Process Safety Information for *Explosives*

Focus Article

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Process Safety Management (PSM) was promulgated by OSHA in the 1990s to incorporate into general chemical industry practice many of the self-imposed concepts and rules that the leaders of the explosives industry were using to be among the safest of all industrial workplaces. Key to the entire concept of PSM is a clear and accurate understanding of the process materials. Process materials include ingredients, key intermediaries, and final products.

Without accurate and adequate understanding of the process materials, assumptions and rules of thumb replace engineering analyses and informed decisions. These substitutes may appear to work for a while, but sooner or later they'll fail. In today's marketplace, products change, processes are updated, and faster and less-expensive options are implemented. And without a sound understanding of the energetic material characteristics, risk management will be lost in the shuffle. Lost product, lost facilities, lost contracts, injuries, or loss of life may result.

Complacency

One of the biggest hazards in our industry is complacency. Years can pass without a serious incident. This is good! But then, people forget why the various safety requirements were implemented in the first place. Sometimes, new employees don't appreciate the catastrophic nature of the hazards that surround them. Changes in procedures, in process techniques, and in products proceed without a stringent review. Management, line operators, process engineers, and even safety professionals are all prone to fall into a deep safety-sleep. Complacency can rapidly turn a first-rate facility into an accident waiting to happen.

Complacency often creeps in along several well-worn paths. These paths include:

- Superficial review of new and existing procedures
- Designs and decisions based on assumptions instead of on data-based hazards analyses
- Lax housekeeping and maintenance, including failing to verify the adequacy of grounding systems in buildings, bag houses, filters, etc.
- Overreliance on production or on process engineering teams for safety analyses, audits, and reviews
- Failure to generate and maintain the data required for an adequate understanding of the hazards

Procedure Reviews

PSM requires that all new covered processes have a written procedure. A preliminary process hazard analysis (PHA) should be done in conjunction with the process design phase in order to avoid costly redesign and program delays, which are inevitable when safety concerns with the original concept are discovered late in the implementation stage. For example, a preliminary PHA could identify concerns that simple changes in the choice of processing materials or energetic components can resolve. An update of the PHA should be completed when the process design and procedure are finalized. A final operational PHA should include a pre-startup review and a detailed safety review of the functioning process and actual process procedures. Periodic safety audits, safety reviews, and on-going effective management of change will keep the operation safe and efficient. At least every five years, the PHA should be reviewed in order to build upon the original PHA. It must also include a review of incidents or accidents that have occurred in the process. Lessons learned should be formally captured and incorporated into the PHA and related procedures, as appropriate. This is also an ideal time to verify that the other PSM elements are still active in the process. PSM elements, such as mechanical integrity, management of change, and training, should be reviewed, as they relate to the process. Ineffective or skimmed-over procedure reviews for energetic processes are a sure sign of complacency in an explosives manufacturing facility.

Process Safety Data

There are several basic sets of data a company needs for its energetic products. These include performance data, reliability data, lot acceptance tests, supplier specifications, and various quality- control parameters that will assure a consistent product and reliable and safe use. Companies will often go to great lengths to obtain this type of data and the associated analysis because their viability as a business often depends on it. Even small changes in the product or process are often accompanied by a new round of qualification tests to confirm that the end product has either remained the same or been improved—but not degraded.

Similarly, there are several sets of basic safety data a company must have in order to establish and maintain safe and efficient operations. These include sensitivity, reactivity, and stability data. Specific tests to provide some of this data may be prescribed, such as the UN Tests for the Transport of Dangerous Goods, and related tests required by the Department of Transportation. Similarly, the military, ATF, and other regulatory or contractual entities may prescribe data based on specific standards, methods, or protocols. Often, this test data is vital to proper site-planning, storage, determination of manufacturing parameters, in-process classification, etc.

Putting It All Together

A process hazards analysis has been described as "the accident investigation before the accident." It is in the development of a PHA that appropriate data needs are often identified, and all the pieces of data come together. By evaluating

the energetic material's sensitivity, reactivity, in-process potentials, workstation protection, engineered controls, procedural controls, and other process parameters, as one whole system, the what-ifs, failure modes, and effects, flow diagrams, and fault trees, as appropriate, bring into focus the hazards and effects when the process does not function as planned. A simple process, normally, requires only a correspondingly simple PHA. A very complex process may require all the tools a team of qualified hazards analysts have to offer. In either case, an effective final PHA is a data-based, real-world, as-built, and as-used analysis.

At times, a company may fail to recognize or appreciate the benefits of adequate process safety data. This may be evident due to a reliance on assumptions-based hazards analysis, sketchy material data, or even "gut feel". Some may fail to recognize the risk-management benefits of an effective process safety program. These benefits become realized on the corporate bottom line as avoided costs and greater ability to implement value-added improvements. When accidents or other destructive incidents happen, the same people that tend to resist and excuse adequate process safety also tend to say things like "It was something that no one could have foreseen and prevented."

Usually, foresight requires more thought and understanding of the total process or situation than hindsight. But it is well worth the cost, when compared with the costs of investigating and cleaning up a catastrophe, rebuilding facilities and lost business, and the human cost in the loss of well-being or even lives.

Examples of Common Explosives Testing

So what data is needed in order to conduct a thorough PHA? That depends on the process, the energetics or other hazardous materials involved, the quantity of material involved, the potential for a catastrophic event, or risk-management goals, etc.

Here are some examples. (Often, a test fits in more than one category—in which case, the choice shown below may be somewhat arbitrary.)

Sensitivity Tests	Reactivity Tests	Thermal/Stability Tests
Impact Sensitivity (TIL, Screen, Time-Pressure PROBIT)	Time-Pressure	Differential Scanning Calorimeter (DSC)
Friction (TIL, Screen, PROBIT)	Deflagration to Detonation Transition	Accelerated Rate Calorimetry (ARC)
ESD (TIL, Screen, PROBIT)	Internal Ignition	Simulated Bulk Acceleration Temperature
Critical Height (to explosion or detonation)	Koenen	Thermal Stability
Critical Diameter (detonation propagation)	Vented Pipe	Heat of Combustion
Card Gap	Single Package	Self-Accelerating Decomposition Temperature, SADT
Dust Explosibility (minimum energy, minimum concentration)	Stack (Propagation)	Self-Heating Substances
Dielectric Strength	Bullet Impact	Vacuum Stability
Thin Layer Propagation	Slow Cook-Off	Compatibility
Cap Sensitivity	TNT Equivalency	Henkin Time-to-Explosion

DEKRA Process Safety

The breadth and depth of expertise in process safety makes us globally recognized specialists and trusted advisors. We help our clients to understand and evaluate their risks, and work together to develop pragmatic solutions. Our value-adding and practical approach integrates specialist process safety management, engineering and testing. We seek to educate and grow client competence to provide sustainable performance improvement. Partnering with our clients, we combine technical expertise with a passion for life preservation, harm reduction and asset protection. As a part of the world's leading expert organization DEKRA, we are the global partner for a safe world.

Process Safety Management (PSM) Programs

- Design and creation of relevant PSM programs
- Support the implementation, monitoring, and sustainability of PSM programs
- Audit existing PSM programs, comparing with best practices around the world
- Correct and improve deficient programs

Process Safety Information/Data (Laboratory Testing)

- Flammability/combustibility properties of dusts, gases, vapors, mists, and hybrid atmospheres
- Chemical reaction hazards and chemical process optimization (reaction and adiabatic calorimetry RC1, ARC, VSP, Dewar)
- Thermal instability (DSC, DTA, and powder specific tests)
- Energetic materials, explosives, propellants, pyrotechnics to DOT, UN, etc., protocols
- Regulatory testing: REACH, UN, CLP, ADR, OSHA, DOT
- Electrostatic testing for powders, liquids, process equipment, liners, shoes, FIBCs

Specialist Consulting (Technical/Engineering)

- Dust, gas, and vapor flash fire and explosion hazards
- Electrostatic hazards, problems, and applications
- Reactive chemical, self-heating, and thermal instability hazards
- Hazardous area classification
- Mechanical equipment ignition risk assessment
- Transport & classification of dangerous goods

We have offices throughout North America, Europe, and Asia.

For more information, visit www.dekra.us/process-safety

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