



Industrial Process Hazard Analysis: What Is It and How Do I Do It?

At *Eyes on China* we believe very seriously in our own Corporate Social Responsibility and that of our clients. We advise new investors to pay strict attention to the health, safety and environmental impact of their new manufacturing investment in China.

***Eyes on China* will assess their client's needs to meet all regulatory and compliance requirements. Here is a brief discussion of one of the most critical components of an Industrial Process Safety Management philosophy.**

Hazard and Risk

A **hazard** is defined by the United States Federal Airline Authority (FAA) as "*a condition, event or circumstance that could lead to or contribute to an unplanned or undesirable event.*" Seldom does a single hazard cause an accident. More often, an accident occurs as the result of a sequence of causes. A hazard analysis will consider system state, for example operating environment, as well as failures or malfunctions.

Assessment of **risk** is made by combining the severity of consequence with the probability of occurrence in a table or matrix. Risks that fall into the "unacceptable" category (high severity and high probability) must be mitigated by some means to reduce the level of safety risk. While in some cases safety risk can be eliminated, in most cases a certain degree of safety risk must be accepted and different industries will have statutory guidelines.

What is Process Hazard Analysis?

Process Hazard Analysis (PHA) is a set of organized and systematic assessments of the potential hazards associated with an industrial process. A PHA provides information intended to assist managers and employees in making decisions for improving safety and reducing the consequences of unwanted or unplanned releases of hazardous chemicals. A PHA is directed toward analyzing potential causes and consequences of fires, explosions, releases of toxic or

flammable chemicals and major spills of hazardous chemicals, and it focuses on equipment, instrumentation, utilities, human actions and external factors that might impact the process. In many cases, an additional benefit of conducting a full PHA is a more thorough understanding of the industrial process, thus leading to opportunities for improving process efficiency and cost reduction.

PHA is a key component of a Process Safety Management (PSM) philosophy. Other critical areas of PSM include: employee involvement, employee and contractor training, pre-commissioning safety review, management of change, incident review, emergency planning and response and compliance audits.

Mandated Requirement

The use of PHA is mandated by the **United States Occupational Safety and Health Administration** (OSHA) for the identification of risks involved in the design, operation and modification of processes that handle hazardous materials and conditions. An agency of the United States Department of Labor, OSHA was created by Congress in 1970. PHA has been an integral part of OSHA Occupational Safety and Health Standards since 1992.

The European Union also has statutory requirements for PHA. The **European Agency for Safety and Health at Work** (also known as OSHA) was set up in 1996. Its mission is to make Europe's workplaces safer, healthier and more productive. This is done by bringing together and sharing knowledge and information, to promote a culture of risk prevention within the Member States. Much of the pioneering work in defining systematic methodologies for hazard analysis was conducted many years earlier in the 1970s by Imperial Chemical Industries in the UK.

While not mandated to the same degree, there should be no question about whether or not to conduct PHA as a new investor in China. As part of a Process Safety Management philosophy, Process Hazard Analysis saves lives, protects the environment and offers opportunities for manufacturing efficiency improvements. Simply put, PHA allows the employer to: determine locations of potential safety problems, identify corrective actions to improve safety and pre-plan emergency actions to be taken if safety controls fail.

How is the PHA Carried Out?

The PHA must be conducted in the following manner:

- Use one or more established methodologies appropriate to the complexity of the process
- Performed by a team with expertise in engineering and process operations
- Include personnel with experience and knowledge specific to the process being evaluated and the hazard analysis methodology being used

The PHA must address the following:

- The hazards of the process
- Identification of previous incidents with likely potential for catastrophic consequences

- Engineering and administrative controls applicable to the hazards and their interrelationships
- Consequences of failure of engineering and administrative controls, especially those affecting employees
- Facility siting and human factors
- The requirement to promptly resolve PHA findings and recommendations

A Variety of Methodologies for PHA

Depending on the complexity of the industrial process, there are a variety of different methodologies to consider:

- What-if
- Checklist
- What-if/Checklist
- HAZOP (Hazard and Operability Study)
- FMEA (Failure Mode and Effect Analysis)
- Fault-Tree Analysis

Here is a brief explanation of each methodology:

“What-if”

Method: Experienced personnel brainstorm a series of questions that begin with “What if...?” Each question represents a potential failure of the process or unplanned operation of the process. The response of the process and/or operators is evaluated to determine if a potential hazard can occur. If so, the adequacy of existing safeguards is weighed against the probability and severity of the scenario to determine whether modifications to the system should be recommended.

Summary:

- Perhaps the most commonly used but least structured methods
- Can be used in a wide range of circumstances
- Success highly dependent on experience of the analysts
- Useful at any stage in the facility life cycle
- Useful when focusing on change review and control

“Checklist”

Method: Consists of using a detailed list of prepared questions about the design and operation of the facility. Questions are usually answered “Yes” or “No” and used to identify common hazards through compliance with established practices and standards. Categories of questions include causes of accidents through equipment failure, human error and external or environmental events. Also addresses facility issues such as alarm systems, construction materials, instrumentation and control systems and training and documentation.

Summary:

- The simplest and easiest to use analysis, easily adjusted for different levels of detail
- Provides quick results and allows effective communication of information.
- Creativity not encouraged, therefore not helpful in identifying new or unrecognized hazards
- Should be prepared by experienced engineers
- Its application requires knowledge of the system/facility and its standard operating procedures
- Should be audited and updated regularly

“What-If/Checklist”

Method: A hybrid of the What-If and Checklist methodologies, combining the brainstorming of What-If method with the structured features of Checklist method.

Summary:

- Encourages creative thinking with a structured approach

“HAZOP”

Method: Addresses hazards (safety, health, environmental) and problems affecting operability. A single piece of equipment or process vessel is chosen, its purpose and mode of operation discussed and then *guideword* are used to ask questions about any potential *deviation* to the mode of operation.

Summary:

- A rigorous and structured analysis which is also flexible
- Forces creativity and open-mindedness
- Identifies safety *and* operability issues (time consuming)
- Relies on having the appropriate people in the room
- Does not distinguish between low probability, high consequence events (and vice versa)

“FMEA”

Method: A bottom-up analysis to determine the consequences of component, module or subsystem failures. Consists of a spreadsheet where each failure mode, possible causes, probability of occurrence, consequences, and proposed safeguards are recorded.

Summary:

- A very structured and reliable method for evaluating hardware and systems.
- Easy to learn and apply, even for the evaluation of complex systems.
- Can be very time-consuming (and expensive) and does not readily identify areas of multiple faults or human errors that may occur.

“Fault-Tree Analysis”

Method: A graphical, top-down analysis that starts with a hazardous event and works backwards to identify the causes of the preceding event. Intermediate events related to the preceding event are combined by using logical operations such as AND and OR.

Summary:

- Provides a traceable, logical, quantitative representation of causes, consequences and event combinations
- Ideal for analysis of software
- Not intuitive, requires training
- Not useful when dealing with time-based activities

How Can *Eyes on China* Assist the New Investor in China?

Whether you are conducting an initial PHA or revalidating or updating the original PHA, perhaps carried out on a similar process in a different location, *Eyes on China* will guide you through the costs and benefits of each approach and help you assess the appropriate methodology for your specific industrial process requirements.

No PHA method can identify all accidents that could occur in a process: even with experienced guidance on which methodology to use, how to use it and rigorous screening of team members, it is possible that some accident scenarios may be missed or judged insignificant. *Eyes on China* will ensure your company, your employees and the environment receive maximum benefit from this hazards assessment by supporting you with highly skilled and experienced facilitators employing rigorous techniques. Inexperienced team members will be trained in the methodology; all aspects of the process will be fully documented; updating and revalidating will become a routine element of your Process Safety Management philosophy.

Remember: Companies that rigorously exercise PHA are seeing a continuing reduction in frequency and severity of industrial accidents and *Process Hazard Analysis* will continue to play an integral role in the design and continued examination of the safety of industrial processes.