



Evaluation of process safety indicators collected in conformance with ANSI/API Recommended Practice 754



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ABSTRACT

At the request of the U.S. Chemical Safety and Hazard Investigation Board (CSB), we examined some of the possible uses of the process safety event metrics proposed by the American Petroleum Institute and published as ANSI/API Recommended Practice 754. We examined many sources to try to estimate what the likely number of Tier 1 and Tier 2 process safety events would be at refineries. Then we calculated the statistical power that would be available to compare rates, both over time and across facilities and firms. As Tier 1 and Tier 2 are defined, it appears that the event frequencies estimated for U.S. refineries (i.e., 0.12 per 100 employees for Tier 1 and 0.26 for Tier 2) would make it unlikely that even two-fold differences in the rates would be statistically significant, except at large refineries with several thousand workers.

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1. Introduction

This paper examines whether reporting of process safety incidents under ANSI/API Recommended Practice (RP) 754 (April 2010) can provide useful measures of process safety performance in the petroleum industry. That was the objective of the United States Chemical Safety and Hazard Investigation Board (CSB) when it recommended that a new reporting system be established for process safety incidents.

The CSB made this recommendation in its report (CSB, 2007) on the 2005 explosion at the BP Texas City refinery, which killed 15 workers and injured more than 170. A key finding from its investigation was that many firms used only the injury and illness rates that OSHA requires them to maintain as measures of their safety performance. However, firms in process industries also face risks from low-probability, high potential accidents; and the OSHA rates may not tell firms very much about their safety performance with respect to these risks.

The CSB concluded that firms needed a measure or measures specifically focused on process safety and made a recommendation to both the American Petroleum Institute (API) and the United Steelworkers of America (USW), which represent employees at about 50% of the nation's refineries, to develop such metrics. In response, API developed and the American National Standard

Institute (ANSI) approved Process Safety Performance Indicators for the Refining and Petrochemical Industries. The USW initially participated in the API/ANSI committee, but withdrew primarily because of what its leaders perceived to be an imbalance in the voting membership of the committee.

To conform to ANSI/API RP 754 companies are expected to collect and publicly report rates of Tier 1 and Tier 2 process safety events. Conformance to the standard and reporting of the data are voluntary. API has stated that it is collecting data for 2011 and 2012 from participating companies and intends to make national data at the industry level publicly available sometime in 2014.

For process safety indicators a key issue is whether, in the relevant time periods, there are sufficient instances of the events being counted to be able to meaningfully estimate a rate of events. More specifically, the "events" that are counted must occur in sufficient numbers to permit statistical comparisons and trend analyses (often called "benchmarking"), so that the indicators can be used to drive process safety performance improvements. The selected indicators must be true precursors or predictors of more serious events, and their statistical power must be sufficient to permit the kinds of comparisons that can drive process safety performance improvements.

In sponsoring this study, the CSB's objective was to understand the usefulness, from a statistical perspective, of Tier 1 and Tier 2 process safety incidents (as defined by Recommended Practice 754) to permit the analyses and comparisons described below. The first task was to learn about the average number, range and distribution of Tier 1 and 2 events per facility and per corporation in US

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Glossary

ANSI	American National Standard Institute
API	American Petroleum Institute
BSEE	Department of Interior's Bureau of Safety and Environmental Enforcement
CONCAWE	Conservation of Clean Air and Water in Europe
CSB	Chemical Safety and Hazard Investigation Board
EPA	U.S. Environmental Protection Agency
FTE	full-time equivalent
HSEES	Hazardous Substances Emergency Events Surveillance
LOPC	loss of primary containment
OSHA	Occupational Safety and Health Administration
PS	process safety
PSE	Process Safety Event
RMP	risk management plan
RP	recommended practice
USW	United Steelworkers of America

refineries. We also tried to estimate the number of direct and contract employees at refineries so that we could calculate the rate of process safety incidents per worker.

2. The provisions of Recommended Practice 754

The objective of RP754 was to recommend leading and lagging indicators for use in the refining and petrochemical industries.¹ The focus was solely on process safety in these industries, not general worker safety. The indicators would be used for public reporting and safety monitoring at individual facilities.

It is important to note what the “guiding principles” behind the choice of performance indicators were. RP754 states that:

- “Indicators should drive process safety performance improvement and learning.
- Indicators should be relatively easy to implement and easily understood by all stakeholders (e.g., workers and the public).
- Indicators should be statistically valid at one or more of the following levels: industry, Company, and site. Statistical validity requires a consistent definition, a minimum data set size, a normalization factor, and a relatively consistent reporting tool.
- Indicators should be appropriate for industry, company, or site level benchmarking.”

Tier 1 and Tier 2 both represent undesired process safety events; they differ only in the magnitude of the harm or risk.

¹ These terms can be a source of confusion. In the simplest terms, a “lagging indicator” is a measure of the riskiness of a facility during a certain prior period. In contrast, a “leading indicator” helps to predict riskiness in a future period. One problem with this distinction is that a lagging indicator, e.g., the injury rate, is often a good predictor of what the injury rate will be in the future. Similarly, one lagging indicator (e.g., minor injuries) will often, but not always, be a good predictor of the rate of another lagging indicator (e.g., more severe injuries). A more meaningful distinction is between indicators which have preventive potential and those which do not. Both may be predictive. The number of injuries this year may predict the number next year, but it cannot prevent them. In contrast, a larger number of inspections of safety equipment may prevent injuries and, if it does, a measure of that activity will also contribute to predictions. In this sense, a useful leading indicator must be an activity or condition that has preventive value. We usually lack hard evidence about preventive value, which means that the judgments are made primarily on the basis of professional judgments.

A Tier 1 Process Safety Event (T-1 PSE) is a loss of primary containment (LOPC) leading to an unplanned and uncontrolled release of any material from a process which results in one or more of the following consequences:

1. An employee or contractor experiences an injury which involves “days away from work” or death.²
2. A hospital admission or death of a third-party
3. An officially declared community evacuation or community shelter-in-place
4. A fire or explosion resulting in more than \$25,000 in direct costs to the firm
5. A pressure relief device discharge to the atmosphere, if it results in one or more of the following:
 - Liquid carryover
 - Discharge to a potentially unsafe location
 - An on-site shelter-in-place
 - Public protective measures (e.g., road closures)

AND if there is also a pressure relief device discharge quantity greater than a threshold quantity in a 1-h period.

- A release of material greater than the threshold quantity in Table 2 [not shown here] in any one-hour period.

The definition of a Tier 2 PSE event is the same except that the injury can be less serious (any “OSHA recordable” injury—a category about 3 or 4 times as large as the DAW injuries), the damage can be as little as \$2,500, and the threshold release of chemicals can usually be only 1/10th as large.³ Both Tier 1 and Tier 2 rates are calculated as the number of events divided by 200,000 work hours (also referred to as 100 full-time equivalent workers).

Although they are not the subject of this paper, we should note that RP754 also called for reporting of what it labeled Tier 3 and Tier 4 incidents. RP754 defined a Tier 3 PSE as “a challenge to the barrier system that progressed along the path to harm, but is stopped short of a Tier 1 or Tier 2 LOPC consequence.” Tier 4 indicators apply to the performance of the management system. The document gives examples, but leaves it to firms to decide which to use.

3. Dissemination of performance information

RP754 states that “Annually, each Company shall publicly report Tier 1 and Tier 2 PSE information specified in Table 3.” That Table includes PSE counts and PSE rates at the industry level and PSE rates at the company level. The firm is required to annually submit “a summary of its site-specific Tier 1, Tier 2, Tier 3, and Tier 4 PSE information to employees and their representatives.” The term “PSE information” is not defined. The “Notes” to the 2010 edition of RP754 cautions that “Public reporting of Tier 1 and Tier 2 data may not occur for the first few years while the recommended practice is being implemented and the quality of the data is being validated.”

Although the authors of RP754 discuss the general criteria for selecting indicators, they did not explain their reasoning about the trade-offs involved in choosing these particular indicators.

² The term “days away from work” is drawn from OSHA recordkeeping regulations. It excludes injuries resulting in restricted work activity or job transfer.

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