	Lethal dose (for 50% of population): Rats (oral): 550 mg/kg Lethal concentrations for inhalation (for 50% of population): Rats: 104 ppm for 4 hours Guinea pigs: 50 ppm for 4 hours
Permissible exposure limits	OSHA PEL: 8-hour time-weighted average (TWA): 0.5 ppm
Physical data	Clear, colorless, fuming liquid Melting point: –111.8°C Boiling point: 76°C Density: 1.574 at 21°C Vapor pressure: 100 mm of mercury at 21°C Vapor density: 4.75
Reactivity data	Highly reactive with a variety of acids, oxidizers, and even water or steam. Fire and explosion hazard
Corrosivity data	Department of Transportation Classification: corrosive material
Thermal and chemical stability	Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and PO_x. Can react with oxidizing materials
Hazardous mixing	Potentially explosive with nitric acid, sodium peroxide, oxygen (above 100°C). Violent reaction with water evolves hydrogen chloride and diphosphane gas, which then ignite. Will react with water, steam, or acids to produce heat and toxic corrosive fumes

Case Study 6.1 was used to show how published data in chemical reference volumes can be used to provide the data necessary for analysis of hazardous processes. Not all data contained in reference volumes are required. For instance, in Case Study 6.1 under the category "hazardous mixing," only those materials that could foreseeably be inadvertently mixed with the hazardous chemical in the process under study are included.

Beyond the properties of the chemicals used in the process, OSHA wants employers to document the technology of the process, including at least a block flow diagram (Figure 6.1) or a simplified flow process diagram (Figure 6.2). In addition, process chemistry data, maximum intended inventory, and safe upper and lower limits for temperatures, pressures, flows, or compositions must be provided. Any deviations from the standards of the process that might affect the safety and health of employees

safety standard, OSHA has been shown to adopt an aggressive definition of the word "process." Thus, a poultry processing plant, for example, can be seen to be covered by the process safety standard, because its process might employ chlorine for refrigeration, a dangerous chemical. Even a discrete-items manufacturing plant, might employ dangerous acids in its plating operations and thus fall under the scope of the process safety standard because it processes or stores a dangerous chemical in excess of a threshold amount.

PROCESS INFORMATION

In Chapter 5, the growing influence of information systems on the field of industrial safety and health was emphasized. This influence was evident in the content of OSHA's process safety standard. Before any analysis of the process is to begin, OSHA requires the employer to compile information on the highly hazardous chemicals to be used or produced by the process, the equipment to be used in the process, and the technology of the process itself. It is clear that OSHA's intent is for this information to be available to the union or other employee representative at the plant.

The safety and health manager (or whomever has been designated to deal with process safety hazards and standards) should first address the problem of where to find information about the chemicals used in the process. In Chapter 5, we studied the primary document of information regarding chemicals used within an industrial plant, and that document is the MSDS. The MSDS may provide all information necessary to comply with process safety requirements, but if it does not do this, the safety and health manager can turn to standard reference volumes on the properties of hazardous chemicals. The safety and health manager can win the confidence of the committees or teams of engineers, employees, and employee representatives assigned to analyze a hazardous process by knowing these standard reference volumes and relying on them when advising the analysis team. Following are a few of the popular standard references regarding hazardous chemicals:

- Irving Sax, *Dangerous Properties of Industrial Materials* (Sax, 1975)
- Robert E. Lenga, *Sigma-Aldrich Library of Chemical Safety Data*
- Gessner G. Hawley, *The Condensed Chemical Dictionary* (Hawley, 1975)
- *NIOSH Registry of Toxic Effects of Chemical Substances*

These references were used in the development of Case Study 6.1.

CASE STUDY 6.1

HAZARDOUS CHEMICAL INFORMATION FOR PROCESS SAFETY ANALYSIS

Name of chemical	Phosphorus chloride (PCl_3), sometimes known as *phosphorus trichloride*
Toxicity information	Poison by inhalation. Moderately toxic by ingestion A corrosive irritant to skin, eyes (at 2 parts per million (ppm)), and mucous membranes