An Impetus for Management Involvement in Process Safety

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ABSTRACT

Process Safety Management (PSM) at a facility is typically implemented to satisfy regulatory requirements because it is the minimum necessary for successful management of the facility. Ultimately managers are rated by top management on good financial performance, compliance with regulations, and an absence of safety, health and environmental incidents. Thus, lagging indicators such as the OSHA log are commonly used resulting in incidents when process safety performance has not been up to par. For the most part, good PSM performance is left to the interpretation of process safety professionals in the facility and, in the absence of incidents, is not viewed as part of good overall management performance.

If practical process safety performance indicators, similar to financial indicators, were provided to management, it would give them a tool to rate good PSM and provide an impetus for superior performance in this area. These performance indicators should be, similar to the financial ones, relatively simple to understand and give top management a measure to which site management would be held accountable.

It is proposed that these indicators be based on activities that increase the short-term risk of the facility, such as open MOCs, unresolved PHA recommendations, out-of-service critical instrumentation and unaccomplished refresher training, among others. Longer term measures such as audit findings, incident investigations, PHA completion, emergency manual upkeep, etc., would continue to be traditionally monitored. The paper will discuss and describe how these indicators would be structured, the method and frequency of their determination and the potential corrective actions that would improve performance.

Introduction

Good process safety management (PSM) requires management involvement in order to go beyond just regulatory compliance and to set a safety culture in which the principles of PSM can be properly applied. In this paper we will take a very pragmatic approach to explore the means to get management continually involved in process safety. The objective is to develop simple indicators that, analogous to financial performance indicators will provide a continuous measure of PSM performance and an impetus for management to demonstrate good performance.

An indicator provides two functions: it lets the manager know how well he's doing and it serves as a communication tool to upper management and to the employees. The indicator will use metrics to come up with a value or values that can be communicated and easily be understood by the target audience. That is, no matter how technically correct and complex the metrics are, the distilled indicator has to be simple in order to be effective.

The main indicator for management performance in private industry is profits. Typically profits contributed by the facility will result in advancement and pay bonuses for the facility manager and thus he/she will endeavor to have a staff that will manage the various functions that contribute to increase in profits and that avoid factors that may decrease them. On the positive side of the balance sheet are direct factors for increased profits: increased sales and lower production costs. On the negative or neutral side are indirect factors such as safety and environmental non-compliance, loss of production due to incidents and loss of reputation (although it could be argued that on the other hand a good reputation may lead to increased business and thus could be a positive factor). Maintenance is usually included in calculating the regular production costs, by balancing the cost of having the maintenance versus the cost of lost production due to equipment failures. Other factors that may not directly affect the facility's bottom line (at least not in the short term) but could have a severe effect on the facility manager's performance evaluation are safety and environmental impact on the community, personnel injuries and loss of life.

For the direct factors there are many leading indicators that the manager uses to forecast profit: net sales, orders, cost of raw materials and utilities, fixed costs (facility and labor), maintenance costs and non-compliance costs. We will use analogies to these indicators in the process safety area and propose indicators that can be used to forecast good process safety management.

Existing Indicators for Process Safety

Lagging Indicators

Some facility managers still rely on lagging indicators such as an injury index based on hours worked at the facility, e.g. the OSHA 300 Index (29 CFR 1904),

or the number of incidents that occurred in the facility in the previous period with an arbitrary target being set to indicate good safety performance. As it became evident that this indicator correlated well only with basic "hard hat" safety and almost not at all with significant incidents, the search for better indicators started. Better definitions as promoted by CCPS of what constitutes a Process Safety Incident (PSI) and indices that include total plant working hours (Process Safety Incident Rate or PSR) and severity of the incident (Process Safety Severity Rate or PSSR) [1] will potentially bring about in the future better indicators, although those will still be lagging indicators.

The use of "near misses" as an indicator has been tried (and is still being tried) with mixed success. Defining exactly what a near miss is is difficult and the implementation of the program is fraught with problems—employees were reluctant to report too many misses for fear of appearing unable to perform their job or for fear of being blamed for them in spite of extensive support from management. When the definition of a near miss was narrowed to include only releases that exceed a threshold indicating a potentially significant process safety impact, the dearth of consistent data defeated the purpose. This is not to say that these efforts are without value because the involvement and emphasis of management when implementing these programs has brought about an improvement in safety culture in the facilities where they have been tried. This is though, a side effect which is observed frequently: people will tend to perform better when their performance is watched closely and the results meet the expectations. CCPS' efforts to "harmonize" industry wide the definition of a near miss [1] may result in more consistent data down the line to assess the effectiveness of this indicator. But, it does not resolve the influence of human behavior on the data itself, i.e. underreporting or misreporting in order to look better.

With the advent of the OSHA Process Safety Standard (29 CFR 1910.119) the target became compliance with the Standard as a measure of good process safety performance. Although the implementation of the Standard has brought with it a reduction in the number of significant incidents in the petrochemical industry [2], compliance with it alone has not proven to be a good predictor of avoiding disaster. It is widely accepted that because the Standard is open to interpretation, the manner in which the elements of the Standard are implemented and execution follow-up are crucial to good process safety. There is a need for metrics to measure how well each of the elements are being performed (positive factor) or how many missteps are occurring that indicate impending systems failure and a possible severe incident (leading indicators). Since there aren't yet objective standards by which good performance can be judged, we are relegated to measure the deficiencies, or using the Swiss Cheese Model, the holes in the cheese. These can provide some leading indicators though only by going through an arduous road.

Leading Indicators

CCPS has proposed to use and standardize on metrics in the following areas [1]:
1. Maintenance of Mechanical Integrity
2. Action Items Follow-up
3. Management of Change (MOC)
4. Process Safety Training and Competency
5. Safety Culture.

These were selected based on the assessment of hazards inherent in operations, critical factors that resulted in major incidents, and metrics in the CCPS risk-based safety book. Except for the Safety Culture they are very detailed, and seem to require the involvement of experienced process safety professionals and the availability of sufficient resources in terms of instrumentation and personnel to collect them. The purpose is first to try to standardize on the definition of the metrics across industry and then collect the data that will lead to an understanding of the factors that result in good process safety. In order to achieve the latter, results will have to be correlated with lagging metrics such as actual and near miss incidents.

A paper sponsored by the Abnormal Situation Management (ASM) consortium [3] provides a good discussion of these metrics and suggests addressing other causal categories for metrics that should be collected in order to complete the understanding of contributors to process safety incidents.

CCPS' metrics proposal is timely and necessary to arrive at a technical understanding of process safety. It, like financial and accounting principles, will ultimately become the technical basis for guidance to management. That guidance is still yet to be developed and we are proposing a method to do so in a way that will get management engaged in process safety.

Management Guidance

Unlike in the financial field, management is currently left without specific mid-way guidance in the process safety area. There will be an ultimate target once the metrics are accepted by industry, the information gathered, and the results correlated with good performance over time. The immediate guidance remains continued compliance with the Process Safety Standard, improved execution of its elements, and implementation of new concepts such as Operational Discipline and Safety Culture that have been developed in the last few years and seem to be harbingers of better process safety. The interpretation of how to do this continues to be left to the process safety professionals in the plant and participation of management is relegated to giving support to his staff without direct involvement.

In addition, developing the metrics proposed by CCPS requires a level of trained personnel, equipment and instrumentation resources, that many small and mid

size companies won't be able to mobilize. When companies already have problems finding experienced people to review the safety analysis made in an MOC, and when there aren't enough resources to close the MOC that was started months ago, identifying and analyzing the type of changes that tend to bypass the MOC procedure (one of the CCPS metrics) may not be the highest priority for the facility. The facility manager will be hard put to allocate resources for metrics while satisfying the usual requirements of PSM is not being accomplished. Thus, simple management indicators are proposed where the metrics are collected as part of the usual conduct of business.

Proposed Management Indicators

The proposed indicators are simple in order to achieve the objectives of (a) easy gathering of the information, (b) easy communication to both employees and top management and, (c) a reflection of the level of risk in the facility at any point in time. If these objectives can be met then site management will be involved in the administration of site process safety and the employees will be engaged. As mentioned above, just the fact that management gets involved tends to produce better results, in this case probably an improved safety culture.

The indicators are based on maintaining low facility risk as will be explained later. The areas of focus are:

6. Action Items Follow-up
7. Management of Change (MOC)
8. Process Safety Training, and
9. Operational Integrity.

These four areas are not too dissimilar to those chosen by CCPS as far as selected areas but there are differences in their treatment. Mechanical Integrity (MI) is not included as part of the metrics because this is an area where site management is already involved and, as discussed before, the objective of keeping the plant running without equipment breakdowns has already been set. It can be argued that the usual MI program will not single out the critical equipment and therefore it will not get the attention it deserves. But, let's give some credit to the people managing the program in that they understand the importance of the usual safety devices (reliefs and vent devices, interlocks and safety shutdown systems, emergency response equipment, etc.) and provide the appropriate care and inspection. As for other critical equipment, it is better covered under Operational Integrity (see below). The metrics in the other areas and the reasons for their selection are as follows.

Action Items Follow-up. Since our objective is to maintain low overall risk, any open action item from a PHA, an open incident investigation recommendation or an incomplete incident investigation impede attaining that objective. The metric here is the total number of open action items in each of the three categories. These numbers should be easy to obtain and should be reported on a monthly

basis. The selection of this metric is obvious given the reason for performing PHAs and doing incident investigations—a potential risk has been discovered from the PHA on one side, or an actual risk exists and resulted in an incident on the other side, and that incident needs to be investigated. If the investigation was conducted and the action items were not closed out, that means that the causes of the incident have not been removed and the potential for an equal or similar incident is very actual. It is also assumed that the PHA was conducted using a risk matrix and the action items resulting from it have already been screened for high risk. The percentage of action items completed is not as important as the total number of open ones because the percentage only reflects the resources put to work in that area—it is a measure of the rate of reduction of risk rather than the total risk present.

Management of Change (MOC). By definition MOC represents flux in the plant outside of predefined safe limits. The more undergoing changes there are at a given point in time, the higher the total facility risk. That is, the more open MOCs there are, the higher the probability of making mistakes, if nothing else because the process safety information is fluctuating and the knowhow has not yet kept up with it. Furthermore, we know that startup or shutdown of a process represent a more hazardous operation than steady state. By analogy the sum of changing conditions in the plant increase the hazards of the plant. Therefore we want to know the total number of open MOCs at a point in time. If the number is high (facility dependent) it means either that the facility is engaging in too much activity, or if the changes are necessary, not enough resources are being allocated to complete the changes. This is the type of decisions that site management ought to be doing and where the underlying reasons are not difficult to fathom. The number will depend on the size and dynamics of the facility. It should be reported monthly.

The corollary to risk represented by change is that the longer a change is incomplete the higher the probability of something going wrong. Since we already require an expected date of completion when doing an MOC, we need to watch that that date is not exceeded. When dealing with temporary changes this becomes more critical because we have done an assessment on the safety of the change taking into consideration a specific and limited length of time. Thus, if follows that both the number of past-due MOCs and past-due temporary MOCs ought to be also monthly metrics for risk reduction. Collection of these data ought to be simple since they should be part of any efficient MOC system [4].

Process Safety Training. Having well trained personnel to operate the plant processes is essential to good process safety. It is assumed that a plant will have competent trainers and a method for testing effectiveness of the training. As opposed to CCPS' metric in this area, the measure that is being sought is one of training of anybody that operates a process rather than just those in PSM critical positions. In order to maintain a continuous level of skills refresher training is required and is mandated also by the PSM Standard. Because of the nature of

training and the capacity of an individual to absorb the training, it cannot be a once-a-year event but needs to be distributed throughout the year. To follow if this is being done the metric would be the percent of operators that have been provided refresher training in a quarter on one fourth of the existing operating procedures. The objective would be to provide refresher training to all the operators and maintenance personnel on all their procedures at the end of each year. By watching this number the site manager can track the maintenance of skills of the work force.

Operational Integrity. The metrics in this area try to capture the quality of operations that have inherently higher risks. This is accomplished by inspection of the PHA completed for the process and identification of the personnel, equipment and instrumentation that act as safeguards against the occurrence of a high-severity incident. This personnel, equipment or instrumentation would then be considered "critical" and a maximum time for their unavailability and/or backup protections for the missing item would be defined. For example, a redundant flammability meter used to initiate a shutdown (1oo2) that is out of order could be out for a day until a replacement is found and installed before having to shut down the process. A backup during the unavailable time could be setting the flammability alarm at a lower setting and/or putting an additional operator to watch it (if the same instrument was out for an hour for routine calibration this should have been taken into consideration when assessing the risk during the PHA and wouldn't constitute a critical unavailability).

In the same vein, if there was a critical administrative safeguard, e.g. operator rounds in which a variable is read at a certain frequency during a shift, then a decrease in coverage during that shift due to an operator's absence would be a critical unavailability. The metric in all cases would be the number of "critical unavailabilities" recorded each week. The unavailability would be recorded even if a backup plan was in effect. Of course, just recording the unavailability wouldn't excuse not taking corrective action before too much time passes. The number of unavailabilities during a period would be an indication to management of how well the Mechanical Integrity program takes into consideration risk, of how good is the understanding of the process risks by the operators, and of how good is the understanding and follow up of operations supervision in maintaining an operational discipline of minimizing the length of the outages.

Once the upfront definition of the critical items has been completed collection of the metric should be straightforward. Unavailable critical items would be posted on a high-visibility board in the control room and remain there until those items are returned to service. This would serve the dual purpose of reminding operators of the unavailability of these items during and across shifts, and help record the unavailabilities for each shift. The daily numbers would be reported to site management possibly on a bi-weekly basis depending on the facility.

Conclusions

Simple indicators of facility risk have been proposed for use by site management for making decisions that impact process safety and for communicating the health of the process safety program to employees and top management. These indicators are:

1. Action Items Follow Up – the number of open action items from PHAs and incident investigations and the number of incomplete incident investigations;
2. Management of Change (MOC) – the number of monthly open, past due and temporary past due MOCs;
3. Process Safety Training – the percentage of operations and maintenance personnel given refresher training in each quarter to ensure that all personnel will be trained on all procedures within a year's time; and,
4. Operational Integrity – the number of daily critical unavailabilities.

These indicators do not claim to be a measure of total facility risk but they provide direction on how to reduce and maintain a lower facility risk and are predicated on a good underlying process safety program. Because of their easily understood relationship to risk the indicators will make site management more apt to become involved and directly influence the performance of process safety in the plant. The indicators provide a continuous short-term link between desirable management action and the underlying technical basis without having to have total reliance on the technical staff.

Direct involvement of management in process safety can only improve Safety Culture in the site which is turning out to be a key element in good process safety. Additional improvements can be obtained by integrating these simple metrics into the management structure, i.e. a management system designed with process safety in mind [5]. It is hoped that with the continued use of these indicators as a communication tool will help to build in process safety performance as a part of total site management's performance and eventually be rewarded similarly to fiscal performance.

REFERENCES

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