the production areas from air plenum and associated cleanroom areas. The main sources of combustibility arise from poor housekeeping practices.

For the largest scale pharmaceutical production, supporting utilities or mechanical service equipment are often located in the open and will consist of cooling towers, heat transfer systems, bulk liquid

transfer lines and process safety systems, such as nitrogen purging and pneumatic compressed air lines for control equipment. Significant pipe racks and cable trays can also be located in these areas.

The peril associated with these utility rooms is primarily that of business interruption. Lacking any redundancy, a loss by fire or by electrical or mechanical breakdown will lead to the shutdown of the associated production area and the loss of its output.

Chemical Rooms

Chemical rooms are used for transferring limited volumes of flammable solvents to production areas. These areas can include tablet coating and powder blending processes.

Chemical rooms can often expose adjoining cleanrooms and production areas. These rooms can have elaborate liquid transfer and ventilation systems, and can constitute a severe fire risk.

Production Areas

Typical production areas are chemical synthesis areas, tableting, liquid filling and powder filling machine rooms, aerosol filling operations, packing halls, and associated plant areas. These areas have the fire and explosion hazards associated with flammable liquids and combustible dusts. Furthermore, all these areas are critical to production and are sensitive to contamination.

A number of these areas are considered cleanrooms. In addition, the majority of these areas have suspended ceilings and raised floors.

Additional equipment that might be found in production areas includes:

Large Compressors And Turbines

This type of equipment is used in power plants or air liquefaction plants, which may be part of the production area.

These machines have long lead times to obtain replacements so the associated business interruption potentials are high.

Piping And Pipe Racks

Pipe racks are routed between bulk raw material tanks and intermediate tanks, utilities, and process buildings. The pipelines transferring flammable liquids can expose plant equipment and buildings, control rooms, and fire protection equipment (control valves, hydrants, and hose houses).

Cable Trays

Cable trays are found between production, control and power generation facilities. These systems are important to the effective operation of the plant. Since there is usually no redundancy in cable trays, the loss of these systems poses a significant business interruption loss potential due to the time required to trace and repair the lines.

Cable trays are frequently used to transfer power and data cables from one fire area to another. This creates an exposure from equipment located beneath the trays and an exposure to adjacent fire areas.

Cooling Towers

Cooling towers are associated with chillers that control environmental temperature and conditions in tableting buildings.

In chemical synthesis plants, large cooling towers can be used to remove process heat from the cooling water systems. These units can have high value and pose a significant business interruption potential due to long replacement times.

LOSS PREVENTION AND CONTROL

Management Programs

Develop and implement written management programs for loss prevention and control as specified in *OVERVIEW* (PRC.1.01). Management program administrators should report to top management through the minimum number of steps. They should also institute adequate loss prevention inspection and audit programs to communicate program effectiveness to top management. This management feedback is a key feature of AXA XL Risk Consulting's total management program for loss prevention and control. Give particular attention to the following areas:

Process Hazards Evaluation

Develop a program to determine the pertinent physical and chemical properties of reactants, intermediate products, by-products and end-products. See PRC.1.13.0. Choose test conditions that best represent all possible operating conditions.

Establish routine procedures for testing physical and chemical properties of all incoming raw materials, intermediates and final products to confirm properties required for safe operating conditions.

In process design, consider the desirability of reducing flammable and combustible material holdup. Improved equipment may require less of these materials, and consequently the amount that could be spilled by equipment failure or operator error will be less.

Determine the safe operating and potential upset conditions of all new or existing chemical processes used by the plant. Include scaling factors, such as bench, pilot, semi-works or full scale, in establishing the safety parameters.

Design all processes for inherent safety by using instrumentation and by adhering to written operating procedures, with ultimate safety provided by adequate pressure relieving devices. Also consider process layout, valving, sizing of vessels and piping, choice of materials for vessels and piping, and choice of process materials. Interlock processes to shut down automatically and safely in event of operator error or equipment failure. Provide intermediate alarms to allow operators time to take corrective action.

Provide redundant instrumentation for all critical controls. In redundant loops, include **both** separate signal transmitters and separate signal receivers. In most cases, install a comparator to notify operators when redundant signals differ significantly.

To limit the amount of materials released by equipment failure, include the following in shutdown measures: block valves; venting to flare stacks or to incinerators; liquid dumping to blowdown systems; and purging or flooding of equipment with a nonhazardous fluid. Actuate these shutdown measures with combustible vapor detectors where appropriate.

When designing safety features, assume a minimum of two consecutive errors, one of which may be misinformation from a faulty instrument or a misunderstanding of instructions.

Design and specify equipment considering all possible operating conditions, both normal and abnormal. Give particular attention to suitability of the equipment to handle the process materials and to withstand external environmental influences.

Operator Training

Educate all operators in the hazards involved and in functions of the safety control equipment. Forbid operators to run the process when any of this equipment is out of order. Train operators in manual emergency shutdown procedures. Forbid deviations from the written procedures.

Schedule re-education and training at least annually. Include testing to assure proper performance of all assigned duties with particular emphasis on emergency shutdowns. See PRC.1.4.0 for further details.

Pre-Emergency Planning

AXA XL Risk Counsuling's "PEPlan," the pre-emergency plan from PRC.1.7.0, may be used to develop a customized plan. This customized plan should include the following features:

- A fire and disaster alarm system.
- An emergency communications system, including radio where needed.
- An adequately trained, staffed and equipped organization of employees for firefighting and other emergency duties.
- A planned program of cooperation with neighboring plants and with public firefighting and disaster control organizations.

Business Continuity Management

A program to analyze the interruption of business that may result from potential incidents and to develop plans for minimizing loss of production during rebuilding.

A program to list critical items, spares carried and spares available from recorded suppliers, lead time for delivery, and cost of items.

Maintenance

Inspect and maintain process equipment, piping, instrumentation, electrical equipment and pressure relief devices according to a schedule established with proper consideration of design and service conditions. Include all appropriate types of modern nondestructive testing, IR scanning and vibration analysis in the inspection techniques. Establish a detailed record-keeping system, including equipment retirement forecasts. Guidance can be found in PRC.1.3.0.

Smoking Regulations

Limit smoking to specified areas. Strictly enforce this limitation as a formal policy. Guidance can be found in PRC.1.2.0.

Hazardous Materials Evaluation

Carefully analyze raw materials and finished products for potential hazards, including flammability, corrosivity and toxicity. Record these properties on SDS sheets. Update this information for any change to raw materials or finished products. Guidance can be found in PRC.1.8.0.

New Construction

Regulate new construction projects with safety precautions to ensure loss potential is reduced to a minimum. See PRC.1.5.0 for guidance.

Proper Housekeeping

Enforce good housekeeping practices. Guidance can be found in PRC.1.14.0.

Management Of Change

Apply all management programs to any changes made to the facility's physical arrangements or procedures. Pay particular attention to the following areas:

- Repeat the process hazards evaluations program for all new processes or for any modification to an existing process. Determine the need for new or different safety equipment or measures.
- Whenever equipment is changed from one service to another, or when process changes are made, examine the inspection and maintenance program and modify as necessary. Monitor daily operating changes.
- Verify new construction materials and all maintenance parts and supplies as conforming to original (or modified) design specifications.
- Apply the program for handling new construction, including the control of outside contractors.

- Update operations procedure manuals after each process unit modification, which results in a change in operating procedure.
- Review and follow through expeditiously on all inspection recommendations from insurance, code enforcement and regulatory agencies.

See PRC.1.0.2 for guidance.

Other Management Programs

Incorporate these features into the comprehensive management program for loss prevention and control:

- Welding, cutting and other “hot work” permit programs.
- A program of supervision of impairments of fire protection equipment using AXA XL Risk Consulting’s “RSVP” program.
- Plant security and surveillance.

Construction

Construct buildings of noncombustible materials throughout.

Install roofs that are rated by UL as “fire classified” (for interior fire exposure) with a UL listed roof covering (for exterior fire exposures). Design roofs to withstand combined wind and snow loading in accordance with American Society of Civil Engineers ASCE 7 (or equivalent) and PRC.2.0.3 and PRC.2.0.1.1.

For areas handling, storing, or processing pharmaceuticals or their raw materials, arrange in accordance with the relevant sections of NFPA 318 and PRC.17.11.1. In such areas, use only interior finishes, wall and ceiling panels, pipe insulation, and adhesives that have a flame spread rating less than 25 and fuel contributed and smoke developed ratings less than 50 when tested in accordance with ASTM E84 (UL 723). Do not use plastic covering or plastic panels on interior walls or ceilings.

Water Supplies

Review water supplies carefully for the anticipated maximum demand, pumping capacity and size and routing of distribution mains. The following offers AXA XL Risk Consulting’s position with regard to water supplies and should be read in conjunction with other referenced PRC Guidelines:

- Provide reliable and adequate primary and secondary water supplies. Base designs for each water supply on the highest demand for fixed protection and manual suppression systems on site.
- Design the minimum storage capacity for fire protection water based on fixed and manual fire suppression equipment operating simultaneously. Base the supply on a duration of 3 h for tablet production/filling plant and 4 h where large volumes of flammable liquids are processed.
- The two on-site water supplies must be able to operate independent of each other. This requires individual tanks and pumps. Do not combine domestic or process water with fire protection storage in the same tank.
- Arrange water supplies in accordance with PRC.14.0.1, NFPA 20, NFPA 22, and NFPA 24.

Water Distribution

Arrange fire protection water distribution systems in accordance with NFPA 24 and PRC.14.5.0.1.

Distribute the fire protection water to sprinkler lead-ins and hydrants by looped yard mains. Hydraulically verify all designs. Calculate the maximum demand for the site through each leg of looped mains to confirm that any system could be adequately supplied even with one leg impaired.

Protect significant bulk distillate or flammable liquids storage tanks with either monitor nozzles or circumferential waterspray.

If the monitor nozzle option is chosen, install one foam-water nozzle with a 20 min foam concentrate supply at each of the corners of the tank farm. Use the monitor nozzle option only if both the tank spacing and fire brigade response and training are fully adequate. If not, then circumferential protection is preferred. See PRC.12.2.1.2 for details.

Where drainage is not adequate per PRC.2.5.3, use foam-water spray to reduce water demand/drainage requirements. (See PRC.12.2.1.2.)

If the facility handles or stores large quantities of flammable liquids, store foam concentrate on site and make it available to all emergency services. This foam concentrate is in addition to that maintained for the facility's own protection systems. Review the quantities and conditions of the foam concentrate periodically.

Surveillance

Provide surveillance in accordance with PRC.11.0.1 to the level recommended by the AXA XL Risk Consulting Account Team.

Electrical Systems

Define hazardous rated areas in the facility in accordance with NFPA 497 and NFPA 499. Install electrical equipment in those areas in accordance with Article 500 of NFPA 70.

Cleanrooms

Install sprinkler protection as specified in NFPA 318 and PRC.17.11.1. Where one sprinkler riser feeds more than one level of the production area including clean rooms, install separate control valves to restrict impairment of protection to only one level in the production building.

Install automatic sprinklers in the underfloor areas of cleanrooms and in plenum chambers, using the same design as the sprinklers in the cleanroom.

General guidance can be found in PRC.17.11.0.

Ventilation And Exhaust Ducts

Use metallic ducts wherever possible. Use only FM approved plastic ducts for use without sprinklers in cleanrooms. Do not install dampers or other devices in plastic ducts that could obstruct them. Arrange and protect plastic ducts in accordance with PRC.2.3.2 except provide sprinkler protection for ducts of 8 in. (200 mm) diameter or larger.

Detection Systems

Install a high sensitivity, sampling type smoke detection system throughout the underfloor area of all critical cleanrooms in accordance with the requirements of NFPA 72.

Smoke Exhaust System

Design air handling systems to automatically divert recirculated air to exhaust upon actuation of any smoke detector. Additional make up air may be required to prevent unacceptable pressure differentials.

When air handling systems cannot be used for smoke removal, provide an independent smoke removal system and design it to provide not less than 3.0 $ft^3/min/ft^2$ (0.9 $m^3/min/m^2$) of floor area. Distribute smoke exhaust points uniformly throughout the cleanroom.

Locate make up air intakes remote from smoke exhaust points. Install dampers in the air intake system and arrange them to close upon detection of smoke.

Use ductwork constructed of noncombustible material in smoke removal systems. Provide emergency switches for actuation of the smoke removal system outside each clean room exit. Wire the smoke removal system from an independent power supply and fire proof cables exposed to the area being served.

Separation

Separate cleanrooms exposed by adjacent combustible occupancies or other clean rooms with walls of a minimum of 2 h fire resistance. Protect door openings with single 3 h fire rated fire doors.

Laboratories

Protect laboratories using chemicals in accordance with NFPA 45 and PRC.9.11.1.

Fixed Protection

Install sprinkler protection at the ceiling level and in fume cupboards and ducting. A fixed gaseous extinguishing system can be installed in fume cupboard hood and ductwork. Arrange systems in accordance with NFPA 13 and PRC.12.1.1.0, and with NFPA 45 and PRC.9.11.1.

Motor Driven Apparatus

Do not locate ordinary electrical motors in hoods or ducts.

Storage Of Flammable Liquids

Label all flammable liquids storage cabinets, storage spaces or other storage locations in the laboratory with labels in accordance with NFPA 704. Provide material safety data sheets (SDS) for all chemicals stored.

Warehouses

Separation

Locate warehouses a minimum of 50 ft (15 m) from critical buildings. If this is not possible, provide a 3 h fire wall to separate each warehouse from other production areas, warehouse areas and office areas. If the warehouse contains Class IV or higher commodities, provide 4 h fire walls.

Sprinklers

Evaluate the height of storage and particularly the commodity classification of the product. Be sure to consider the packaging, as it often determines the commodity classification.

Provide sprinkler protection in accordance with NFPA 13 or NFPA 30. Use AXA XL Risk Consulting's maximum reliability design where applicable. Refer to PRC.8.1.0 and PRC.12.1.1.0. The preferred protection option for flammable liquids is a foam-water based protection system. This will also reduce the requirement for process liquid and surface liquid run off in the area.

Drainage

Contain fire protection water run-off in a recessed sump in the warehouse or in a safe location outside the building. The latter is the preferred option, so long as the fire protection water is safely routed.

Additional Protection For Flammable Liquids

Provide explosion relief, classified electrical equipment, bonding and grounding of dispensing vessels, and ventilation as needed. See NFPA 30 and PRC.8.1.0.

Review the automatic solvent transfer lines. These lines should be either closed loop or provided with a dump line to dump contents to a safe exterior location.

Utility And Mechanical Service Rooms

Separation

If flammable gases or liquids are present, then enclose this area in a minimum of a 2 h fire rated enclosure as per NFPA 30 and PRC.8.1.0.

Sprinklers

Evaluate the level of combustibility in these areas carefully. The main sources of combustibility arise from poor housekeeping practices. In particular, review the material of construction of the suspended

ceiling. In cases where the flame spread rating of the ceiling tiles is < 25 as per ASTM E84, and no other combustible occupancy or construction is present, then sprinkler protection in this area is not required.

If ordinary combustibles are present, provide sprinkler protection designed for 0.2 gpm/ft^2 (8 L/min/m^2) over the hydraulically most remote 3000 ft^2 (279 m^2) of floor area. If flammable liquids or gases are present, provide protection in accordance with NFPA 30.

Detection

Unless the plant room is constantly manned, provide automatic fire alarms connected to a constantly manned location. Arrange this system in accordance with NFPA 72.

Management Programs

Evaluate the redundancy of services to ensure that production would not be affected significantly in the event of an outage. Also review pre-emergency planning to find out contingencies for loss of critical services. Install a good preventive maintenance program to limit or eliminate potential sources of ignition and mechanical and electrical breakdown. Enforce good housekeeping practices.

Chemical Rooms And Production Areas

Fireproofing

Provide fireproofing to exposed structural steelwork exposed to a potential spill fire. Install fireproofing in accordance with ASTM E119, ISO 834-1, EN 1363-1, or AS/NZ 1530.

Rate all fireproofing per UL 1709. Provide 2½ h fire proofing for column protection. However 1½ h ratings are acceptable for structures **fully** protected by automatic water spray systems and provided with **adequate** drainage per PRC.2.5.3. Water sprays must directly impinge upon all structural steel and process vessels. See PRC.2.5.1.

Sprinkler Protection

Protect cleanrooms and production areas with a wet pipe sprinkler system designed to provide 0.20 gpm/ft^2 (8.0 L/min/m^2) over the hydraulically most remote 3000 ft^2 (279 m^2) unless there are flammable liquids present in large quantities (See protection for lab areas).

Protect areas used for chemical synthesis including batch and continuous processing using flammable liquids according to PRC.12.2.1.2.

Install deluge sprinkler protection where there is a spill fire potential. This can be found in high hazard, exposed or easily damaged equipment in an organic synthesis plant. Similar protection is needed for high pressure and high temperature pumps, air-cooled heat exchangers and vessels with large quantities of liquids. Such equipment can be located in open process structures. In addition it may be found in solvent stores and specific application over bulk tanks.

Use the following deluge sprinkler densities:

- 0.25 gpm/ft2 (10.2 L/min/m2) over the protected area for areas involving combustible liquids.
- 0.35 gpm/ft2 (14.2 L/min/m2) over the protected area for areas involving flammable gases and liquids. Where deluge foam water sprinkler systems are provided to protect against flammable liquid hazards the required density can be reduced to 0.25 gpm/ft2 (10.2 L/min/m2). Evaluate whether flammable liquids are water miscible and select the foam accordingly.
- 0.50 gpm/ft2 (20.4 L/min/m2) over the area for pumps handling liquefied flammable gases, flammable liquids, or combustible liquids.

Design fixed extinguishing systems referenced in this section in accordance with NFPA 15 for water spray systems and NFPA 11 or NFPA 16 and PRC.12.3.1.1 or PRC.12.3.2.1 for foam-water sprinkler and spray systems.

Location

The location of specific equipment can reduce the loss potential and the level of exposure to nearby equipment. For new construction projects this is particularly important as major cost savings can result. For these projects it is important to forecast the longer-term expansion of the site to allow for spacing of future equipment. Reference should be made PRC.2.5.2 and in particular to Table 1 (Inter-Unit Spacing Recommendations For Oil And Chemical Plants). Separate rooms within the same building by 3 h fire rated barriers in accordance with NFPA 80.

Liquid Storage

Arrange and protect flammable liquids storage in accordance with NFPA 30.

Liquids Delivery Systems

Install pneumatic pumps in areas of flammable liquid dispensing to reduce the ignition potential in these areas. If electric pumps must be used, install only pumps rated in accordance with NFPA 70 for the area.

Locate the pump, bulk tank, piping and day tank in an area with secondary containment. Locate pumps in an area separately diked from the diked area of the tanks. As an alternative, raise the pumps above the highest possible liquid level of the diked area. Provide manual shutoffs at the bulk tank and at the points of use.

Install adequate grounding on all flammable liquid transfer pumps.

Arrange all chemical delivery systems to fail in a safe position as determined by a hazard evaluation study with manual reset only. Provide redundant liquid level and over temperature sensors in series with the normal operating controls. Analyze the transfer system and evaluate the requirement for emergency power. Provide emergency power to interlocks arranged to close supply valves, open vents and turn off heat sources in the following situations:

- Loss of power
- High liquid level
- Low liquid level
- Excess temperature

Terminate day tanks or the vents from their cabinets outside the building. Do not manifold vents or terminate them in ductwork. Provide secondary containment inside tank cabinets.

Electrical Design

Determine hazardous zones in accordance with NFPA 70 or interpretation of the local electrical standard.

Provide emergency power for all fume exhaust systems and smoke removal systems.

Process Heating

Protect organic heat transfer systems in accordance with PRC.7.1.5.

Arrange interlocks to shutdown reaction heating sources upon the loss of cooling water, nitrogen purging, and other rate of reaction dependent parameters.

Protect recirculation ducts in accordance with guidance given for semi conductor occupancies.

Compressors And Turbines

Provide fixed water spray protection for bearings and governors of compressors and turbines designed to supply 0.25 gpm/ft^2 (10.2 L/min/m^2) over the protected area in accordance with PRC.12.2.1.2.

Piping And Pipe Racks

Identify and mark all pipelines containing flammable liquids.

Protect such piping in major pipe racks as follows:

- Pipe racks up to 3 ft (0.9 m) in depth — Water spray protection designed for 0.25 gpm/ft2 (10.2 L/min/m2) onto the underside of the lower level of the piping.
- Pipe racks deeper than 3 ft (0.9 m) — Water spray protection designed for 0.25 gpm/ft2 (10.2 L/min/m2) onto the underside of level of piping.

Cable Trays

Install exposure protection for cable trays that are exposed by pumps or other equipment.

Where cables are exposed and shielding or fireproofing is provided, provide fixed water spray in accordance with NFPA 15 and PRC.17.12.1, located under and above the tray with the spray directed onto the tray. A density of 0.30 gpm/ft^2 (12.2 L/min/m^2) is recommended.

Where exposed cables are provided with a bottom shield, provide fixed water spray with a density of 0.25 gpm/ft^2 (10.2 L/min/m^2) onto the upper part of the tray.

Where cable trays are fully enclosed in a 30 min UL 1709 fire rated enclosure, water spray for exposure protection is not required.

Cooling Towers

Construct cooling towers of noncombustible materials and use noncombustible fills.

Protect cooling towers in accordance with NFPA 214.

Provide vibration monitoring of the horizontal axis of the fan shaft.

If the cooling tower is a multi cell unit, install fire barriers of at least 20 min fire resistance rating per ASTM E119, ISO 834-1, EN 1363-1, or AS/NZ 1530 between cells.

Determine the criticality of each cooling tower and incorporate it into the pre-emergency plan. Include the following:

- The cooling requirements for each part of the facility.
- The cooling capacity of the cooling towers and associated redundancy.
- The number of cells in each tower and associated redundancy.
- A detailed evaluation of the consequences of the loss of one or more of the cooling towers.
- The replacement policy and names and contact addresses for repair and or replacement companies.
- The register of spares for this equipment.
- Any emergency connections or cross connections.