Stakeholder outreach on process safety for process industry using risk based approaches

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Abstract
For past decades, the industry and academician realized the core of effective process safety management (PSM) is closely related to good process safety culture. Major accidents in process industry occur at low frequency but the consequences on people, environmental, and assets damage are catastrophic. Previous accidents in process industry recorded many deaths and injuries of facility personnel and public. Hence, many regulations and best practices were introduced to avoid major accidents from occurring and to mitigate the consequences. Risk based process safety (RBPS) Guide- line is one of best practices to manage PSM, using risk-based approaches. When accidents happened, internal and external stakeholders are greatly impacted if it is not mitigated effectively. Thus, element stakeholder outreach which lies in Commit to Process Safety pillars are considered as important elements to protect the stakeholders and promoting good safety culture. This article presents a structured technique for stakeholder outreach using RBPS approaches and a work-aid model to ease its implementation in process industry. The technique and work-aid model are beneficial to help the organization managing stakeholders, educating the public on risk management and the importance of embracing safety culture in their life.

KEYWORDS
emergency management, process safety management (PSM), risk-based process safety (RBPS), stakeholder management, stakeholder outreach

1 | INTRODUCTION

In mid-2017, the world population reached 7.5 billion, which has been tripled as compared to only 2.5 billion on 1950’s. Research statistically predicted that by year 2100, there will be more than 11 billion population across the global. Consequently, the need for global resources are increasing along with rapid growth of modern technologies, due to the higher number of population. The growth of process industry is important to sustain the need of modern civilization. The process industry is the sectors producing bulk commodities such as petrochemical, oil and gas, pharmaceutical, and chemical industry. The process industry however is dealing with hazardous processes and substances. The operation failures may cause uncontrollable release of toxic substances, fire, and explosion. The accidents will pose threat to human, ecosystem, and causing property damage.

During the early industrial revolution, there are many deaths and injuries due to major accidents especially in chemical industry. Flixborough explosion (1974), Bhopal disaster (1984), Chernobyl accidents (1986), and Phillips disaster (1989) were among the major accidents that caused many fatalities and injuries of the workers and public. Most of the accidents had similarity in term of poor emergency
management, resulting to loss of lives. Bhopal 1984 has been cited in many literatures as the worst disaster in process industry, and it is a wake-up call for the industry to have a better safety measures.5,6

The impacts from the major accidents had urges the regulators to improve on safety regulations and standard especially when the industry and technology are vastly developing. Prior to Bhopal disaster, Occupational Safety and Health (OSHA) of Unites States direct action was to promulgate 29 Code of Federal Regulations 1910.119—Process Safety Management of Highly Hazardous Chemicals or generally known as OSHA PSM 1992. The European Union introduces Seveso Directive. Both regulations are the turning points for safety awareness in process industries.

In 2016, a research on Chemical Safety Board (CSB) investigation report of process incidents showed that many accidents happened in facility that practices PSM.7 This proves that there are still gaps in PSM implementation and there is urgency to improve PSM since the severity is high and potentially causing long term damage.8

CCPS published RBPS Guideline in 2007 to encourage process safety management excellence. RBPS includes 14 elements in OSHA PSM 1992 and introduces six new elements, covering the management and human aspect in PSM. The total of 20 elements in RBPS are governed by four pillars which are Commit to Process Safety, Understand Hazard and Risk, Manage Risk, and Learn from Experience. The stakeholder outreach element falls under the first pillars in RBPS, Commit to Process Safety.9

Commit to Process Safety pillar is strongly discussing on the need of solid commitment and good safety culture to enhanced process safety implementation. Environmental Protection Agency (EPA), OSHA, and other regulatory body acknowledge the importance of having strong safety culture to reduce the probability of major accidents.10 Weak safety culture has been identified as the underlying cause of many major accidents such as BP Texas Fire and Explosion (2005) and Deepwater Horizon oil spills (2011).11

Stakeholder outreach is the element that guides the organization to establish a great relation and ensure successful process safety communication among the stakeholders. Studies showed that, accidents prevention should not only focusing on technical elements, but the safety culture and effective communication also play a big role.12 The importance of managing stakeholder frequently neglected by some organizations. The Fukushima Dai-ichi accidents in 2011 show poor emergency and stakeholder management which are ruining the organization and the Japanese government reputation.13 They failed to identify, alert, and evacuate the affected residents within brief time and some of the residents are facing shortage of food supply at the shelter.14

The condition continues to worsen when the patients evacuated from affected hospital did not get medical attention. The incidents did not only affect the nuclear industry in Japan, but it caused global public fear on potential of nuclear accidents. Germany and Belgium nuclear policy has changed due to this accident, where they are phasing out the nuclear program and stopping the extension of the program.15,16 China is undergoing similar crisis where the citizen is opposing the nuclear program. Antinuclear demonstration is marching to boycott the Fourth Nuclear Power Plant.

The construction plan of an uranium plant in Guangdong province are canceled due to public opposition.17 This shows how strong the stakeholders can impact the organization. However, the Chinese government made a huge effort to continue the program, by conducting campaign, survey and educating the public on nuclear activity. In 2013, they successfully restart their nuclear power plant construction. China continues investing to strengthen the public trust by disclosing relevant information to the public, be transparent on their decision and conduct open discussion.18

Although some country decided to phase out the nuclear program due to public concern, China proves that good stakeholder management program leads to success of the nuclear project. Stakeholder outreach can help to widen the body of knowledge, reduce and uncover risk, increase the project success rate, and build trust and confidence among the stakeholders. There are many stakeholder management programs available, but only a few of them are focusing on process safety communication. The other stakeholder management programs also did not have a structured framework for process industry application.

The difference between stakeholder outreach elements and emergency response procedure (ERP) is this element is focusing on the communication between stakeholders regarding process safety while ERP is more on technical management plan during emergency. In process industry, the stakeholders include all workers inside the facility, contractors, vendors, shareholders, and local communities who will be affected or believe they may be affected by the operations.

Although RBPS has been established in the industry since 2007, the implementation in process industry are not vigorous. This article will present the structured and easy method of stakeholder outreach implementation in process industry. The work-aid model is developed to assist its application in the industry. The stakeholder outreach is a crucial element to ensure the stakeholders need will be address accordingly, and any occurrence of major accidents will not severely affect the stakeholders. Stakeholder outreach also will help to strengthen the safety culture of the society and improves the quality of emergency response.

2 METHODOLOGY

2.1 Compliance with RBPS guidelines

The RBPS Guideline consists of 20 elements which are interrelated to each other. For example, Process Safety Information (PSI) is the basis to understand hazard and risk in the facility. The technical information enquire from PSI is used to strategized other PSM elements such as Operating Procedure, Hot Work Permit, and Process Hazard Analysis (PHA).19 PHA is one of the important elements where the risk is determined using any one of the risk assessment technique, either qualitative, semiquantitative, or quantitative method. The identified risk is used to plan and manage the activities in other elements including stakeholder outreach.
The risk-based approach is a strategic approach where the degree of implementation of the element will vary from one facility to another because RBPS clearly stated their principle that all hazards and risk are not equal. It suggested more resources are allocated to a higher risk facility. Another uniqueness of RBPS is the ability to be applied to all stages of facility life cycle. The “Plan-Do-Check-Act” concept is used to construct the framework for continuous corrective system.

2.2 | Using piping and instrumentation diagram as basis

Figure 1 shows the flow diagram on how to use Piping and Instrumentation Diagram (P&ID) as the basis of stakeholder implementation. The P&ID will show the nodes, and possible hazard from the process. The end user will develop and execute the stakeholder outreach program from one node to another until all nodes are addressed. Different nodes will have different hazard; thus, it has different level of risk and required different outreach program. Using P&ID as basis of stakeholder outreach implementation has been successfully used by other elements such as Contractor Management, Compliance of Hot Work Permit, and other elements for PSM implementation.20,21

2.3 | Using risk as basis

Risk contour is used as the basis of conducting the stakeholder outreach program. The FN curve and societal risk contour can be retrieved from Quantitative Risk Assessment (QRA) report. The stakeholders are classified into three groups, high-risk, medium-risk, and low-risk group. Different group requires different stakeholder program.

For example, high-risk group may require more information on the risk of facility, how to act when there are major accidents and what are the safeguards to mitigate the effect while low-risk stakeholder group only need a brief information on the risk of the facility. This approach will help to manage the resources and gives more attention on high-risk group.

2.4 | Development of Stakeholder Outreach Work-Aid Model

The stakeholder outreach program can be executed manually. However, it requires longer time and manpower to collect, analyze, and stored the data. A computerized model seems to be more practical especially in a large organization. Thus, a work-aid model is developed using Microsoft Access 2016.

The work-aid model serves as a database system, where the end user can easily track the requirements of the program, location of the relevant report, person in-charge, and the current program status whether it has been completed, incomplete, or currently not available. The work-aid model will require shorter period to find the program report and makes the audit process smoother. Any missing data can be simply identified. The model has been developed based on the stakeholder outreach framework in Figure 1.

3 | CASE STUDY

Since RBPS is a guideline, the scope suggested is by following the laws where the facility operates. For example, if the plant operates in Malaysia, the minimal requirements is subjected to follow guidelines from Department of Environmental (DOE) ERP procedure and Regulations Under Occupational Safety and Health Act 1994 (Act 514), and Community Awareness and Emergency Response Code of Management Practices. The first step is to check the availability of the program and verify if the program meets the minimal requirement of the law. If there are programs available, continue to update the program, but if the program is not available, the facility needs to establish a program that covers three main category, internal and external stakeholders and crisis communication plan.

The program will be evaluated by following up with the stakeholders, conducting program, assessment, and carry out corrective action plan if necessary. The program response and feedback will be documented and kept for future references. If the information is well delivered, the program ends. However, if the information delivered does not meet the stakeholder requirements or needs, the program will be updated. The Figure 2 shows the complete cycle on how stakeholder outreach program works, and it is adapting Plan-Do-Check-Act concept to have a continuous improving process.

To validate the model, a case study using a pilot-lab carbon dioxide (CO2) is chosen. The Lab X is used as a pilot plan on studying separation
of high CO2 content from natural gas using cryogenic separator. Lab X use gas separation and dehydration test facility (IRIS) to be integrated with crystallizer test skid (CTS) to build the cryogenic separator. Lab X is surrounded by classroom, students’ residential areas, and parking. Since Lab X is handling natural gas at high pressure, a consequence study has been conducted to determine possible accidents.

According to HAZOP and HAZID report, there are few worst cases scenario identified, for example, catastrophic rupture, leaking of flammable, and toxic mixture from methane (CH4) and CO2 at CTS, IRIS, and Vent System. From the P&ID, the study node chosen is a buffer vessel (V25) containing CH4 as shown in Figure 3. The operating condition of V-25 is 39 barg at -40°C. The possible scenario is release of the toxic and flammable materials due to catastrophic or full-bore ruptures from the vessels or connecting pipelines. The potential accidents will cause toxic release and fire.

From consequence analysis conducted, many factors are considered. The worst effect from the consequence analysis is the fatality of personnel working in Block Y where Lab X is situated and the effect to the surrounding communities. From the full-bore rupture of V-25, fireball with radiation intensity of 12.5 kW/m2 will cause extreme pain within 20 seconds and the fireball with 9.35 distance may reach the nearby control room. The leak from V-25 will cause 12.5 kW/m2 of fireball with distance of 30.42 m and flash fire with distance of 12.30 m. Both fires will reach the control room, nearby classroom and parking.

3.1 Development of stakeholder outreach program using RBPS guideline

Figure 4 shows the first steps in development of stakeholder outreach program. It comprises of two section, preplanning and stakeholder analysis. Preplanning is used to determine the program scope, objectives, and personnel in-charge for each program. Stakeholder analysis divides the stakeholders into internal, external, and further classify into primary and secondary stakeholders to identify which group need more focus. The determination of stakeholders should adhere the minimum requirements of the law where company operates. Lab X SHOP has clear scope and program objectives. The roles of each department are well defined in the program.

3.2 Implementation of stakeholder outreach program

The program implementation has three subsection, internal stakeholder outreach program, external stakeholder outreach program, and crisis communication program as shown in Figure 5. For internal stakeholder program, Lab X have specific training program for ERT team, On Scene Commander, Manager-in-charge, and newcomers.
### FIGURE 3  P&ID for equipment V25

![P&ID for equipment V25](image)

### FIGURE 4  Stakeholder outreach development

| Element              | Description                              | Status    | Evidence                                      | Revision | Action by | Remarks                          |
|----------------------|------------------------------------------|-----------|-----------------------------------------------|----------|-----------|----------------------------------|
| Pre-Planning         | Program scope & objectives               | Complete  | D:\SO Development\PP                        | 20/4/2018| KZ        |                                  |
| Select person-in-charge/owner of program |                            | Complete  | D:\SO Development\PP                        | 20/4/2018| KZ        |                                  |
| Stakeholder Analysis | Determine the stakeholders               | Complete  | D:\SO Development\SA                        | 20/4/2018| KZ        |                                  |
| Classification of stakeholders |                                        | Not Available|                                      |          |           |                                  |

### FIGURE 5  Stakeholder outreach implementation

| Element              | Description                              | Status    | Evidence                                      | Revision | Action by | Remarks                          |
|----------------------|------------------------------------------|-----------|-----------------------------------------------|----------|-----------|----------------------------------|
| Internal Stakeholder  | Communication training                   | Complete  | D:\SO Implementation\SS                      | 30/5/2018| WK        |                                  |
|                       | Communication tools                      | Complete  | D:\SO Implementation\SS                      | 30/5/2018| WK        |                                  |
| External Stakeholder  | Written procedure on program execution   | Complete  | D:\SO Implementation\ES                      | 18/6/2018| WK        |                                  |
| Formal log system     |                                         | Complete  | D:\SO Implementation\ES                      | 18/6/2018| LKK       |                                  |
| Scheduled monitoring information |                                  | Complete  | D:\SO Implementation\ES                      | 18/6/2018| LKK       |                                  |
| Industry sharing participation | Not Available                             |           |                                               |          |           | No written record of industry sharing activities |
| Crisis Communication  | Crisis communication plan                | Complete  | D:\SO Implementation\CC                      | 25/6/2018| AN        |                                  |
| Crisis program simulation |                                        | Complete  | D:\SO Implementation\CC                      | 25/6/2018| AN        |                                  |
| Emergency communication tools |                                    | Complete  | D:\SO Implementation\CC                      | 25/6/2018| AN        |                                  |
There is also refresher training provided every 2 years to ensure they are competent to handle the program. Various communication tools and media used for announcement or evacuation process such as email, phone call, WhatsApp, and so on. There is no information available for industry sharing participation. Lab X is highly recommended to participate in industrial safety sharing to obtain more information.

From Figure 5, there are four sub-elements for external stakeholder outreach program for Lab X. There is complete written procedure, and formal log system to complaint, and method to identify the government agencies such as BOMBA, police, hospital, and so on. There are designated emergency facilities for internal stakeholder but there is no facility mention for external stakeholders.

Lab X has a written guideline on how to act during emergency. The potential emergencies are listed in guidelines to ensure that the team are prepared. To ensure the ERT Team are familiar with the system, communication tools, facilities, and procedure during emergency, there are drill and evaluation conducted at least once a year. The emergency facilities, such as incident command post (ICP) for coordination and response of the team, emergency control center (ECC), emergency control vehicles (ERV), water tank trailer, and so on are provided accordingly.

### 3.3 Evaluation of stakeholder outreach program

To evaluate the success of the program, there are two subsection, program assessment and corrective action plan as shown in Figure 6. After the emergency is under control and no possibility of crisis escalation, the emergency status is ended. Postmortem will be conducted to identify good practices and any gaps to be improved.
There is a checklist to track if the required actions are fulfilled. There are also feedback logs, to examine, assess, and validate the availability, validity and completeness of the plan, manpower usage, and emergency equipment and facilities. There is periodic program assessment, but there are no specific leading or lagging indicators for the program. The documents are well recorded such as handing over certificate, yearly drill plan, postmortem report and incident action plan. The digitalization of documents would be preferred to make them easy to trace, environment friendly, and safely kept.

### 3.4 Using risk as basis

From the risk contour in Figure 7, the risk of worst-case scenario estimated is within $1 \times 10^{-6}$ to $1 \times 10^{-9}$. This shows that the risk lies in the broadly accepted ALARP region. Lab X does not specify risk communication to the stakeholder. Table 1 shows the possible risk communication for Lab X application. Level 1 shows the highest risk whereas level 3 shows the lowest risk. From Table 1, level 1 and level 2 communications are not applicable since the risk lies starting from $1 \times 10^{-6}$.

### 4 Conclusion

Implementation of stakeholder outreach in process industry is crucial to reduce the impact of major accidents to the stakeholders. Previous disaster in process industries showed that lack of understanding and training on how to handle the situation worsen the accident impacts. Through stakeholder outreach program, the stakeholders will receive information about the risk of the facility, how to act during emergency, and channel to communicate when they need extra information or to complaint about any abnormal situation. The framework will help the organization to have a structured method to conduct stakeholder outreach program.

The work aid model will assist in tracking the completeness of the program, file location, and person responsible for the program. The method proposed also have corrective actions where the program will be update as necessary. The risk-based approaches used in this method will ensure the information disseminate to the right persons and the operating cost could be optimized. Different facility may have different risk and stakeholders’ groups; Hence, this method can be adopted to any facility according to their needs. Strong and positive safety culture within community can be achieved through implementation of stakeholder outreach and committing to the process safety itself.

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