

The Taxonomy (Classification) of Process Safety

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ABSTRACT

The knowledge base of process safety has grown in the last ten years by leaps and bounds showing its increasing maturity, but bringing with it the perennial problem for its practitioners of finding the desired information among the myriad documents available. The global participation in process safety and use of different nomenclatures In this information age the problem is compounded by the excellent search engines available that can search for every word in a document. The more specialized the field, such as process safety, the more the recurring number of words. For example, searching for PHA would find tens of thousands of documents, the great majority of which wouldn't be particularly relevant to our search. The way to narrow such searches is to define common keywords that will have a relevant meaning to the searcher and specifically include these keywords all published documents to enable the desired search.

It is proposed then to create a taxonomy (classification with dependencies) of the process safety knowledge to help solve this problem and thus gain access this knowledge that otherwise would be lost. The methodology to do this would be to propose an initial taxonomy and keywords for each section and let the process safety community help in reaching a consensus of when and what for these keywords would be used. To accomplish this, a Wikipedia-type website would be established where process safety professionals would add their contributions under the proper heading. This paper will present the concept and an initial taxonomy, proposed keywords and initial definitions.

Defining Process Safety

Process safety in the U.S. has been mainly defined by OSHA's Process Safety Standard, 29 CFR 1910.119, and its predecessor the Chemical Manufacturers Association's (currently the American Chemistry Council, ACC) Responsible Care™. In other countries it has been defined by local or international regulation, such as COMAH (Control of Major Accident Hazards) promulgated by Great Britain's Health and Safety Executive [1], and the Seveso Directive II [2], applicable to the European Union countries. Although all comprise similar basic elements such as mandating the use of hazards analyses and management of change, the language used for managing process safety starts to differ and the requirements, under different names, may be different. These differences (or similarities) detract from understanding what is

necessary in order to have “process safety” and how to manage it, and erect barriers as to when and how to apply best practices. Thus, we need ways that will allow us to communicate in a universal language and discuss process safety.

The Need for Process Safety Taxonomy

The word “taxonomy” was used first in the biological sciences and defined as “A classification of organisms into groups based on similarities of structure or origin”. Today the term is applied in a wider, more general sense and now may refer to a *classification* of things, as well as to the *principles* underlying such a classification. By using a classification we can define terms and have a better understanding of the definition given that we now know their origin and relationship with other terms.

The existing variations in process safety nomenclature not only results in confusion as to meaning, but also limits sharing safety data and information, lessons learned and general knowledge on the subject. The aviation industry, for example, has recognized this fact and chartered a group, the Common Taxonomy Team (CICTT) [3] to come up with rules or naming conventions that would allow an effective use of data for safety analysis and sharing purposes. For subsets of process safety, such as incident investigation, a taxonomy is crucial for building a database where terms have to have an exact meaning and thus efforts are directed to this end when the need arises [4].

The Benefits of Taxonomy in Sharing Knowledge

Not only does a taxonomy help in getting better definitions and communicating more accurately, it also helps us in disseminating knowledge. We can publish to a targeted audience and find the exact information that we need and not waste time on extraneous information. But, since the knowledge base of process safety has grown in the last ten years by leaps and bounds the task of finding the pertinent information has become increasingly difficult. The problem is compounded by the excellent search engines available that can search for every word in a document. The more specialized the field, such as process safety, the more the recurring number of words. For example, searching for PHA would find tens of thousands of documents, the great majority of which wouldn't be particularly relevant to our search. An example of the problem is reflected in a recent search using various keywords as shown in Table 1. It can be seen that putting compound keywords inside quotes to limit the number of results didn't help much. This problem can be ameliorated with a taxonomy that would help us focus our search.

With the help of a taxonomy with can classify the process safety knowledge and thus organize it for easy retrieval [5]. The classification will also help produce the metadata for the documentation ensuring an appropriate method for publication and dissemination of the knowledge [6].

Table 1. Results of a Google search for the given keywords

Keyword	No. of “Hits”
PSM	4,090,000
process safety	105,000,000
process safety keyword	725,000
“process safety”	475,000
“process hazards analysis”	290,000
PHA (Philadelphia Housing Authority)*	26,400,000
PHA facilitation	238,000 (3,328 in my computer)
HAZOP	216,000
LOPA (La. Organ Procurement Agency)*	658,000
LOPA process safety	39,300

* Part of the results

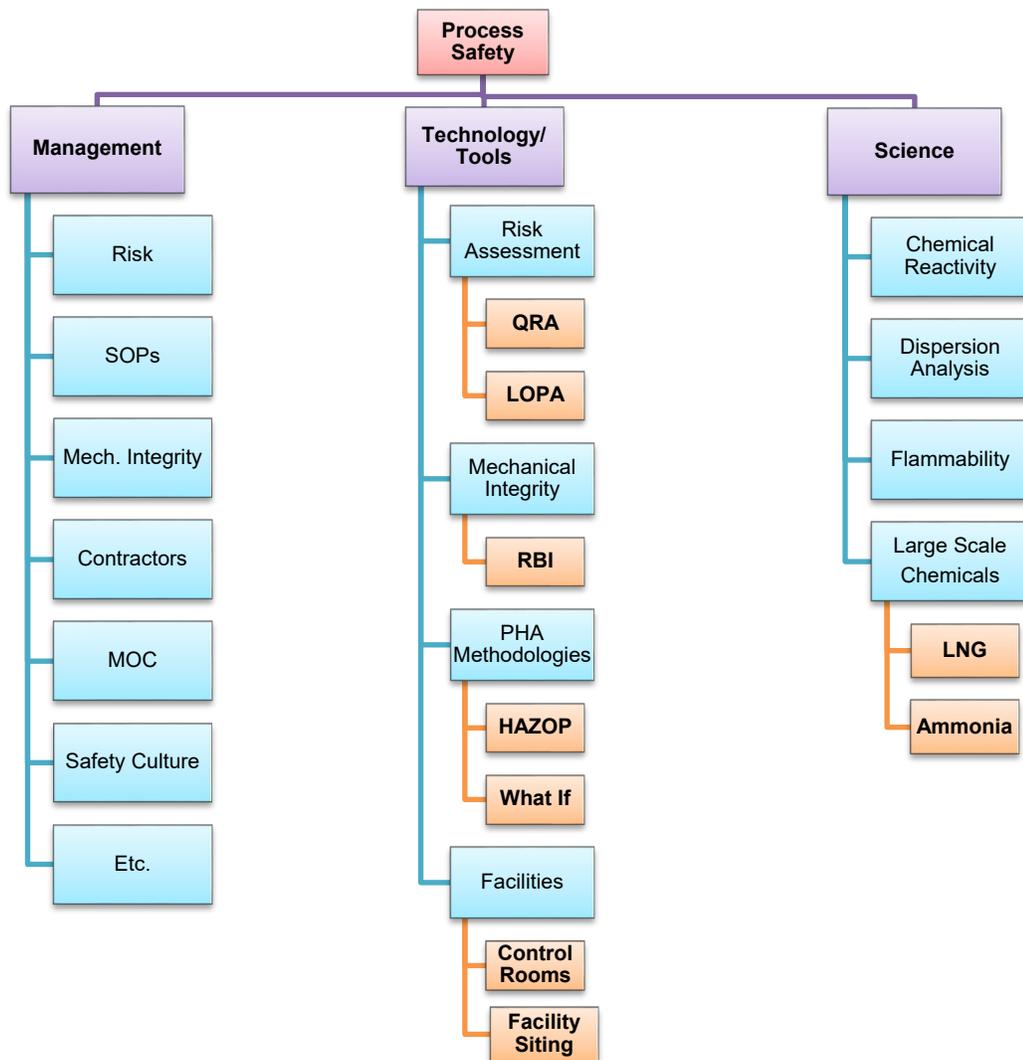
A Proposal for a Process Safety Taxonomy

It is proposed to develop a taxonomy for process safety to help in defining the field and to alleviate the search for related knowledge. The classification would start with three branches that typically apply to any area of applied knowledge: management, technology/tools and science. Management is what we would call PSM (process safety management) a term which currently tends to be incorrectly applied to every aspect of process safety. Management would only refer to the act of guiding, controlling, directing, administering, or using process safety in a desired manner and the ways of implementing these actions. Technology/tools would refer to the tools necessary or used in managing process safety. For example, a PHA methodology such as HAZOP would be a *technology or tool* to be used in carrying out a process hazards analysis, which in turn is a means to manage risk, a necessary part of the *management* of process safety. The underlying *science* to enable this PHA could be the data that allows us to perform a dispersion analysis or find the toxicity of a chemical.

Each of the three branches would have sub-branches that fit (there’s a dependency) under them. And each sub-branch would in turn have subdivisions up to a depth to fit the necessity, taking into consideration that simplicity, rather than preciseness, will get more people to use the taxonomy to the benefit of all. A snapshot of a simplified taxonomy is given in Fig. 1. As can be seen, some aspects of process safety would appear in all three branches, for example Mechanical Integrity (MI). Under

Management there would be the requirements and methods for managing an MI program. Under Technology would appear the different methods and tools for carrying out the program, one example being Risk Based Inspection (RBI). Under Science would appear metallurgical, piping specifications, thicknesses and other data that would be necessary to accomplish the objectives of the program.

Figure 1. A Snapshot of a Simplified Process Safety Taxonomy



Developing the Taxonomy

The first requirement of a taxonomy is meeting the objective of its creation. This objective is a practical means of communication and the dissemination of process safety knowledge, and not the exact scientific classification of the field. The latter may come after an initial taxonomy is developed and used for a while, if the users see a

need for this kind of effort. The initial efforts should go to a relatively simple classification that employs the most commonly used terms in the field and that has as few sub-categories as possible. Only when there's an abundance of specialized knowledge for a subject a subset should be used. To this effect a proposed classification of the Management branch is shown in Table 2 (only one sub-branch is shown).

Table 2. Proposed Taxonomy of the Management Branch

Process Safety Management (PSM)	Keyword	Subset	Keyword
Management Principles	<i>Principles</i>	Leadership	<i>Leadership</i>
		Commitment	<i>Commitment</i>
		Continuous Improvement	<i>Continuous Improvement</i>
		Integration with Operations	<i>Integration</i>
		Metrics and Benchmarking	<i>Metrics</i>
Process Safety Knowledge and Information	<i>Process Safety Information</i>	Information Procedures	<i>Procedures</i>
		Trade Secrets	<i>Trade Secrets</i>
Project Management	<i>Project Management</i>	Design Procedures	<i>Design</i>
		Review Procedures	<i>Review</i>
Management of Risk	<i>Risk</i>	Management Actions	<i>Management</i>
		Hazard Identification	<i>HAZID</i>
		Risk Assessment	<i>Assessment</i>
		Business Risk	<i>Business</i>
Management of Change	<i>MOC</i>	Process and Technology	<i>Process</i>
		Facility	<i>Facility</i>
		Organizational	<i>MOOC</i>
Mechanical Integrity	<i>Mechanical Integrity</i>	Reliability Engineering	<i>Reliability</i>
		Construction	<i>Construction</i>
		Fabrication	<i>Fabrication</i>
		Inspection	<i>Inspection</i>
		Maintenance	<i>Maintenance</i>
Training	<i>Training</i>	Procedures and Materials	<i>Procedures</i>
		Records	<i>Records</i>
Operational Integrity	<i>Operations</i>	Operating Procedures	<i>SOP</i>
		Safe Work Practices	<i>Safe Practices</i>
Emergency Planning and Response	<i>Emergency</i>	Emergency Planning	<i>Planning</i>
		Emergency Response	<i>Response</i>
Auditing		Procedures	<i>Procedures</i>
		Findings	<i>Findings</i>

Process Safety Management (PSM)	Keyword	Subset	Keyword
		Observations	<i>Observations</i>
		Recommendations	<i>Recommendations</i>
Incident Investigation	<i>Incident Investigation</i>	Investigation Procedures	<i>Investigation</i>
		Incident Analysis	<i>Analysis</i>
		Lessons Learned	<i>Lessons</i>
		Incident Taxonomy	<i>Taxonomy</i>
		Metrics	<i>Metrics</i>

The success of a taxonomy of course lies on its acceptance and use, and therefore its development should have the contributions of as many process safety experts as possible. One way to accomplish this is to post it in a controlled website and let process safety professionals add or edit terms to the proposed structure, or edit their definitions. This would be a Wiki-like website with the difference that access would be controlled. The Mary Kay O'Connor Process Safety Center (MKOPSC) has agreed to host and manage such a site where explanations on the process will be available.

In order to develop a taxonomy each item in the lists needs to have a title, its place in the taxonomy tree, a keyword which may or may not be the same as the title, a clear definition, an example to clarify further that definition and an exposition of the example. Table 3 shows an example of how each item should appear in the website.

Table 3. Presentation of a Taxonomy Item for Review

Item Title	Layer of Protection Analysis (LOPA)
Path	Process Safety>Technology>Risk Assessment>LOPA
Keyword	LOPA
Definition	A semi-quantitative technique for assessing risk in which consequence is determined qualitatively and frequency is determined by analyzing each layer of protection and assigning it a probability of failure on demand and calculating their effect on the frequency of the initiating event.
Example	"After completing the PHA, the high consequence items were selected for further analysis using LOPA, which provides a more robust method for assessing probability. In order to do this the frequency of the initiating events for the selected scenarios were necessary."
Comment	LOPA is used as a technique or method for assessing risk. It is a tool that can be used in risk assessment.

Use of the Taxonomy

Once the taxonomy has been developed and there is a good certainty of what each item means, the keywords can be used in manuscripts or publications to guide the user in his search for the relevant document. The place in the taxonomy tree of the document's subject should correlate well with the intent of the document. For example, when discussing how to manage risk, the discussion could take us to talk about doing PHAs, and further, as to when it's better to apply the HAZOP methodology. In this case we are talking about process safety management. If we were to keyword the paper we should use as keywords:

Process Safety > Management > Risk Assessment > Process Hazards Analysis > HAZOP.

If, on the other hand, we are explaining how the HAZOP methodology works, we would keyword as follows:

Process Safety > Technology > Risk Assessment > Process Hazards Analysis > HAZOP.

It is important to use the whole chain of keywords when key wording a document. Remember that the searcher is searching through a universe of documents and only the chain will lead him to the relevant subject. As shown in Table 1, using a single keyword or a simple combination of keywords can lead us to many irrelevant results. Doing a search using the keywords 'process, safety, PHA' only can lead us to the article entitled "PHILLY: CORRUPTION PUTS PUBLIC SAFETY AT RISK" where the Philadelphia Housing Authority (PHA) is discussed.

Conclusions

A taxonomy for process safety has been proposed together with a method for building it. Its development should produce a classification that is simple to apply and thus gain wide usage. The resulting taxonomy would provide agreed-upon definitions of the various aspects of process safety which would help us communicate better and share our knowledge in this subject. Using the developed keywords would greatly simplify our searches and make our knowledge sharing much more efficient.

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