

PROCESS SAFETY ISSUES FOR SMALL BUSINESSES

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Many process safety incidents in small- and medium-sized enterprises (SME's) can be traced to lack of knowledge or appropriate worker training. Most SME's do not have sufficient resources or technical staff with detailed process safety knowledge. The technical staff in SME's usually wear several hats, with process safety, environmental, health, quality assurance, and perhaps even operational or maintenance responsibilities.

How does the small business technical staff gain process safety information in today's fast changing regulatory climate? It is not from formal courses (as they take too much time away from the plant even if they were affordable). It is not from the outreach programs of the regulatory agencies as their information is either too "legalese", too general or incomprehensible to the focused technician. Sometimes biased information is provided by equipment vendors or incomplete local news coverage. Delivering the appropriate process safety information to the worker or designer who most needs the information is the challenge of modern safety profession.

Tell me, I may forget

Show me, I may remember

Involve me and I will understand.

While we get caught up in the latest technologies to deliver information, the above adage must be remembered to be effective. For small businesses with their focused needs, directly applicable information, with no time wasted on abstract concepts, is the requirement.

INTRODUCTION

The implementation of the requirements of Process Safety Management (PSM) to a small chemical business is a substantial task that can easily overwhelm the resources of a small chemical plant or other small business that utilizes chemicals. Small and in many cases medium-sized enterprises do not have the technology and manpower resources of larger organizations which limits their ability to implement a complete and effective Process Safety Management program.

In 1999, the Mary Kay O'Connor Process Safety Center conducted a study on "Y2K Readiness of Small and Medium-sized Enterprises (SME's) involved in chemical, petrochemical, refining, and offshore petroleum activities." The complete results of the survey and study are available elsewhere¹; however, an overwhelming majority of the respondents (79%) reported that they had never been surveyed for a Y2K readiness survey or any other similar surveys. Almost all of the SME's surveyed either did not belong to any organized professional/trade association, or participated nominally in some regional

or nominally active professional/trade association. These findings point towards a problem much more fundamental and far-reaching than the Y2K issue. SME's are, in general, far-removed from technology advances, basic information and know-how, and access to technical and financial resources. While the turn of the century did pass without any particular Y2K-related safety problems, these specific findings point to a societal and industry problem that can only be mitigated or solved through industry/government collaborative efforts. Long-term nation-wide programs to bring SME's up to par with respect to chemical safety as well as other related technologies are needed. This consideration has ramifications with respect to a healthy economy and product stewardship.

The problem is of resources, technology or lack thereof, and sometimes a lot of confusion sprinkled among some information. One example is Material Safety Data Sheets (MSDS's). While MSDS's are the primary source of hazard information, for SME's even using MSDS's becomes a challenging and prohibitive task. The reason is that most of the time MSDS's are written with so many caveats that they make everything seem possibly very hazardous with little real guidance or perspective. This is a generic problem faced by SME's with respect to almost everything because there is an almost infinite amount of information, which have impact on the regulations that apply directly to their businesses but they probably have no idea where to start or what's important.

WHAT DO INCIDENT INFORMATION AND DATABASES TELL US

Under the Risk Management Program (RMP) regulation² of the US Environmental Protection Agency (EPA), regulated facilities must report all incidents meeting specified criteria to the EPA. The five-year accident history covers all incidents involving regulated substances, but only from covered processes at the source that resulted in serious on site or certain known offsite impacts in the five years prior to the submission of the RMP. Even though the five-year accident history database covers a very narrow range of incidents, analysis of the five-year database available for the period 1994–1999 provides some interesting conclusions. It is interesting to note that even within RMP which has fairly high threshold quantities that about half the facilities are chemical users not manufacturers. Figure 1 shows a plot of consequences as a function of full-time employees (FTE), which shows that the severity of consequences for SME's is about the same as for larger companies. Further analysis of the RMP five-year accident history database shown in Table 1 indicates that SME's with 1 to 25 employees have 47 times more releases per employee than those with 1,500 or more employees. In addition, the SME's with 1 to 25 employees have 17 times more injuries per employee than organizations with 1,500 or more employees. This implies that employees at SME's are at greater risk of exposure to a release than those at large facilities.

According to statistics from the Occupational Safety and Health Administration (OSHA), the federal agency charged with regulating health and safety in the workplace, small business's top OSHA headaches, the standards cited most often in manufacturing

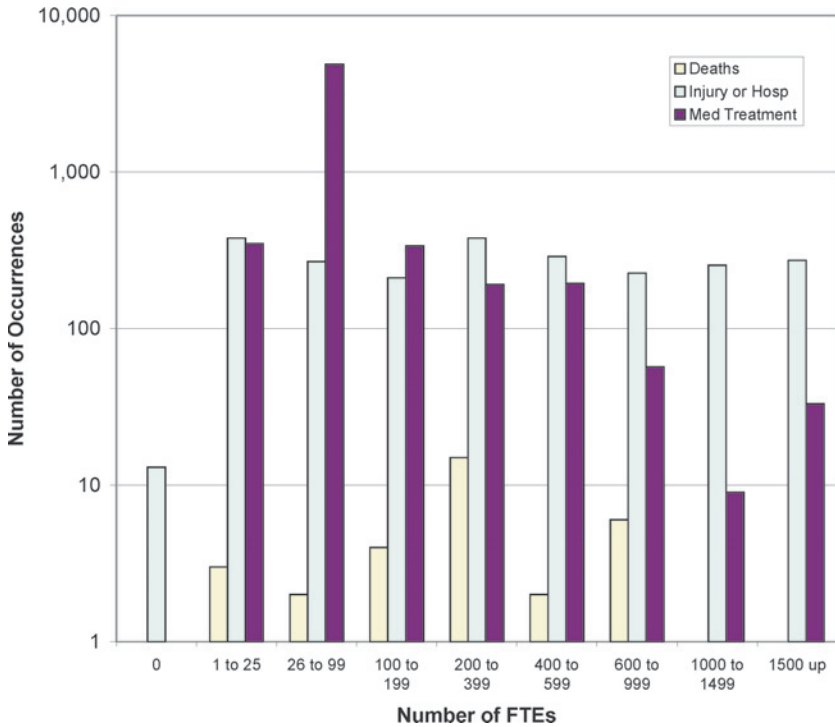


Figure 1. Release consequences by FTEs (Data source: US EPA Risk Management Program 5-year accident history, 1994–1999)

sites with 50–99 employees from October 2002 through September 2003 are:

1. The Control of Hazardous Energy, Lockout/Tagout
2. Machines, General Requirements
3. Hazard Communication
4. Respiratory Protection
5. Electrical, Wiring Methods, Components & Equipment
6. Mechanical Power-Transmission Apparatus
7. Electrical Systems Design, General Requirements
8. Occupational Noise Exposure
9. Mechanical Power Presses
10. Powered Industrial Trucks

In contrast, larger businesses’ top OSHA headaches, the standards cited most often in manufacturing sites with more than 250 employees from October 2002 through

Table 1. Consequences as a function of number of employees

FTE Range	Facilities	Releases with Consequences	Consequences					Total FTE's	Releases per 10,000 FTE's	Injuries and Hospitalization per 10,000 FTE's
			Fatalities	Injuries – Hospital	Medical treatment	Evacuation	Shelter- in-Place			
0	912	14	0	13	1	775	0	0	0.0	0.0
1–25	8,136	306	3	379	349	7,501	9,928	72,262	42.8	52.4
26–99	1,959	221	2	268	4,869	6,344	4,770	101,091	21.9	26.5
100–199	934	184	4	211	337	7,817	46,199	130,320	14.1	16.2
200–399	889	264	15	379	191	3,860	59,616	248,766	10.6	15.2
400–599	441	158	2	288	194	2,461	64,240	212,522	7.4	13.6
600–999	407	142	6	226	57	228	3,270	310,306	4.6	7.3
1000–1499	205	109	1	254	9	770	2,404	244,275	4.5	10.4
1500 up	192	80	0	273	33	148	2,848	884,671	0.9	3.1

Source: US EPA Risk Management Program 5-year accident history, 1994–1999.

September 2003 are:

1. The Control of Hazardous Energy, Lockout/Tagout
2. Machines, General Requirements
3. Electrical, Wiring Methods, Components & Equipment
4. Electrical Systems Design, General Requirements
5. Hazard Communication
6. Respiratory Protection
7. Mechanical Power-Transmission Apparatus
8. Guarding Floor & Wall Openings & Holes
9. Powered Industrial Trucks
10. Permit-Required Confined Spaces

It is interesting to note that lock-out/tag-out (LOTO) is the biggest safety problem for BOTH large and small businesses.

SMALL AND MEDIUM-SIZED ENTERPRISES

Determining if a chemical plant or company is a small or medium-sized enterprise is easy if you are involved in the enterprise. The management knows, without much prompting, that the enterprise is small in relative terms to large corporations. The Small Business Administration defines small business using the Standard Industrial Code (SIC) of the business with limits on the number of employees and a maximum value of annual sales.

The size of the small business sector of the chemical industry is not precisely defined. However, there is no denying the fact that this sector plays a vital role in the economy and is a key element in a competitive market place. The flexibility and low cost of production offered by the SME's plays a key role in the development of intermediates and critical chemicals for larger chemical facility operations. As indicated by the incident data analysis, the exposure for hazardous chemical releases to employees is likely to be greater from SME's than from larger facilities. The existence of this degree of risk cannot be ignored if process safety is to be second nature in the chemical industry.

The managers and owners of SME's are concerned about safety; however, the SME managers often conclude that process safety and risk management programs are more of a large company type program, another intrusion into their already busy and chaotic world. The process safety community needs to examine criteria for what is vital for an SME program and provide guidance on how to develop programs that are customized to provide effective process safety without imposing unnecessary administrative burdens on the SME's.

CHARACTERISTICS AND LIMITATIONS OF THE SMALL BUSINESS

Analysis of the SME's submitting the risk management plan under EPA's risk management program regulation indicates some interesting results. For example, as shown in Table 2, only about 33% of the SME's with 0–25 employees are covered by the

Table 2. RMP facilities by North Atlantic Industrial Classification System and number of employees

North Atlantic Industrial Classification System	Industry Sector	Facilities with 0–25 employees		Facilities with 26–50 employees	
		Number	%	Number	%
111	Crop production	122	1.1	8	0.6
115	Ag & Forestry support	540	5.0	30	2.3
211	Oil and gas extraction	437	4.1	95	7.2
22111	Utilities — power	100	0.9	39	3.0
22131	Water supply	1,757	16.4	156	11.9
22132	Sewage treatment	1,183	11.1	202	15.4
325	Chemical manufacturing	628	5.9	413	31.5
422	Wholesale, Non durable	4,843	45.3	209	15.9
454	Fuel dealers	335	3.1	13	1.0
493	Warehousing and storage	553	5.2	123	9.4
561	Services	99	0.9	3	0.2
562	Waste management	103	1.0	20	1.5
	<i>Total</i>	10,926	100.0	1,500	100.0
	<i>Number of facilities regulated by OSHA PSM regulation</i>	3,636	33.3	1,075	71.7

Source: US EPA Risk Management Program 5-year accident history, 1994–1999.

Occupational Safety and Health Administration's process safety management (PSM) regulations. In the 26–50 employees category, about 72% of the SME's are regulated by the PSM regulation. Table 2 also provides an interesting combination of RMP facility/industry sectors that populate the SME world.

Typically the SME's have, among other characteristics, the following limitations:

- Limited time for management to implement, supervise, manage, or control process safety and risk management programs
- Insufficient funds to support a major process safety and risk management program
- Small staff
- Poor quality information on process safety and risk management programs and techniques
- Inexperienced or less than sufficiently trained process safety and risk management staff

SME's may be performing a hazardous process on contract to a large corporation that may have discontinued or not considered the process for their plants because of the

high risk inherent in the process. Some of these smaller facilities have experienced major process release incidents resulting in loss of life and/or property damage. These incidents indicate that despite improvements and advances in process safety, there is a sector of the chemical process industry that has not been influenced by the safety technology.

Process safety and risk management requires extensive documentation demanding sufficient resources to assist in program development. Documentation might assure that process safety is being performed but it can become counter productive to the achievement of an effective safety program in SME's. The extent of documentation actually required for SME's needs serious review to determine what is absolutely needed. It must be noted however that in many cases documentation is an aid to an effective process safety program; such as Process Safety Information.

DIFFERENT SME SECTORS

The following provides a description of some of the SME sectors and the unique hazards associated with each sector.

PROPANE

It is common knowledge that propane is a flammable substance. The most common hazardous scenarios in SME's that are handling propane are as follows:

- distribution of portable propane tanks without gaskets
- poorly ventilated storages
- overfilling
- poor maintenance
- failure to connect filling hoses appropriately (by deliverers)
- failure to disconnect hoses after refilling (by deliverers as well)
- failure to ground delivering trucks before downloading propane

The list above consists of direct contributing factors. However, issues as poor labeling, lack of training in performing propane-related tasks, lack of understanding of the consequence associated with improper handling of propane, and employers/employees who are not familiar with emergency response are some of the indirect factors that contribute to the severity of propane incidents.

AMMONIA

While only large manufacturing sites typically manufacture ammonia, there are many small and medium enterprises that use, blend, or handle anhydrous ammonia. The food and grocery warehouse industries typically have large quantities of ammonia on site within their refrigeration systems. These machines are almost exclusively maintained by third party organizations. But the food company employees are at risk when a leak occurs, and rarely have sufficient training or personal protective equipment to mitigate the dangerous leak.

A growing user of ammonia is the many industries, even schools, which have rather large central gas-fired heating or boiler systems. To keep below the environmental NOx regulations, many of these older units have been retrofitted with ammonia injection systems. Handling trailer loads of ammonia, blending with water, and significant quantities of on-site ammonia storage have drastically increased the hazards for many SME's. Again, the SME's rarely have adequate training or equipment to handle emergencies involving ammonia incidents.

The April 2003 explosion at the DD Williamson food coloring plant is an example of the safety challenges facing SME's. The explosion and release of large quantities of aqueous ammonia is detailed in the report issued by the U.S. Chemical Safety and Hazard Investigation Board (<http://www.csb.gov/>).

CHLORINE

Workers may be exposed to chlorine in industries where it is produced or used, particularly in the food, water and paper industries. In addition, persons breathing air around these industries may be exposed to chlorine.

Chlorine usage at municipal water districts, typically unattended chlorine disinfecting stations in the middle of housing areas, are serviced by contractors. Sometimes the contractors use untrained workers, with the result that a rash of chlorine releases in the last few years have been noted. Adding to the problem is the availability of cheaper parts from "web-based" suppliers who may send parts with gaskets or metallurgy incompatible with chlorine service.

TOLL PRODUCERS

Small toll processing companies typically specialize in specific chemical operations such as distillation or filtration or blending. While they generally focus on a limited chemical base due to the specific nature of their equipment, occasionally, during slow business periods, they venture into manufacturing processes and procedures that may push the limits of their knowledge and equipment containment capacity.

Rarely do toll producers have significant laboratory research facilities, relying therefore on the client to provide all the relevant manufacturing information (including safety information). This becomes a real problem when the entrepreneurial client really does not have an adequate technical background or just rudimentary safety information.

The limited staff of the toll processor means that regulatory changes and technological advances, even impacting their common client base, are rarely incorporated into their standard practices. This point was recently vividly evident in a project involving blending of silica filter media. Very few of the powder toll processing companies were aware of the fact that crystalline silica had been designated as a carcinogen by federal regulators³, with the concomitant increased personnel protection and training requirements that carcinogens demand.

SPECIALTY CHEMICALS

Batch processing of smaller quantities results in many specialty chemical companies operating outside of the OSHA PSM regulation⁴ due to the OSHA de minimus quantity rules. Therefore, the signal to upper management has been that the hazards are not as serious, with the ultimate effect of not budgeting resources for developing an adequate PSM program.

WHAT IS PREVENTING EFFECTIVE PROCESS SAFETY MANAGEMENT IN A SMALL BUSINESS?

As mentioned previously herein, SME's do not always have the information needed to develop and implement a Process Safety Management program. Many SME's started their PSM programs by asking for suggestions on program techniques and procedure from the government or from large companies. Often the suggested solutions do not work for the SME.

A simple method of determining PSM program adequacy is to evaluate the impact of PSM on the operation, management, and effective performance of the facility. Most SME's have difficulty in demonstrating the effect of Process Safety Management on their operations. SME's are reluctant to hire a PSM development consultant. Solutions need to be targeted towards the plant culture and realities, instead of trying to force fit to a standardized program.

Most of the available literature, typical solutions, or consultant programs are not helpful or usable by the SME's. Programs requiring large amounts of documentation or using costly computer programs usually focus on solutions, which are costly and often too general or too complex rather than providing a solution that is compatible with the location.

Another area where typical programs are not effective for the SME is in the requirements for training. Training programs focused on certification strictly based on hours spent in training rather than performance based solutions is a concern for the SME. There is a lot of wasted time and effort involved in this type of training that is counter productive when compared with the desired outcome of the regulatory requirements.

THE CURE

Process Safety Management has contributed to improved procedures and practices in the Chemical Process Industry — both large and small. Basically, the small number of people in a small chemical company contributes to the difficulty of implementation of process safety programs as well as other safety and health programs because there are not enough hours in a day and enough people to handle the plans, procedures, and other activities.

Industry and academic groups can provide the means to improve safety training in colleges and trade schools as an aid to the smaller plant.

Table 3. Process chemicals by industry group and number of employees

North Atlantic Industrial Classification System	Industry Sector	Facilities with 0–25 employees			Facilities with 26–50 employees		
		Total Number of Process Chemicals	Process Chemicals that are not “Common”	%	Total Number of Process Chemicals	Process Chemicals that are not “Common”	%
115	Ag & Forestry support	551	0	0.0	31	2	6.5
211	Oil and gas extraction	772	125	16.2	202	44	21.8
22111	Utilities – power	104	11	10.6	40	2	5.0
22131	Water supply	1,800	4	0.2	167	1	0.6
22132	Sewage treatment	1,328	5	0.4	235	8	3.4
325	Chemical manufacturing	744	190	25.5	529	259	49.0
422	Wholesale, Non durable	5,059	93	1.8	247	38	15.4
454	Fuel dealers	349	5	1.4	19	5	26.3
493	Warehousing and storage	605	55	9.1	134	13	9.7
562	Waste management	76	23	30.3	98	79	80.6
	Totals	11,388	511	4.4	1,702	451	26.5

Note: “Common chemicals are: ammonia, chlorine, propane, butane, formaldehyde, hydrofluoric acid, flammable mixtures, and sulfur dioxide.
Source: US EPA Risk Management Program 5-year accident history database.

The use of suggested guidance PSM programs would assist the SME's meet the needs of individual sites. These should include programs for process safety information, focused PSM training, Mechanical Integrity, and Management of Change procedures and requirements to eliminate a one size fits all approach to PSM programs. Review, audit, and certification by a third party may be one suitable alternative to the current regulatory approach. One possible step could be the audit of a site plan using demonstrations of proficiency in PSM program elements as an alternate to review piles of documentation and certifications to prove PSM regulatory compliance. Drills or audits involving simulations, for example, could be used to demonstrate the ability to handle an emergency. Similar exercises could be developed as standard approaches to evaluate Mechanical Integrity or Management of Change reducing the emphasis and dependency on documentation to a manageable scale.

One casualty of the emphasis on Process Safety Management and Risk Management Planning is the demise of loss prevention programs at the plant level. Loss prevention programs were the driving force for development of Risk Management Planning and Process Safety Management concepts. The insurance industry has scaled back on the expertise and amount of personnel schooled in loss prevention concepts and applications to the process industries. Loss prevention staffs have been cut in many larger companies. The result is that small and large businesses face complex fire and explosion hazards without trained personnel, which were the foundation of effective chemical industry loss prevention programs.

SMEs need very specific programs aimed at their specific business. They may need things like simple forms to document MOC. The task of each SME developing a program is burdensome. They also need to know what are common problems in their industry, with the chemicals they use and the types of operations they perform. As shown in Table 3, the percentage of chemicals used by SME's that are not common chemicals is quite low and thus, it is conceivable that best practices, documents, and guidance tailored to specific SME sectors can be developed. The term "common chemicals" as used in this paper refers to: ammonia, chlorine, propane, butane, formaldehyde, hydrofluoric acid, flammable mixtures, and sulfur dioxide. Thus procedures, documentation, lessons learned, and training regarding a finite number of chemicals could cover 90% or more of the businesses.

Academia, government, industry, industry associations, as well as public interest groups all have a role to play. A collaborative effort is needed to compile best practices/guidance documents for specific industry-chemical combination. The guidance could address hazards, consequences, as well as procedures and training needs. It should be easy to pre-calculate release scenarios and regulatory programs such as process safety management programs could be explained and customized specific to the industry-chemical. Incident history specific to the industry-chemical could also be included. The guidance could be so specific to the industry-chemical combination that it would be difficult if not impossible for the SME to ignore it. For example, the guidance would be separate for ammonia for refrigeration as compared to ammonia for agricultural use. Government and industry could help fund this effort.

Some examples of effective and useful guidance, procedures, and best practices are listed below:

1. Model Risk Management Program and Plan for Ammonia Refrigeration available on the web at <http://www.epa.gov/swercepp/rules/ammon.pdf>
2. OSHA information on ammonia refrigeration available on the web at <http://www.osha.gov/SLTC/ammoniarefrigeration/>
3. Ethylene Oxide Manual developed by Shell
4. Butadiene Manual developed by BP

An organized and prioritized effort to bring together the best information on very focused areas similar to ammonia refrigeration and disinfection by chlorine could provide a one notebook guide for SME's that covered all the legal requirements as well of informing in plain English the hazards, good practices, accident history, and other appropriate information.

Industry can play a major role in improving the process safety programs at SME's through product stewardship. It is interesting to note that for <25 employees, the US EPA Risk Management Program 5-year accident history database indicates very few of the facilities are chemical manufacturing facilities, they are mostly users.

SUMMARY AND CONCLUSIONS

Most small and medium-sized businesses handling chemicals are having difficulty providing the resources and talent necessary to administer and sustain effective process safety programs and other health and safety programs. In most cases, the difficulty is associated with lack of resources and the lack of industry-chemical specific guidance documents, training, and hazards information.

The chemical industry, regulatory authorities, and other interested parties, including the public, should actively promote the development of programs that are focused on development of measures that assure that PSM is useable in Small Business Chemical Plants without a heavy penalty in loss of resources and high cost. The overall thrust of PSM programs should be away from the big business model to more flexible models, which can improve safety in the Small Business Chemical Plant. The development and dissemination of industry-chemical specific guidance documents is strongly recommended.

ACKNOWLEDGEMENTS

This research presented in this paper was sponsored by the Mary Kay O'Connor Process Safety Center at Texas A&M University.

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