Strategies for developing comprehensive occupational health programs for the paper industry

James J. Novak and William W. Bosch

ABSTRACT: Occupational health programs are necessary to identify, evaluate, and control the chemical and physical agent hazards found in pulp, paper, and paperboard mills and other paper product manufacturers. Good programs can be developed by combining common sense with regulatory knowledge and technical expertise. High-quality programs will help ensure OSHA compliance, reduce the potential for large financial penalties, criminal prosecution and third-party lawsuits, and provide a healthy workplace. This article reviews the many occupational health standards which impact the paper industry.

KEYWORDS: Hazards, health, OSHA, paper industry, safety, standards.

In this time of increasing governmental regulation, mills and manufacturers of paper products must recognize the benefits of a successful health and safety program. A well developed and maintained program not only provides protection against unfavorable governmental and expensive legal action but can measurably decrease illness and injury rates, reduce insurance premiums, lower operating costs, increase productivity, and improve employee morale. However, even more importantly, no one wants to be injured or see a friend or fellow worker hurt on the job.

Common sense is useful for reducing many plant hazards. However, some hazards are not obvious to the senses. In addition, increasingly numerous and complex regulations imply an enhanced "standard of care" requiring regulatory knowledge and technical expertise.

Industry demographics and OSHA statistics

The Occupational Safety and Health Agency (OSHA) is the regulator of workplace safety and health. However, many "state plan" states enforce federal OSHA or their own equivalent standards to which federal OSHA will, usually, defer. States and Territories under federal jurisdiction and those with "state plans" are listed in **Table I.** OSHA general industry standards are encoded in the Code of Federal Regulations, Title 29, Parts 1901–1910 *(1)*.

OSHA will conduct a workplace inspection in response to an employee or union complaint, referral from another governmental agency, or on a programmed basis. Programmed inspections may be based on statistical industry injury and illness rates or on agency-initiated special emphasis programs aimed at addressing a particular industry or hazard. Pulp, paper, and paperboard mills are high-risk industries and, therefore, are frequently targeted for programmed inspections. Financial penalties for cited violations can be as high as US$ 7000 per serious violation or US$ 70,000 per willful violation.

Table II provides a list of specific sub-industries that comprise the paper industry, as defined for this article, classified by Standard Industrial Classification (SIC) Code *(2)*.

Table III provides frequency of citation data for selected sub-industries, by SIC Code, for the 33 states and territories under federal jurisdiction for the period Oct. 1, 1990, through Sept. 30, 1992. The data includes the 14 most frequently cited violations and others involving hazardous chemicals use. The percent of violations classified as serious, repeat, or willful is also

Novak is a consultant, 812 Sparrow, Lansing, MI 48910. Bosch is an industrial hygienist at the Michigan Department of Public Health, Division of Occupational Health, 3423 North Logan, P.O. Box 30195, Lansing, MI 48909.

shown. It will be beneficial to refer to the table when an OSHA standard, shown in the text as (1910.XXXX), is discussed in this article.

Several violations of the OSHA Act, section 5(A)(1), more commonly called the "general duty clause," are included in Table III. These were issued for the employer's failure to provide a workplace free from a recognized occupational safety or health hazard and include violations for process space entry, heat stress, ergonomic, or other hazards for which OSHA has no applicable standard.

Michigan data indicate the typical paper and pulp mill has more than 250 employees, while paperboard mills and manufacturers of paper products have fewer, usually between 51 and 250 employees. Small employers with less than 50 employees are found in almost all sub-industries. Plant size is an important factor since larger employers are more likely to employ one or more safety professionals to develop and maintain the occupational health and safety programs. Small employers tend to distribute these responsibilities among plant management and technical staff.

General management practices

To succeed, a health and safety program must have genuine commitment from top plant management down to all employees. Management must provide necessary resources, such as money and staff time, to ensure continuing workplace hazard evaluation and control, employee involvement, and effective training. Foremen and supervisors must enforce the programs and lead by example. Employees must actively participate and be constantly alert to potential safety and health hazards in every task. Specialized training in the applicable health and safety programs must be provided to the responsible employees.

In both large and small plants, a properly administered employee safety and health committee is one excellent method to coordinate the ideas and concerns of all organizational members. However, plant management must be responsive to issues raised by this committee or an effective health and safety program will be difficult, at best, to develop.

Managers of small plants (less than 250 employees) may take advantage of consultation and training services provided by OSHA and "state plan" states to: assist the employer in evaluation of employee exposure to workplace conditions, chemicals, and work practices; to correct health hazards; and to establish an effective occupational health program. OSHA's training institute in Des Plaines, IL, can provide training to the private sector in a variety of occupational health and safety program topics. Chemical suppliers, insurance carriers, and private engineering and industrial hygiene consultants also can provide assistance in employee training and program development.

Pulp, paper, and paperboard standard

Pulp, paper, and paperboard mills comprise one of the few industries covered by a comprehensive, industry-specific OSHA standard (1910.261). This standard is the one most frequently cited in pulp, paper, and paperboard mills. Among its many safety and health requirements, the standard:

- Adopts and makes mandatory 27 consensus standards issued by the American National Standard Institute, including requirements regarding ventilation, prevention of sulfur fires and explosions, personal protective equipment, piping identification, and others
- Adopts and makes mandatory: (a) American Society of Mechanical Engineers "Boiler and Pressure Vessel Code, Section VIII"; (b) National Fire Protection Association "Building Exits Code for Life Safety from Fire"; and (c) IME pamphlet "Safety in the Handling and Use of Explosives"
- Sets safe practice requirements for machine guards, lockout, vessel entry, and emergency lighting
- Sets requirements for the following specified pulp processing steps: handling and storage of pulpwood, pulp chips, and other raw materials; preparing pulpwood; rag and paper preparation; chemical processes of making pulp; bleaching; mechanical pulp process; stock preparation; machine room; finishing room; and materials handling.

Hazard communication

The Hazard Communication Standard (1910.1200) requires the implementation of a hazard communication program to include all hazardous chemicals for which a manufacturer or supplier provides a material safety data sheet (MSDS) or which are otherwise determined to be hazardous. MSDS must be readily accessible to the employee. Storage and process vessels, drums, bags, tote containers, piping systems, and other containers that contain a hazardous chemical must be labeled with identity and hazard warning.

Employees must be trained and provided information regarding the written hazard communication program and hazards of chemicals used in the workplace. Training must include the hazards of nonroutine tasks such as process space entry and pipe breaking. Refresher training is recommended, and supplemental training is mandatory whenever a new hazard is introduced to the workplace or when an employee is assigned new tasks for which prior training is inadequate.

Recordkeeping and medical records

Accurate illness and injury records, including the No. 200 (Log and Summary) and No. 101 (Supplementary Record) forms, are OSHA requirements (1004.002). However, even more importantly, accurate records are fundamental to management's full understanding of plant hazards. Thus, records must be periodically reviewed to identify the basic factors causing injury and illness and to determine the

I. State and federal OSHA jurisdictions

"State plan" states and territories

Alaska	Michigan	South Carolina
Arizona	Minnesota	Tennessee
California	Nevada	Utah
Connecticut*	New Mexico	Vermont
Hawaii	New York*	Virginia
Indiana	North Carolina	Virgin Islands
Iowa	Oregon	Washington
Kentucky	Puerto Rico	Wyoming
Maryland		

Federal OSHA states and territories

Alabama	Louisiana	Oklahoma
American Samoa	Maine	Pennsylvania
Arkansas	Massachusetts	Rhode Island
Colorado	Mississippi	South Dakota
Delaware	Missouri	Texas
Florida	Montana	Trust Territories
Georgia	Nebraska	of the Pacific
Guam	New Hampshire	Washington, DC
Idaho	New Jersey	West Virginia
Illinois	North Dakota	Wisconsin
Kansas	Ohio	

*Connecticut and New York plans cover public employees only.

II. Paper industry Standard Industrial Classification codes

SIC code	*description of industry or products*
2611	Pulp mills
2621	Paper mills
2631	Paperboard mills
2652	Setup paperboard mills
2653	Corrugated and solid fiber boxes
2655	Fiber cans, tubes, drums, and similar products
2656	Sanitary food containers, except folding
2657	Folding paperboard boxes, including sanitary
2671	Packaging paper and plastics film, coated and laminated
2672	Coated and laminated, not elsewhere classified (NEC)
2673	Plastics, foil and coated bags
2674	Uncoated paper and multiwall bags
2675	Die-cut paper and paperboard and cardboard
2676	Sanitary paper products
2677	Envelopes
2678	Stationery, tablets and related products
2679	Converted paper and paperboard products, NEC

engineering controls, protective equipment, training, or other controls to be used to eliminate or reduce the causative factor. *Recordkeeping Guidelines for Occupational Injuries and Illnesses (3)* is an excellent publication for answering questions regarding recordkeeping procedures.

Employees have the right to access and copy their occupational medical records including medical diagnoses, test results, and even industrial hygiene data and MSDS. The Medical Records and Trade Secret Standard (1910.20) also provides union representatives access to the medical records of represented employees.

Chemical exposure hazards

The OSHA Air Contaminants Standard (1910.1000) lists chemical concentrations above which employees may not be legally exposed. If a limit is exceeded, feasible engineering controls, referred to as "primary" methods of control, must be implemented. Appropriate respiratory protection also must be provided while primary controls are being installed or if the installed controls do not completely achieve compliance with the limit. Many hazardous chemicals used in the paper industry are listed in **Table IV** along with the applicable OSHA limits and other pertinent data.

The OSHA permissible exposure limit (PEL) is the maximum concentration to which an employee may be exposed, calculated as an eight hour, time-weighted average (TWA). In addition, some chemicals have a short-term exposure limit (STEL), calculated as a 15-minute TWA, which cannot be exceeded at any time during the workday. A ceiling (C) limit, not to be exceeded at any time in the workday, and skin (S) contact restrictions due to potential absorption also are established for selected chemicals. In addition, an employer should comply with the chemical's Threshold Limit Value, published annually by the American Conference of Governmental Industrial Hygienists (ACGIH) *(4)*, which may be lower than the equivalent OSHA contaminant standard.

One additional contaminant limit is important in the planning and response to chemical emergencies. The Immediately Dangerous to Life and Health (IDLH) concentration, set by the National Institute for Occupational Safety and Health (NIOSH) *(5)*, represents the maximum concentration from which, in event of respirator failure, one could escape within 30 minutes without experiencing any escape-impairing or irreversible health effects. Self-contained breathing apparatus, in positive pressure mode, must be used during work in contaminant concentrations exceeding the IDLH.

(Editor's note: See the "enforcement update" sidebar for important information regarding the enforcement of PELs.)

Hazardous chemicals of special note

Experience has documented the serious and sometimes fatal effects of employee exposure to three chemicals that can be encountered at both infrequent and nonpredictable intervals.

Carbon monoxide is an odorless, colorless gaseous by-product of the incomplete combustion of hydrocarbon fuels, such as gasoline and fuel oil, which becomes extremely hazardous in poorly ventilated areas and enclosures. Exposure decreases the blood's oxygen-carrying ability and can cause headache, nausea, weakness, dizziness, rapid breathing, unconsciousness, and death. Periodic source monitoring should be conducted, particularly during cold weather when doors and other openings are closed to conserve building heat, to evaluate carbon monoxide hazards. Routine maintenance of forklift vehicles, gas-fired heaters, and other potential sources effectively controls these hazards.

Hydrogen sulfide gas is generated by the reaction of acid with sulfur bearing materials, liberation in closed containers containing organic matter, and other manners. It acts rapidly as a systemic poison causing respiratory paralysis with consequent asphyxia. Coma may occur after inhalation of a single breath of 1000–2000 ppm and death may be rapid. The risk of acute exposure is high during vessel entry or line breaking and even routine inspection, testing, and maintenance of process vessels that contain sulfide bearing materials.

Asbestos was extensively used into the 1960s for heat insulation on pipes, ovens, furnaces, etc. Chronic asbestos exposure can cause asbestosis, lung cancer, and mesothelioma. Asbestos acts synergistically with cigarette smoke to cause an increased risk of lung cancer in smokers. Disease potential is dependent on the length and severity of exposure. Thus, employees with years of high exposure are most likely to develop asbestos-related disease. Also, the amosite and crocidolite forms are markedly more toxic than the chysotile form. An employer must survey the workplace to determine what pipe insulation and other materials may contain asbestos. All asbestos-containing materials must be clearly identified. Employees must be trained in asbestos hazards and proper removal techniques such as enclosure and wet removal.

Several chemicals encountered in the paper industry have expanded standards which may be cited by OSHA including: asbestos (1910.1001), lead (1910.1025), ethylene oxide (1910.1047), and formaldehyde (1910.1048). Anhydrous ammonia has an applicable safety standard regarding its storage and use (1910.111).

Respiratory protection

Respiratory protection can be effectively used to reduce employee exposure to airborne hazardous chemicals. However, respirators are uncomfortable, they increase stress on the cardiorespiratory system, and their proper use is difficult to monitor and enforce. Thus, respirator use should be limited to the greatest extent possible through contaminant reduction achieved by the use of engineering controls.

If used, the respirator standard (1910.134) requires written standard operating procedures (SOP) be established to govern the selection and use of all respirators including dust masks, cartridge respirators and gas masks, airline masks, and self-contained breathing apparatus (SCBA). The SOP must address the following critical elements of a respirator program:

- Employees must be trained in the use and limitations of their respirators. Training must include a fit test, using an approved qualitative fit test protocol, to ensure good facepiece-to-face seal.
- Respirators must be cleaned and disinfected after each day's use or after each use for a shared respirator.
- Employees should not be assigned work tasks requiring respirator use until a physician determines their physical capacity to perform the task while wearing the respirator. This determination must be periodically repeated. In addition, SCBA use in emergency response operations may be subject to additional medical surveillance requirements.
- All escape-type and 30-minute SCBA units, escape gas masks, and other respirators intended for emergency use must be inspected at least monthly. SCBA inspection must include a determination of proper regulator and low-air warning alarm function. Monthly inspections must be documented.

Additional requirements exist for SCBA use during emergency response, process space entry, or work with highly toxic chemicals such as hydrogen sulfide. For example, SCBA use in a nonemergency response IDLH atmosphere requires two standby persons be stationed to perform a rescue and written procedures covering these work practices.

Process space entry

Entry into tanks, manholes, pits, process, and other confined spaces can be extremely hazardous. A process space that is inadequately ventilated can become nonrespirable, even lethal, due to oxygen deficiency or flammable or toxic contaminants. Examples include: settling of chlorine gas into low spots, rusting of interior steel surfaces, evolution of hydrogen sulfide due to mixing of acid with sulfur-bearing liquid waste, and painting or solvent cleaning fluids inside a tank or other process space.

Deaths in confined spaces are frequent and may involve the would-be rescuers. To prevent confined-space-entry-related fatalities and injuries, OSHA recently published a comprehensive confined-space-entry standard (1910.146) in the Jan. 14, 1993, *Federal Register*. Prior to promulgation of this standard, pulp, paper, and paperboard mill operators would have

III. OSHA violations issued in the paper industry (1991–1992)[a]

OSHA standard reference	Standard subject	Number of violations listed by industry SIC Codes 2611	2621	2631	2653	2657	2671	2675	2679	Industry totals (2611-2679), % Total	S/W/R[b]	Rank[c]
29 CFR 1910.261	Paper, pulp, and paperboard	55	861	74	...	...	...	...	...	1,010	84.2	1
29 CFR 1910.1200	Hazard communication	20	259	44	80	27	23	26	56	734	68.3	2
29 CFR 1910.147	Control of energy sources	8	155	46	41	18	16	14	51	532	80.5	3
29 CFR 1910.219	Mechanical power transmission	3	74	30	70	13	20	20	67	473	94.1	4
29 CFR 1910.212	General machine requirements	7	169	28	44	15	14	13	27	458	91.5	5
29 CFR 1910.305	Wiring methods/components	9	163	10	26	6	17	6	28	347	57.6	6
29 CFR 1910.303	General electrical requirements	8	111	19	23	8	6	7	22	252	67.9	7
29 CFR 1910.106	Flammable and combustible liquids	2	75	10	3	...	15	1	19	181	76.2	8
29 CFR 1910.215	Abrasive wheel machinery	5	48	25	26	...	2	3	14	173	82.1	9
29 CFR 1910.37	Means of egress, general	2	62	8	7	6	1	2	12	158	60.1	10
29 CFR 1910.95	Noise exposure	2	57	7	35	...	...	...	11	154	55.8	11
29 CFR 1904.002	Injury and illness records	1	37	11	21	7	3	4	10	148	4.7	12
29 CFR 1910.157	Portable fire extinguishers	...	50	12	19	6	2	5	12	141	50.4	13
29 CFR 1910.304	Wire design/protection	3	52	6	20	5	5	3	11	136	81.6	14
29 CFR 1910.120	Hazardous waste/emergency response	5	98	...	11	1	2	...	4	131	94.7	16
29 CFR 1910.20	Exposure/Medical records	1	28	12	23	2	3	1	5	110	1.8	20
OSHA Act, 5A1	General duty clause	2	80	5	...	...	1	1	3	104	99.0	21
29 CFR 1910.134	Respiratory protection	1	40	11	8	...	...	...	3	74	59.5	24
29 CFR 1910.132	Personal protection equipment	3	19	4	2	1	5	1	7	63	79.4	26
29 CFR 1910.1000	Air contaminants	...	32	4	2	1	4	2	7	57	89.5	30
29 CFR 1910.38	Emergency action plan	3	12	6	5	1	1	2	9	50	82.0	32
29 CFR 1910.1025	Lead	3	24	2	...	...	...	...	...	39	41.0	38
29 CFR 1910.133	Eye and face protection	...	9	1	3	1	1	2	3	37	78.4	40
29 CFR 1910.141	Sanitation	2	15	...	...	2	...	1	3	32	31.2	41
29 CFR 1910.1001	Asbestos, tremolite, etc.	...	23	1	4	...	...	...	...	28	57.1	42
29 CFR 1910.1048	Formaldehyde	...	20	...	1	...	...	...	...	25	52.0	43
29 CFR 1910.165	Employee alarm systems	1	8	1	...	...	...	1	...	13	92.3	53
29 CFR 1910.156	Fire brigades	...	5	4	...	...	...	...	...	9	77.8	60
29 CFR 1910.111	Anhydrous ammonia	5	...	...	...	...	...	...	...	5	100.0	69
29 CFR 1910.1030	Bloodborne pathogens	...	3	...	1	1	...	...	...	5	100.0	72
29 CFR 1910.1450	Hazardous chemicals in labs	...	3	...	...	...	1	...	...	5	80.0	73
29 CFR 1910.1047	Ethylene oxide	...	...	...	...	...	...	...	...	2	100.0	86
Total number of violations issued[d]		209	3191	492	633	163	162	149	521	7,198	72.9	
Percent S/W/R of total violations[e]		76.6	75.9	76.4	69.5	66.4	69.8	70.8	70.9			

[a]Data source: OSHA Integrated Management Information System (IMIS) from Oct. 1, 1990 to Sept. 30, 1992 for 33 states under federal OSHA jurisdiction
[b]Percent of violations for each standard classified as serious, willful, or repeat
[c]Rank based on frequency of violation for each cited standard from 1 (most) to 98 (fewest)
[d]Includes cited standard violations not listed in table
[e]Percent of total violations for each SIC Code classified as serious, willful, or repeat

Enforcement Update

On March 23, 1993 OSHA announced that the PELs for 376 toxic substances, established in 1989, were no longer legally enforceable after being vacated by the 11th Circuit Court of Appeals in July, 1992. Thus, OSHA will temporarily enforce the 1971 PELs until the situation is corrected, probably through OSHA reform currently being discussed in Congress. In addition, some states will continue to enforce the 1989 PELs. Mill operators should contact their state or federal OSHA office to determine the applicable state or federal enforcement policy for 1919.1000.

been cited for hazards associated with vessel entry under 1910.261, paragraph (b)(5), while other paper product manufacturers would have been cited under the "general duty clause" (OSHA Act, 5A1). Pulp, paper, and paperboard mill operators also must realize that their previous compliance with 1910.261, paragraph (b)(5), does not ensure their compliance with the more comprehensive new standard.

The new confined-space-entry standard requires the workplace be evaluated to identify and catalog all potential confined spaces. Do not attempt to guess which spaces might or might not be subject to a hazardous atmosphere. Most fatalities occur in process spaces which had previously been entered without special precautions or reported undesirable effects. The identified confined spaces then will be classified as either permit- or nonpermit-required spaces. Permit-required spaces must be posted with danger signs.

A written permit space entry program must be developed to assure proper entry and rescue procedures are used during all work activities in permit-required spaces. It is critical that atmospheric monitoring be conducted to evaluate the potential for oxygen deficiency and toxic and flammable vapors both before and during entry. Air is generally defined as nonrespirable if the oxygen content is below 19.5% or above 23.5% (normal is 20.9%), if toxic chemical exposure exceeds any OSHA permissible exposure limit or if flammable vapors exceed 10% of the lower explosive limit. Employees using a hazardous chemical in a confined space are at especially high risk of death or serious injury. For example, toluene, xylene, and other solvents often are fatal to employees when used as cleaning agents in confined spaces.

Natural ventilation of the process space can be achieved by opening the space to the ambient atmosphere. Additional mechanical ventilation must be provided, if natural ventilation is not adequate, whenever oxygen falls below 20.8% or if there is any positive indication of flammable gas. A blower or fan unit is normally used to supply clean outside air to the process space. If possible, entry personnel should use a lifeline and safety harness to facilitate rescue. Trained standby personnel must be present to supervise entry, and proper rescue services must be available. Protective clothing must be used if skin or eye contact with skin absorptive or corrosive chemicals is possible. In addition, be absolutely certain that a nitrogen line is not inadvertently used in place of compressed air to supply airline respirators or for ventilation.

The confined-space-entry standard contains additional safety and health requirements beyond those described in this article. Thus, mills and paper product manufacturers should obtain the standard from their state or federal OSHA office to more fully determine its impact on the workplace. In addition, all energy sources that may impact employees working in the confined space must be properly controlled. The Control of Hazardous Energy Standard (1910.147), also called "lock out/tag out," sets the minimal requirements.

Primary and secondary control technologies

There are several methods to control employee exposure to hazardous chemicals. Primary methods reduce the amount of contaminant generated. For example, a less toxic substance, such as sodium hypochlorite (bleach), can be substituted for a more toxic material, such as chlorine, in water treatment activities.

Dilution and local exhaust ventilation systems commonly are used to reduce airborne concentrations of hazardous contaminants. Dilution ventilation is best used to ventilate a building or production area for employee comfort or control of nonpoint sources such as carbon monoxide generated from fork lift vehicle traffic. Local exhaust ventilation is used to control point sources such as stationary vessels where chemicals are charged. Specific information regarding the design, installation, and maintenance of both general and local exhaust ventilation systems may be found in *Industrial Ventilation—A Manual of Recommended Practice (6).*

Preventive maintenance programs should be used to reduce normal equipment emissions, such as carbon monoxide, to the lowest possible concentrations and to prevent pump, gasket, and other leaks involving hazardous chemicals.

Secondary control methods do not reduce the contaminant concentration; they seek to protect the employee from exposure. Respiratory protection, previously discussed, and protective clothing, commonly used to prevent skin contact with skin absorptive, corrosive, or irritative chemicals, are examples of secondary control. Continuous air monitoring equipment may be used to provide employees with early warning of a toxic chemical release. For example, a monitor may be used to continuously monitor the interior of a chlorine room. Work practices also may be modified to reduce exposure. For example, exposure caused by bag charging of powdered chemicals to a vessel may be effectively controlled by slowing the addition rate or slitting the top of the bag to allow displacement of air into the bag during charging.

Employee rotation or other administrative controls also may be used to reduce exposure. However, rotation is not recommended since it does not reduce the amount of contaminant generated or effectively protect the employee from the exposure. It should be considered only as a last resort.

Noise

The Noise Standard (1910.95) is frequently cited in the paper industry, and an employer must conduct initial monitoring to evaluate employee exposure. All employees exposed to occupational noise at or above the eight-hour TWA of 85 decibels, measured on the A scale, must be in a hearing conservation program. This

IV. Hazardous chemicals used in the paper industries

Chemical name	CAS number	OSHA final rule limits [a] TWA	STEL	Ceiling	Skin note	NIOSH IDLH [b]	Flash [c] point	OSHA TQ [d] lb
Acetic acid	64-19-7	10 ppm	15 ppm	...	...	1,000 ppm	104°F cc	...
Acetic anhydride	108-24-7	...	...	5 ppm	...	1,000 ppm	120°F cc	...
Acetone	67-64-1	750 ppm	1,000 ppm	...	...	20,000 ppm	0°F cc	10,000
Acrolein	107-02-8	0.1 ppm	0.3 ppm	...	...	5 ppm	–13°F cc	150
Ammonia, anhydrous	7664-41-7	...	35 ppm	...	...	500 ppm	Combustible gas	10,000
Ammonia, soln (>44%)	7664-41-7	...	35 ppm	...	...	500 ppm	...	15,000
Asbestos	Varies	0.2 f/cc*	...	...	...	Carcinogen	...	...
Carbon dioxide	124-38-9	10,000 ppm	30,000 ppm	...	...	50,000 ppm	...	...
Carbon disulfide	75-15-0	20 ppm	...	30 ppm	S	500 ppm	–22°F cc	10,000
Carbon monoxide	630-08-0	35 ppm	...	200 ppm	...	1,500 ppm	Flammable gas	10,000
Catechol	120-80-9	5 ppm	...	...	S	...	261°F cc	...
Chlorine	7782-50-5	0.5 ppm	1 ppm	...	...	30 ppm	...	1,500
Chlorine dioxide	10049-04-4	0.1 ppm	0.3 ppm	...	...	10 ppm	...	1,000
Chloroform	67-66-3	2 ppm	...	...	...	1,000 ppm	...	...
Dilauroyl peroxide	105-74-8	...	...	...	...	...	Strong oxidizer	7,500
Ethyl alcohol	64-17-5	1,000 ppm	...	...	...	...	55°F cc	10,000
Ethylene oxide	75-21-8	1 ppm*	...	...	...	800 ppm	<0°F oc	5,000
Formaldehyde	50-00-0	0.75 ppm*	2 ppm	...	...	30 ppm	Flammable gas	1,000
Formic acid	64-18-6	5 ppm	10 ppm	...	...	30 ppm	138°F oc	...
Hydrogen chloride	7647-01-0	...	...	5 ppm	...	100 ppm	...	5,000
Hydrogen peroxide, >52%	7722-84-1	1 ppm	...	...	...	75 ppm	Strong oxidizer	7,500
Hydrogen sulfide	7783-06-4	10 ppm	15 ppm	...	...	300 ppm	Flammable gas	1,500
Methyl acetate	79-20-9	200 ppm	250 ppm	...	...	10,000 ppm	14°F cc	10,000
Methyl alcohol	67-56-1	200 ppm	250 ppm	...	S	25,000 ppm	54°F cc	10,000
Methyl ethyl ketone	78-93-3	200 ppm	300 ppm	...	...	3,000 ppm	20°F cc	10,000
MEK peroxide, >60%	1338-23-4	...	...	0.7 ppm	...	...	Strong oxidizer	5,000
Methyl isobutyl ketone	108-10-1	50 ppm	75 ppm	...	...	3,000 ppm	73°F cc	10,000
Methyl mercaptan	74-93-1	0.5 ppm	...	...	...	400 ppm	Flammable gas	5,000
Nitrogen dioxide	10102-44-0	3 ppm	5 ppm	...	...	50 ppm	...	250
Ozone	10028-15-6	0.1 ppm	0.3 ppm	...	...	10 ppm	Strong oxidizer	100
Phosphoric acid	7664-38-2	1 mg/m^3	3 mg/m^3	...	...	10,000 mg/m^3	...	...
Sodium hydroxide	1310-73-2	...	...	2 mg/m^3	...	250 mg/m^3	...	...
Sulfur dioxide	7446-09-5	2 ppm	5 ppm	...	...	100 ppm	...	1,000
Sulfuric acid	7664-93-9	1 mg/m^3	...	...	...	80 mg/m^3	...	...
Toluene	108-88-3	100 ppm	150 ppm	...	...	2,000 ppm	40°F cc	10,000
Xylene	1330-20-7	100 ppm	150 ppm	...	...	1,000 ppm	84°F cc	10,000

[a]Occupational Safety & Health Administration, 29 CFR 1910.1000
ppm = parts per million
mg/m^3 = milligrams per cubic meter
f/cc = fibers per cubic centimeter
[b]National Institute of Occupational Safety and Health, Pocket Guide (*5*)
[c]National Fire Protection Association, 325M (*10*)
[d]Occupational Safety and Health Administration, 29 CFR 1910.119
*See specific expanded OSHA standard

program requires periodic noise monitoring, audiometric testing and follow-up, hearing protection, and employee training.

Feasible engineering controls must be implemented to reduce noise exposures to below 90 dBA, eight-hour TWA. Primary controls include employee enclosures, noise dampening materials, air mufflers, etc. Noise may be excessive in the following mill areas: debarking, chip preparation, mechanical pulping, paper machine rooms, and finishing rooms. Hearing protection is required for: employees exposed to more than 90-dBA, eight-hour TWA, those who suffer a hearing threshold shift, and those who have not had baseline audiograms.

Abnormal temperature hazards

High temperature and humidity environments may exist for employees assigned to work tasks in the digester area or who operate the recovery boiler and paper machines. Persons who work in such environments may experience heat stress conditions including heat rash, muscle cramps, heat

exhaustion, or even heat stroke. Heat stress symptoms may be mild if promptly evaluated; however, heat stroke may be fatal or permanently debilitating. Due to physiological differences, it is not possible to reliably predict an individual's response to a given combination of environmental conditions and work rates.

OSHA has not adopted a standard for heat stress. However, hazards that can cause occupational heat stroke and other heat related illnesses may be cited under the OSHA general duty clause. Thus, the ACGIH consensus standard for heat stress *(4)* is commonly used to assist in evaluation of the occupational environment. When feasible, insulating materials, temperature controlled enclosures, and other engineering controls should be provided to control heat stress conditions. Other secondary controls may include work/rest cycles, provision of copious amounts of fluids, medical surveillance, and employee training in recognition and treatment of heat stress symptoms.

Employees working in cold climates also must be aware of the potential adverse health effects of exposure to cold temperature and wind chill. These effects can include reduced mental alertness, frost bite, hypothermia, loss of consciousness, and death. Temperature controlled enclosures, insulating work clothing, short periods of exposure, and other controls should be provided to reduce cold-temperature hazards.

Emergency response

The Hazardous Waste Operations and Emergency Response (HazWoper) Standard (1910.120) requires that an emergency action plan be in place in the event of an uncontrolled chemical release. This plan must meet the requirements of 29 CFR 1910.38 (A). Additionally, an emergency response plan must be established to protect all employees allowed to take defensive (contain/control release) or aggressive (stop release) actions beyond evacuation. Employees may respond to "incidental releases" which do not cause a health or safety hazard and do not need to be cleaned up immediately to prevent death or serious harm. However, response to incidental releases must be detailed in the emergency action plan as required by the process safety management standard.

If left unattended, chlorine leaks invariably get worse; delay can cause a bigger emergency that might be prevented by prompt action. Consequently, most mills should consider some emergency response capability, such as use of a chlorine cylinder capping kit, in addition to the evacuation of nonessential personnel. If defensive or aggressive emergency response actions are taken, the HazWoper standard requires: a written emergency response plan, use of the Incident Command System (ICS) at a response scene, employee training and certification of their competency, medical surveillance and consultation, selection and provision of proper chemical protective clothing, and specific procedures for post-emergency response operations.

The standard specifies training for five knowledge and skill levels, and employees are not permitted to participate in an emergency response without prior training at their assigned response level. The knowledge and skill levels are:

- **First responder awareness level** is the minimum training required for any employee likely to witness or discover a release of a hazardous chemical. These employees must be able to recognize when to initiate the emergency response, make the proper notifications, and then take no further action except to evacuate.
- **First responder operations level** training is required for employees whose function is to contain the release from a safe distance without trying to stop the release. Their response is strictly defensive, designed to keep the release from spreading. These employees must receive at least eight hours of classroom training or have sufficient experience to objectively demonstrate competency in several specified knowledge and skill areas and in the awareness level.
- **Hazardous materials technician level** training is required for employees who function as Haz-Mat team members to approach the point of release to plug, patch, or otherwise stop the release. These employees must receive at least 24 hours of classroom training and demonstrate competency in additional knowledge and skill areas beyond those previously described.
- **Hazardous materials specialist level** training is required for employees who provide support to technicians by virtue of more directed or specific knowledge of the various chemicals the team may be called upon to contain. The training of specialist-level employees is similar to the technician's, but the knowledge requirement is more in-depth and scientifically focused.
- The ICS requires an **on-scene incident commander**, who will assume control of the site once the emergency response effort begins. Incident commanders must receive at least 24 hours of classroom training at the operations level and demonstrate competency in specified knowledge and skill areas.

Employees who trained beyond the awareness level must be employer certified as competent to perform their assigned duties. Certification methods may include written tests and simulated emergency drills. Annual refresher training must be provided. Trainers must be academically qualified and complete a train-the-trainer course such as those offered by the National Fire Academy.

Occupational exposure to the Human Immunodeficiency Virus (HIV) and Hepatitis B Virus (HBV) can occur during first aid. If exposure occurs, the Bloodborne Pathogens Standard (1910.1030) requires a written exposure control plan be in place. The plan must describe all protective primary and secondary measures taken to reduce or eliminate exposure

such as engineering controls, work practices, protective garments, special handling procedures for contaminated wastes and laundry, decontamination procedures, HBV vaccinations, etc.

Process safety management of highly hazardous chemicals

The Process Safety Management of Highly Hazardous Chemicals (PSM) Standard (1910.119) applies to specific chemicals processed in an amount above a listed threshold quantity. The standard's purpose is to prevent catastrophic release and to reduce potential harm to employees if a release occurs. The standard applies to processes that use many common bleaching agents including chlorine, chlorine dioxide, ozone, and hydrogen peroxide. Flammable chemicals, those with a flash point less than 37.8°C (100°F), also are covered if used in a process. The threshold quantity for many highly hazardous chemicals is listed in Table IV.

The PSM standard requires an employer to:

- Seek employee participation in all elements of the plant's PSM program in accordance with a written plan
- Compile detailed process safety information regarding hazardous chemicals, process technology, and equipment
- Conduct a process hazard analysis for each process that involves one or more highly hazardous chemicals
- Develop written standard operating procedures for all phases of process operation (routine, startup, shutdown, etc.)
- Provide initial and refresher training to plant operators
- Audit and inform contractors with employees working on or near a process covered by the standard
- Conduct prestartup safety reviews for new or substantially modified processes
- Implement a mechanical integrity program for process equipment
- Use a hot work permit system
- Establish a "management of change" program
- Promptly investigate release incidents (including potential releases) and implement necessary corrective measures
- Implement an emergency action or response plan
- Periodically conduct impartial and comprehensive compliance audits.

Most requirements were effective on or before Aug. 26, 1992. Requirements to complete detailed process safety information and hazard analysis are being phased in over a two- to five-year period for plants with more than one covered process. An employer with a single process is required to complete the hazard analysis by May 26, 1994. All covered employers must initiate the analysis as soon as possible. Thus, OSHA violations for inadequate hazard analysis may be cited before the end of the phased compliance date.

Many PSM requirements are not new to mill operators. However, process hazard analysis may be unfamiliar and may require additional expertise. *Guidelines for Hazard Evaluation Procedures—2nd Edition with Worked Examples*, published by the American Institute of Chemical Engineers (AIChE), Center for Chemical Process Safety *(7)* is an excellent reference. AIChE also can provide several other excellent reference books, videos, and training courses on process safety issues. In addition, two OSHA publications *(8, 9)* are available to assist in compliance.

The PSM Standard was promulgated by mandate of Congress when the Clean Air Act Amendments of 1990 (CAAA) were passed. Also included in the CAAA, primarily enforced by the Environmental Protection Agency (EPA), are requirements for Risk Management Plans, which, to a great extent, overlap process safety management plans. Therefore, compliance with the OSHA standard will lessen the effort needed to comply with EPA's risk management requirements when they are eventually promulgated.

Summary

Comprehensive and well developed and administered occupational safety and health programs are not a luxury in today's business climate. Mills and other paper product manufacturers must actively work, on a daily basis, to comply with OSHA standards. This article reviewed occupational health issues pertinent to the paper industry which must be evaluated to prevent injury and illness. Employers may contact their state or federal OSHA office for further information and compliance assistance.

Literature cited

1. *Title 29, Code of Federal Regulations, Parts 1901–1910,* U.S. Government Printing Office, Washington, DC, 1991.
2. *Standard Industrial Classification Manual,* National Technical Information Service, Springfield, VA, 1987.
3. *Recordkeeping Guidelines for Occupational Injuries and Illnesses,* U.S. Department of Labor, Washington, DC, 1986.
4. *1992–1993 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,* American Conference of Governmental Industrial Hygienists, Cincinnati, OH, 1992.
5. *Pocket Guide to Chemical Hazards,* U.S. Department of Health and Human Services, National Institute of Occupational Health, Washington, DC, 1990.
6. *Industrial Ventilation—A Manual of Recommended Practice, 21st edn.,* American Conference of Governmental Industrial Hygienists, Cincinnati, OH, 1992.
7. *Guidelines for Hazard Evaluation Procedures, 2nd edn. with Worked Examples,* American Institute of Chemical Engineers, Center for Chemical Process Safety, New York, 1991.
8. *Process Safety Management,* OSHA Publication No. 3132, U.S. Department of Labor, Washington, DC, 1992.
9. *Process Safety Management Guidelines for Compliance,* OSHA Publication No. 3133, U.S. Department of Labor, Washington, DC, 1992.
10. *Fire Protection Guide on Hazardous Materials, 9th edn.,* National Fire Protection Association, Quincy, MA, 1986.

The authors are grateful to Robert Clark of the Michigan Department of Public Health for producing the data used to compile Table III.

Received for review Dec. 17, 1992.

Accepted March 27, 1993.