Property Risk Consulting Guidelines

A Publication of AXA XL Risk Consulting

PRC.17.18.1

PRINTING PRESS OPERATIONS

INTRODUCTION

Printing has progressed from the Gutenberg press, which required three minutes per impression, to today's multicolor, two-sided, continuous presses that operate well in excess of 2000 ft/min (610 m/min).

There are four major printing processes: lithography, letterpress, gravure and silk-screening. A lithography offset press prints from a level or plane surface; a letterpress prints from a raised surface; a gravure press prints from a depressed or sunken surface; and silk-screening prints by pushing ink through fabric. From the *6th Annual Report to the Congress of the United States: Printing Industry* report, Figure 1 shows 1994 industry market share.

PROCESSES AND HAZARDS

The hazards of printing presses include the transfer and use of flammable inks; solvent recovery and pollution control devices; hydraulic and lubrication oil systems; gas or oil-fired dryers; electrostatic buildup from high press speeds; paper dust; and paper storage near presses.

This section discusses common printing processes and their hazards. Loss prevention and control guidelines address construction features, flammable and combustible liquids handling, protection of the press area, electrical features, drying, and the disposal of solvent vapors.

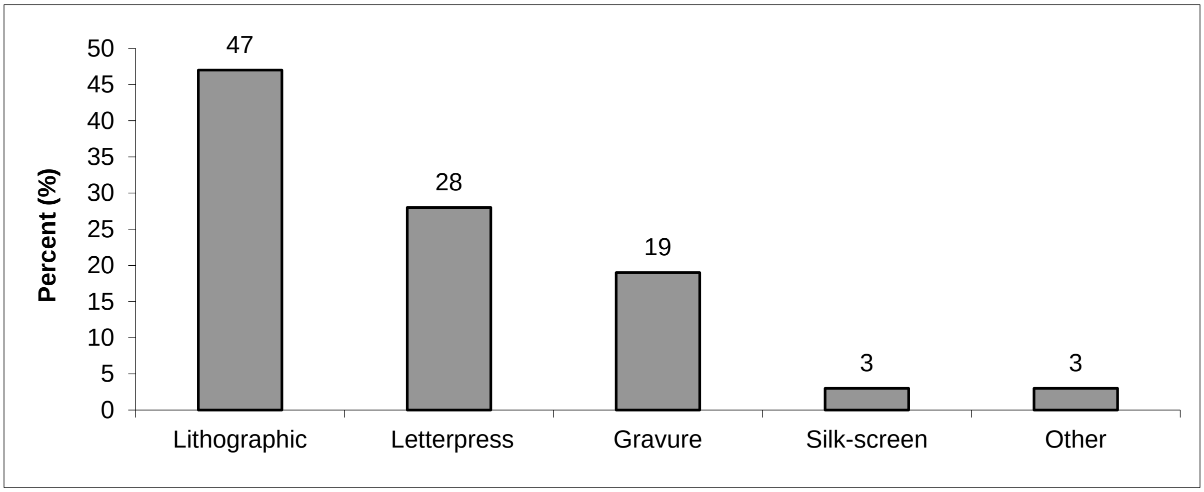

Figure 1. Market share by process.

100 Constitution Plaza, Hartford, Connecticut 06103

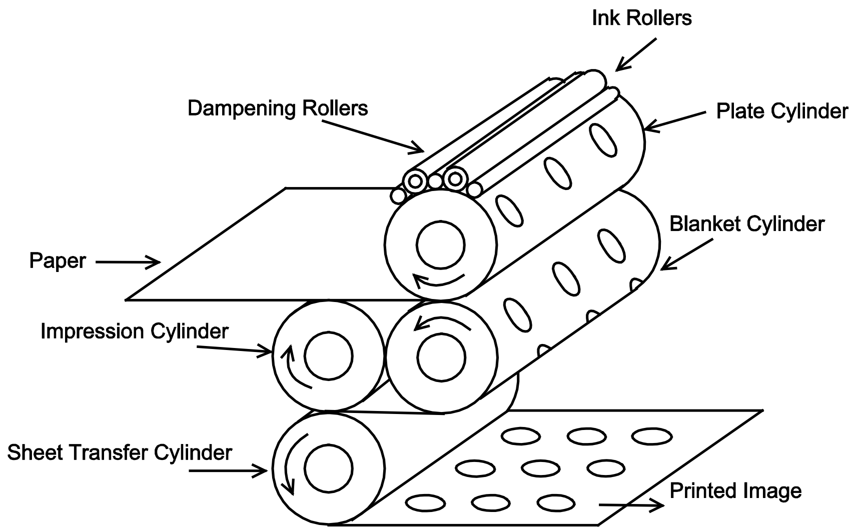

Figure 2. Lithographic Printing.

Lithography

Lithography accounts for almost half of all printed materials in the U.S. In offset lithography, the flat plate is chemically treated so that the image areas are receptive to ink but not water. Conversely, the nonimage areas are receptive to water but not the ink. As the plate cylinder rotates, it is successively wetted first by water, then by the ink paste. The inked surface then transfers to a rubber blanket, which carries the image to the web. See Figure 2.

There are two types of lithographic printing: sheet and web. Sheet presses run individual sheets of paper through the press, while web presses feed paper continuously from a large roll and can use either heat-set or nonheat-set inks. In offset printing, the image transfers directly from a flat or plane surface metal printing plate. Once the image is printed onto the substrate, the paper is fed back onto a roll or cut and trimmed into specific shapes and sizes. Sheet lithography is used mostly for short runs of books, periodicals, posters, advertising flyers, brochures, greeting cards, packaging and fine art reproduction. Web lithography is designed to print large jobs and is used for newspapers, books, catalogs, periodicals, advertising materials and business forms. See PRC.17.18.

The principal materials used in lithographic printing are inks, paper substrates, photographic films, photo-processing chemicals, printing plates, plate-processing chemicals, fountain solutions, cleaning solvents, correction fluids, rags and water.

Getting images and artwork onto an image carrier involves raw materials such as photo-processing chemicals and solutions. Digital processing with computer transfer of digitized images is replacing much of this.

The material to be printed, whether a "camera-ready" paper copy or an electronic version, is converted to film images. Color separations for the four primary colors (yellow, magenta, cyan and black) are also done in this stage. Prior to the use of electronic desktop publishing, these camera-readies involved gluing or waxing the back of the art and text to another sheet of paper. This board was then photographed. If any errors were detected after this step, the board would be corrected and re-shot. Although this process is still in use, it is being replaced by electronic imaging.

Digital electronic imaging allows text to be edited on a computer screen. The image is scanned or created with digital cameras. The cameras digitize the image and then send it to a computer for editing. After correction, the master copy is saved to file. Color separations can also be prepared electronically. This reduces or eliminates the need to photograph, edit and re-shoot, saving time and money. Once the film has been developed and proofed it is sent to plate making. Photo-processed artwork is produced using paper, plastic film or silver-solution emulsions. Some facilities are installing silver recovery, water recovery and chemical recovery systems.

Proofing shows whether all images are in line (registered), whether the color is right, and how the final printed image will look. Most proofing is now done using either a solvent or newer aqueous-based liquids. Proofs are made because the platemaking step affects tone reproduction. Proofs are also used to check camera and scanner separations and correction in color printing.

Although plates may be produced by a number or processes, photomechanical surface plates are most common. They are made from thin anodized or grained aluminum coated with a light-sensitive material. The most common plate coatings are diazo compounds and photopolymer resins, although asphalt, shellac, gum arabic, and polyvinyl alcohol are also used.

The image transparency is placed over the sensitized plate, covered with glass sheet and a vacuum is pulled. The plate is exposed to ultraviolet light, which hardens the coating on the plate to make it insoluble to water or other solvents. The plates can be of the additive or subtractive type. Additive plates are developed with a one-step emulsion that hardens making the image areas receptive to ink. Subtractive plates have a lacquer coating that dissolves the noncoated image area during developing.

The image-carrying plates accept ink from a roller and transfer this image to a rubber blanket. The blanket, in turn, transfers the image to the substrate. This double transfer is where the term offset comes from.

Electrostatic plates are nonmetallic plates. The plates are coated with a photo conductor, which is ionized by an electro-photographic camera. The charged paper is exposed to light. The white areas of the image reflect light and dissipate the charge. The dark areas absorb light. Toner is attracted to the charged areas and forms an image. During press operation, the toner attracts ink and the white areas attract water.

Before printing begins it is necessary to attach printing plates to the press; add ink and fountain solutions to each print unit; test the press to make sure the image is aligned properly (registration); and checks that the prints are in accordance with customer specifications.

Printing occurs when the plate rotates so that the nonimage areas can be treated with an ink-repelling fountain/dampening solution. The plate is then coated with the ink, which adheres to areas of the plate that contain the image. As the cylinder rotates, the image is transferred to the substrate via the impression or blanket cylinder. The press is then fine-tuned to ensure registration and ink density are accurate and identical on all copies coming off the press. After a final check for acceptability, the press run begins. Although an essential step, everything generated during startup is waste. Pre-press planning reduces waste and saves paper, chemicals, time and waste disposal costs.

The press step is the actual printing operation in which inks, cleaning solvents and substrates are used. The printing produces scrap paper, waste ink, and emissions from cleaning solvents and the ink drying process.

Letterpress

Flat plate letterpress printing is the oldest and most versatile method. It uses a plate with a raised image that applies ink directly to the surface of the paper. It was once the predominant printing method, however, today it is used primarily for printing books, business cards, and advertising brochures. Faster lithographic, gravure and flexographic printing is replacing what was once done by the letterpress.

The three types of letterpresses in use today are the platen press, the flatbed cylinder press and the rotary press. On the platen press, the raised plate is locked on a flat surface. The substrate is placed on another flat surface and pressed against the inked plate. The flatbed cylinder press is rather rare. It transfers the image as the substrate passes around a rotating impression cylinder on its way from the feed stack to the delivery stack. On the rotary press (flexographic press), both the impression and the printing surfaces are curved. The paper is passed between the two surfaces to print. Paper can be sheet or continuous roll.

The most common letterpress is the web-fed rotary press or flexographic press. It uses a flexible rubber blanket mounted in a rotary web letterpress to print on a continuous roll or web of paper.

Sheet-fed presses can also be used. Ink transfers to the plate cylinder. Raised type on a flexible plate produces the printing. Then the web passes through a dryer before rewinding.

The print area or image consists of a raised surface, known as relief printing, that can be inked and pressed onto the substrate. Nonimage areas are below the printing surface and do not reproduce. See Figure 3. Both sheet-fed presses and web presses are used in flexographic printing.

Up to six colors are applied at different printing stations on the press. It can be printed on one side, dried and then printed on the reverse side. These presses are used by the newspaper, magazine and catalog industry for color work. See PRC.17.18.

Flexographic printing uses a printing plate made of rubber, plastic, or some other flexible material. Ink is applied to a raised image on the plate, which transfers the image to the printing substrate. The fast-drying inks used in flexography make it ideal for printing on materials like cellophane, polyethylene and foils. This makes flexography the predominant method used for printing flexible bags, wrappers, and similar forms of packaging.

The soft rubber plates are also well suited to printing on thick, compressible surfaces such as cardboard packaging. Inks used in flexography are usually either water-based or solvent-based.

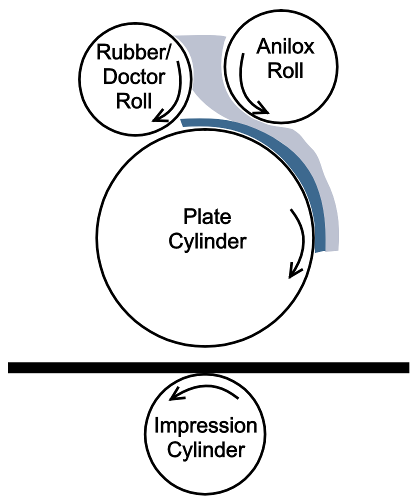

Figure 3. Flexographic Printing.

All original text, pictures, and illustrations are photographed to produce positive or negative film images to make the printing plates. This step includes the use of photographic chemicals, paper, and film. The plates are made using plastic or rubber, and coated with solutions to make certain areas insoluble in water. Ink is applied to the image on the plate. From the plate, ink is transferred directly to the substrate. Wastes associated with this process are waste paper, waste ink, and cleaning solvents. Darkroom chemistry, platemaking, inks and solvents, and maintenance all use chemicals. Also emissions containing volatile organic chemicals from inks and cleaning solvents are a problem and have to be removed as close to their source as possible.

The plate-making process has seen many improvements over the years:

- Citrus-based and other solvents to make photopolymer plates, replacing traditional chlorinated solvents.
- Hard photopolymer masters replacing metal engraving.
- Laser-engraved rubber plates providing a chemical-free means of platemaking.
- In-line plate-making systems that are fully enclosed and have microprocessor-controlled exposure.

Inks have been improved as well:

- Water-based inks are more commonplace. Their colors are more vibrant and crisp than most oil-based inks.
- With water-based inks, ceramic anilox cylinders and plates release the ink more readily to the substrate with less beading. Good ink trapping insures good process printing.
- Enclosed ink systems and temperature control can reduce amine loss and retain the ink's color.
- Water-based inks are more stable in high humidity conditions, however, it is necessary to prevent excessive mechanical agitation, maintain suitable pH, and keep below temperature down.
- Water-dispersible polyester resins are becoming more common. Unlike water-based ink the new polyesters require no pH balancing and no odor problems. They dry faster allowing faster press speeds.

Other improvements in printing include:

- Chambered doctor blades providing better ink transfer from the ink container to the substrate. The chamber is sealed off completely so that no ink goes beyond the width of the unit.
- Infrared drying using electromagnetic radiation.
- Radio frequency drying using high frequency electrical energy to dry water and solvent based coatings. Supplemental convection air dryers are sometimes used in conjunction with radio frequency.

Gravure

The gravure printing process is used for large, high-quality, multi-colored jobs run at high press speeds. These include art books, greeting cards, advertising, currency, stamps, wallpaper, wrapping paper, magazines, wood laminates and rubber or plastic substrates. In gravure printing the printing plate or cylinder, which rotates in an ink bath, has recessed cells that are etched or engraved to differing depths and/or sizes. A doctor blade wipes the excess off the surface. The ink remaining in the thousands of recessed cells or wells directly transfers the image to the paper. The capillary action of the substrate and the pressure from impression rollers draw/force the ink out of the cell cavity and transfer it to the substrate. See Figure 4.

The cylinders are usually made of steel and plated with copper and a light-sensitive coating. The cylinders are machined to remove imperfections in the copper. Although most cylinders are now laser engraved, some are still engraved using a diamond stylus or a chemical etch.

Before etching, a resist (in the form of a negative image) is transferred to the cylinder. The resist protects the nonimage areas of the cylinder from the etch chemical. After etching, the resist is stripped off. This process is similar to the manufacturing of printed circuit boards. Following engraving, the cylinder is proofed and tested, reworked if necessary, and then chrome plated. Often corrections and touch-ups are still done using the old process.

Presses can be of the flat and rotary type. Rotogravure presses operating up to 2000 fpm (610 m/min) with webs as wide as 120 in. (3.1 m) are used in publication plants. Larger webs, up to 150 in. (3.8 m) wide, are used to make floor covering, whereas presses for packaging materials usually have smaller webs, 40 in. – 60 in. (1 m – 1.5 m) wide, with up to eight printing units.

Gravure printers usually use solvent-based inks, although use of water-based and vegetable oil-based inks are increasing due to regulatory issues. Processes that continue to use solvent inks can run considerably faster because the inks dry much more quickly. Since the previous color must be dry before a subsequent color is printed, ovens are frequently used between each printing unit to speed up the drying.

Unlike lithography and flexography, gravure printing does not break solid, colored areas into minute dots (half tones) to print the areas, which makes it ideal for reproducing high-quality continuous tone pictures, especially when using glossy inks.

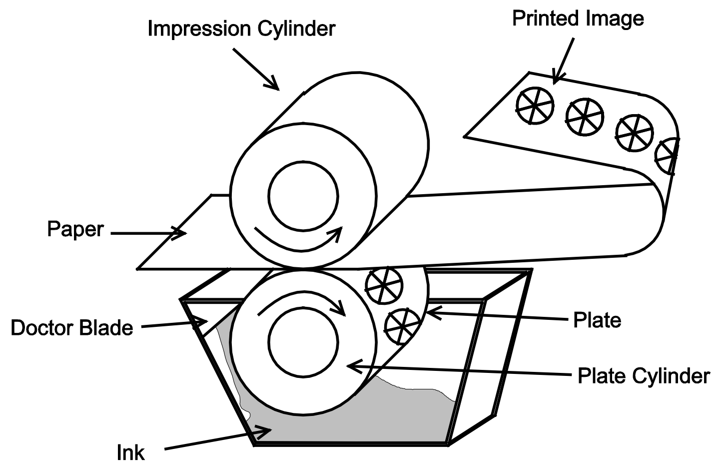

Figure 4. Rotogravure Printing.

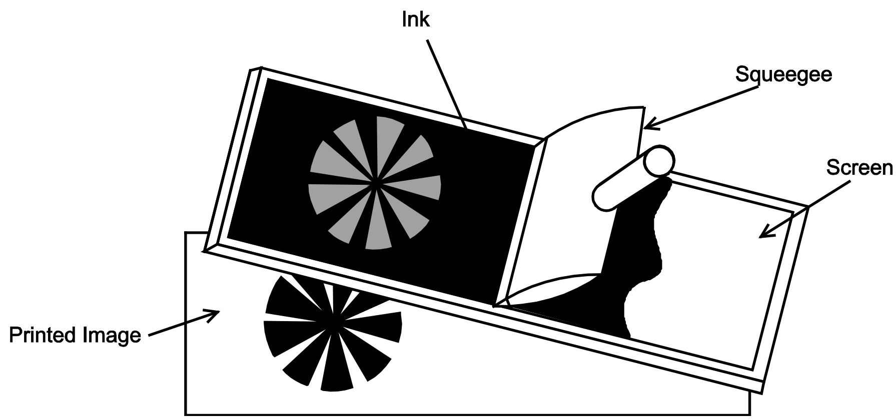

Figure 5. Silk-Screen Printing.

Silk-Screen

Silk-screen printing uses a porous mesh screen with an ink-resistant image on its surface. Nonimage areas of the screen must be blocked and image areas open to allow ink to pass through to the substrate. The type of material used to make a screen depends on the desired result. Most silk-screening facilities are relatively small and produce billboard advertisements, greeting cards, art books, clothing, posters and equipment labeling decals. See Figure 5.

Silk-screen substrates include all types of plastics, fabrics, metals, papers, and other substrates such as leather, masonite, glass, ceramics, wood, and electronic circuit boards. Printing is usually done in short production runs.

Although the stencil image can be transferred manually, it is more common to apply emulsion gelatin or polyvinyl alcohol (PVA) to the screen's surface. The emulsion is spread and hardened. Once the stencil is applied it is exposed to UV light making the emulsion insoluble. The emulsion blocks the pores in the non-image area. For the most part, a water-resistant stencil must accompany solvent-based ink, and a solvent-resistant stencil must accompany water-based ink.

After printing, many facilities reclaim their screens as a cost cutting measure. The residual ink is removed with a solvent. If the image on the screen is not going to be reused, the emulsion is removed with emulsion-dissolving solvents. Emulsion remover is generally sprayed onto the screen then brushed into its pores. After the ink and emulsion have been removed, a ghost image often remains on the screen.

LOSS PREVENTION AND CONTROL

The loss prevention and control guidelines are not all-inclusive and were written with an average hazard level in mind. Increased hazard levels will warrant additional loss prevention and control measures.

Management Programs

Institute adequate loss prevention inspection and audit program and communicate their effectiveness to top management. This management feedback is a key feature of *OVERVIEW*, AXA XL Risk Consulting's total management program for loss prevention and control. In developing a program, pay particular attention to the following important areas:

Housekeeping

Control the accumulation of paper and plastic waste as well as ink residue and starch dusts. If dust generation is excessive, install automatic, properly protected dust collection equipment.

Operator Training Program

Educate all operators in the hazards involved and in functions of the safety control equipment. Forbid deviations from the written procedures.

Pre-Emergency Planning

Develop and maintain a written pre-emergency plan that clearly defines all facets of emergency response and business continuity. *OVERVIEW* may be used to develop a customized plan for the facility.

Preventive Maintenance and Inspection Program

Provide spare parts for key equipment with heavy attrition so that repairs and maintenance can proceed with the plant operating at full capacity. A proper preventative maintenance program with a spare parts program is essential to the continued performance of this equipment.

Inspect and maintain process equipment 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 that includes equipment retirement forecasts. See PRC.1.3.1 for guidance.

Maintain spare parts on the premises for parts expected to wear and require replacement, such as gears, rolls and bearings that are not locally available. Lubricate all presses in a clean and safe manner.

Plant security and surveillance

Restrict access to the site by fencing with guards at all points of access to the property. Provide recorded watchman service in areas that are not constantly attended.

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. Do not operate equipment unless all protection systems are in service.
- Smoking regulations.

Press Protection

Most web-fed rotary press machines use automatic paper splicing to feed successive rolls. Sometimes several rolls of paper are near the machine at one time.

Printing presses, particularly high-speed multicolor machines, represent a significant mechanical exposure. The electric power-supply equipment for the presses may be unique. Solvent recovery equipment involves pressure vessel exposures that must be addressed.

A very significant factor is the close proximity and concentrated high value posed by multiple presses. Minimize the exposure of the entire press area to a single fire. Subdivision by cutoffs will limit the production equipment subject to a single loss.

Operate high-speed presses and maintain them in accordance with the manufacturer's instructions.

If a water-cooled press is used, provide water flow supervision arranged to alarm and shut down operations during cooling water failure.

The following recommendations may be modified, depending upon the inks and solvents handled, the nature of the occupancy near the press, and the degree of protection provided for the press. Limit the number of presses allowed in one area from the standpoint of value and production exposure.

Press Room Construction

Locate presses using highly flammable inks in a separate building or an aboveground room cut off by a 2 psi – 3 psi (0.14 bar – 0.21 bar) explosion-resistant wall having a fire-resistance rating of at least two hours. Locate the room on at least one outside wall to facilitate explosion relief. Arrange explosion venting in accordance with NFPA 68.

Build the floor of the press room of nonsparking, conductive concrete, with enough pitch to allow adequate flammable liquid drainage. If there is a floor above the pressroom, ensure that it is liquid tight.

Provide continuous ventilation of not less than 1 cfm/ft^2 (0.305 $m^3/min/m^2$) of floor area as follows:

- Arrange the ventilation system to remove vapor directly from solvent-wetted surfaces of the presses, even while the presses are stopped.
- Provide a separate room ventilation system along the floor directly under ink fountains and color pans, and throughout spaces to remove flammable vapor-air mixtures that may exist under normal operations. Locate suction pickup within 6 in. (152 mm) of the floor.
- Avoid concealed spaces, but if necessary, continuously vent them to prevent solvent vapor accumulation.

Install noncombustible draft curtains at least 4 ft (1.2 m) deep between presses to help limit the number of operating sprinkler heads.

Storage and Transfer of Flammable Inks and Solvents

In any printing operation, the inks are selected on the basis of the type of paper stock and the printing process. All inks consist of pigment, resin, solvent and additives to enhance drying or to impart special properties to the ink. The resin and solvent mixture is often referred to as the vehicle into which the pigment and additives are mixed.

Letterpress and lithographic inks are fairly stiff. Letterpress inks are in paste form and consist of pigment and drier in an oil base. The ink is worked to the proper consistency and thickness by the press transfer rolls before being transferred to the substrate.

The amount of lithographic inks generally delivered to the substrate are about half of that used in letterpress work, because half the ink remains on the impression roll when it is transferred to the blanket.

Gravure inks, which have the consistency of paint, consist of resin, coloring agent, and solvent. The ink has enough body to be pulled from the engraved wells and it dries mainly by the evaporation of extremely volatile, low flash point solvent. Solvent flash point temperatures of 20°F – 120°F (6.7°C – 49°C) are common. Most gravure inks are Class I flammable liquids and present a severe fire hazard.

Flexographic inks use up to 50% alcohol by volume. This speeds the drying process and allows increased press speeds.

Provide proper electrical equipment, adequate ventilation, and suitable burner location when a high percent by volume alcohol is used.

Store, mix and dispense flammable inks and solvents in a suitably protected flammable-liquid storage room or a detached building in accordance with NFPA 30.

Provide no more than a workday's supply of ink in the press area. Retain a supply for one shift in the press area and store it in approved vented cabinet. Locate the cabinets at least 10 ft (3.0 m) from the presses. When tanks are used, design the piping system with appropriate materials, routing and valving. Evaluate the method of ink transfer. Provide automatic ink supply systems with safety shutoff valves or positive displacement pumps that shut off upon automatic sprinkler, special extinguishing system, or vapor detection operation.

Use safety solvents for cleaning presses. For cleaning hot surfaces, use a liquid with a flash point at least 25°F (14°C) above the surface temperature.

Press Protection

Protect the press room with an approved system of automatic wet-pipe sprinklers. Install sprinklers in the control room, ink storage room, ink mixing room and all concealed spaces or press areas shielded from ceiling sprinkler discharge. Design the sprinkler system in accordance with NFPA 13 and PRC.12.1.1.0 as follows:

- Extra Hazard Group 1 for inks less than or equal to 100°F (37.8°C) flash point. Where the press area is congested, a foam-water sprinkler system would enhance the overall protection.
- Ordinary Hazard Group 2 for inks greater than 100°F (37.8°C) flash point.

Protect presses using inks less than or equal to 100°F (37.8°C) flash point by an automatic fixed-pipe, carbon dioxide extinguishing system with connected reserve in accordance with NFPA 12 and PRC.13.3.1. Design this system to protect all parts of the press, including the ink reservoirs. Arrange carbon dioxide systems to operate automatically by rate-of-rise, rate-compensated detectors. Provide a connected-reserve carbon dioxide supply equipped with a remote manual release.

When local application carbon dioxide protection systems are installed on large press assemblies, they are usually arranged so that various portions of the systems can be operated independently. Such systems require sophisticated logic control that is based on printing press spacing. See Appendix B of NFPA 12 as well as the AXA XL Risk Consulting interpretation in PRC.13.3.1 for appropriate guidance.

Upon system actuation, an alarm should automatically sound and completely shut down the press. Ventilation fans, drive motors, ink pumps, and dryers should stop running and dampers should close.

Extend the carbon dioxide system to include exhaust ductwork, dryers and connecting ductwork, ink mixing and storage rooms, and the control room. Strategically provide carbon dioxide hose reels.

Some newer presses are arranged to accommodate double width sheets. These arrangements make protection piping from press stanchions impractical. To compound this problem, some newer newsprint presses are arranged with vertical stacking of multicolor units. Vertically stacked presses make it easier for fires to spread.

Protect presses using inks greater than 100°F (37.8°C) flash point by automatic sprinklers for areas shielded from overhead sprinkler protection. In addition, provide sprinklers below platforms and in roll paper reel-transfer areas below the presses.

Provide 1 in. (25 mm) hose connections supplied from sprinkler piping. Equip connections with a nominal 1½-in. (40-mm) woven-jacket lined fire hose and adjustable spray nozzles.

Provide adequate portable Class B and C fire extinguishers in accordance with NFPA 10 and located throughout the press room.

Keeps ink mist and dust accumulation in the press area and exhaust ducts to a minimum. Do not let paper scrap, flammable liquids, and cleaning rags accumulate. Lubricate all rotating equipment regularly to reduce heat buildup caused by excess friction.

Maintain excellent housekeeping at all times in the pressroom at presses, ducts, ink troughs, and dryers. Remove dust, lint and ink at least once per shift from the press. Immediately remove waste paper, or “broke” from the press. Keep oily rags in listed safety containers. Keep cleaning agents in approved safety solvents or use high flash point combustible liquids. Do not permit smoking in the pressroom.

Electrical Equipment

The large number of foreign-made presses has introduced electrical equipment that is not listed. Use listed equipment on the presses where listed appliances exist. Install equipment in accordance with NFPA 70. Put large concentrations of cable in conduit or protected them by an approved fire-retardant coating.

When flammable inks are used, protect as follows:

- Use listed Class I, Group D, Division 1 electrical equipment within the press frame.
- Use listed Class I, Group D, Division 1 electrical equipment within a 5-ft (1.5-m) radius, measured from the perimeter of the surface of any ink fountain or color pan.
- Use listed Class I, Group D, Division 1 electrical equipment in areas where vapors accumulate.
- Use listed Class I, Group D, Division 2 electrical equipment around ink fountains or color pans, within a 25-ft (8-m) radius from the vapor source for a height of 3 ft (1 m) above the floor.
- Use listed equipment in accordance with intrinsically safe apparatus, or purged and pressured per NFPA 70, when explosionproof electrical equipment suitable for the Class I areas is not available.
- Maintain electrical equipment in accordance with NFPA 70B and applicable AXA XL Risk Consulting guidelines.
- Maintain spare parts on the premises for nonstandard motor or power supply equipment components.

Because many printing presses are ideal generators of static electricity, it is important to eliminate static charges that may accumulate and become intense enough to ignite flammable vapor.

Electrically ground the entire press framework. Equip the full width of the web at the delivery side of each impression roller and selected points on the press with high-voltage static eliminators or neutralizers to remove nuisance static. Radioactive materials that ionize the air have been used as static eliminators.

Humidification is an effective method of controlling static electricity with high speed printing and working conditions. If used, maintain a 45% – 60% relative humidity. For additional information and guidance refer to NFPA 77.

Drying

Indirect heating is preferred for drying the inks. Locate sources of heat, such as electrical elements, or direct or indirect gas or oil-fired heat exchangers, at least 20 ft (6.1 m) horizontally and 8 ft (2.4 m) vertically from the ink troughs where practical. The dryer burner may be located in the air intake to minimize flammable vapor drawn into the combustion chamber.

Provide a system of combustion safeguard controls and ventilation for dryers in accordance with NFPA 86 and PRC.4.0.1. The dryer ventilation system and associated ductwork prevent vapors from accumulating above 25% of their lower explosive limit.

Provide suitable safety interlocks to shut down the ink pumping system if the press ventilation system fails. Ventilation requirements may be reduced when a vapor detection system using listed equipment is installed. Arrange the system to sound an alarm at approximately 25%, and shut down the press at approximately 50% of the lower explosive limit of the solvent.

Where flammable inks are used, explosions are possible. The fume problem is usually handled in one of three ways: direct exhaust, solvent recovery system, or catalytic fume incineration. The use of direct exhaust is diminishing due to cost of materials and stricter pollution and environmental guidelines. Catalytic fume incinerators are being used more frequently. Protection guidelines for these incinerators can be found in NFPA 86.

Improperly handled fumes could result in an explosion. Such an explosion could cause severe secondary dust explosions resulting from accumulations of starch and paper dust on structural members and on improperly cleaned equipment.

Solvent Recovery

Solvent recovery systems perform successfully in rotogravure printing operations. These systems recover solvents for reuse and reduce the amount of solvents that escape into the room.

In activated carbon solvent recovery systems, solvent-laden air is filtered to remove dust particles and is cooled or heated to its appropriate temperature for optimum absorption. The air is then passed through a vessel containing a bed of activated carbon. The solvent is absorbed and the air is discharged to the atmosphere. When the carbon bed has absorbed the amount of solvent for which it is designed, the supply of solvent-laden air is shut off and steam is introduced into the absorber to release the trapped solvent in a steam mixture. This steam-solvent mixture is condensed and the solvent is separated from the water by specific gravity. Withdrawal of the solvent is by gravity flow. If the solvent is water-soluble, the condensate is directed to a distillation unit or liquid-phase absorber for final separation.

The fire protection requirements of solvent recovery systems will vary depending upon the manufacturer and method of solvent recovery.

When evaluating a system, consider the following recommendations:

- Protect the system of ducts 100 in.^{2} (0.065 m^2) or greater from the press to the solvent recovery system.
- Provide a standard open sprinkler installation controlled by a deluge valve and heat-actuated devices. Expect air flows approximating 80,000 cfm (2240 m^3/min) within this exhaust system.
- When exhaust ductwork is manifolded, use a listed continuous flammable vapor analyzer for each outlet duct of each dryer unit. The system should actuate an alarm at 25% and shut down the press at approximately 50% of the lower explosive limit of the vapor.
- Analyze the solvent vapor at the inlet duct to each solvent recovery unit.
- Provide explosion relief designed in accordance with NFPA 68.
- Provide a system of open sprinklers controlled by a deluge valve within the solvent recovery unit to protect the air filter, carbon bed or absorber, condenser and solvent tank.
- Build and protect pressure vessels against overpressure in accordance with the local laws. See PRC.7.0.5.2 for safety and relief device inspection and maintenance.

Total steam or carbon dioxide flooding of the recovery unit is an acceptable alternative to sprinkler protection.

Consult PRC.9.6.2.2 whenever solvent recovery systems are installed with rotogravure presses.