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Refinery Process Safety Performance and Models of Government-Industry Relations

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RAND Office of External Affairs

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Testimony submitted before the California Department of Industrial Relations and the Governor's Task Force on Refinery Safety on June 11, 2013

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Refinery Process Safety Performance and Models of Government-Industry Relations²

**Before the California Department of Industrial Relations and
the Governor's Task Force on Refinery Safety
State of California**

June 11, 2013

A major explosion at the Chevron refinery in Richmond California in August 2012 did not, fortunately, kill anyone, but it led 15,000 people in the community to seek medical attention. That event spurred the Governor to establish a Task Force to examine what steps should be taken to improve refinery safety in the State.

RAND was asked by Christine Baker, the Director of the Department of Industrial Relations, to investigate several issues in order to inform the Task Force's discussions. This memo is the response to that request. It has 3 parts. The first summarizes information about different regulatory models and provides some recommendations about how to proceed in adopting new models. The second briefly summarizes suggestions about the role that measures of "leading indicators" can play in future regulation. The third reviews what existing measures tell us about changes over time and comparisons across continents.

Models of Regulation

The American model of work safety regulation relies on inspectors to detect hazards at facilities and ensure that they are corrected. California's model is similar except that it puts a greater emphasis on investigating serious accidents that have occurred and less on planned inspections. Over the last 25 years, a perspective has developed that argues that this model is poorly suited to ensure safety at very complex facilities, especially those characterized by risks that have low frequency but very high disaster potential. This perspective emerged first in Europe, triggered by disasters in the North Sea and at Seveso, Italy. The former led the United Kingdom (UK) and Norway to develop a "safety case" approach to regulating off-shore oil platforms in the 1990s, an approach later expanded to other high-hazard process industries. The European Union's Seveso

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Directives ordered some similar measures for all member states. The safety case approach puts the responsibility on facilities to explain what they will do in order to try to ensure their safety. The regulatory authority has to judge whether this effort is acceptable and then takes a role of auditing to ensure that the firm does what it says it would do. It generally does not inspect to find hazards, leaving that job to the company.

The major efforts in the United States to address safety issues in refineries (and the chemical and petrochemical industries) also emerged in the early 1990s. They included the Occupational Safety and Health Administration's (OSHA) Process Safety Management (PSM) standard of 1992 and the Environmental Protection Agency's requirement for Risk Management Programs (RMPs). Both of these were focused on facilities which used minimum quantities of specified toxic substances. OSHA's PSM rule mandated many of the standard activities already used in industry to ensure safe operations. Both OSHA and the EPA required that firms have a written document that explained how the firm would carry out these requirements. The EPA document had to be submitted to the agency and redone every 5 years. It also required that process safety incidents related to the chemicals included in the RMP had to be reported to EPA, although this requirement appears to have been weakly enforced and suffered from major non-compliance.³

Both regulatory agencies appear to have devoted only limited resources to refineries. For example, in the 5 years from September 2007 through July 2012, there were 63 inspections at California refineries (excluding accident investigations). With about 16 operating refineries, this is about 80 "refinery-years;" so there was less than 1 inspection per refinery per year. Federal OSHA has inspected refineries even less frequently, despite a recent campaign focused on refinery safety.

Moreover, the inspections that Cal-OSHA has carried out have not been very effective at detecting hazards. During the same period, 5 of 15 complaint inspections cited a violation, including only one serious violation. Among the 48 programmed inspections, only 4 cited a violation, including only one serious violation. Thus even when there have been inspections, they have contributed relatively little to hazard abatement. We believe Cal-OSHA could be more effective if it shifted its role to place more emphasis on monitoring whether the companies are meeting their own measurable goals for process safety.

One point that needs to be stressed is that both the safety case model in the UK and the Industrial Safety Ordinance (ISO) approach used in California's Contra Costa County involve considerably more resources than OSHA or Cal-OSHA have deployed in the refinery industry.

³ Gomez M, Casper, Smith (2007)

According to Ian Travers, the Director of the Hazardous Facilities Unit that oversees UK safety cases, the Unit typically conducts several audits each year at refineries to assess their safety case activities.⁴ Although we have not calculated the resources used by Contra Costa County agencies, their interactions with refineries clearly have been much more frequent than those by Cal-OSHA. The implication of these findings is that any new initiative, whatever its form, is likely to require additional resources if it is to be effective.

Some have argued that the safety case process often leads to initial gains in hazard recognition and abatement. However, it must remain “a living document” in order to fulfill its objectives. As Ian Travers commented, the main potential concern with the safety case approach is that describing and documenting how you will manage risks is not the same as actually managing risks.

The Governor’s Task Force held numerous hearings for labor, community, and industry representatives. At a meeting with the last group on March 18 in Santa Monica, the participant from Shell in Contra Costa County, who had also spent considerable time in a Southern California refinery, said that she believed that the attention to safety was noticeably greater in the North as a result of Contra Costa’s ISO program. None of the other industry representatives there spoke to that point, either to agree or disagree.

In developing new public policies, it is generally better, other things equal, to choose options that can achieve a goal with a minimum of disruption. Familiar routines, in this regard, are preferable to brand new ones. This maxim suggests giving serious consideration to strengthening the Contra Costa ISO model rather than requiring all to adopt new methods.

However, we have to acknowledge that, at this point, we don’t have a sufficient understanding of all that goes on in the ISO regime to be able to identify the exact ways in which it differs from the UK safety case operation. While there may be useful lessons to be gained by further examination of the UK system, we still think that it makes the most sense to extend and improve the ISO model as the basis for new proposals.

The Role of Leading Indicators

Above, we referred to the role of the regulator in auditing the firm’s safety program. But what practices or conditions should it be auditing? You can’t look at everything. Everyone seems to agree that the traditional measure of injury rates has two major flaws: first, it doesn’t tell you

⁴ Personal communication, March 17, 2013.

much about low-frequency, high severity risks like explosions. In addition, although past injury rates may be predictive of future injury rates, what is needed are measures of activities that are known or believed to be effective at preventing explosions and similar events. These are referred to as “leading indicators.” The terms “leading” and “lagging” indicators 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.

But 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, more frequent inspections of safety equipment may prevent injuries and, if they do, 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 now made primarily on the basis of professional judgment.

At the request of the US Chemical Safety Board, the American Petroleum Institute developed a recommended practice (RP 754) that obligates its member firms to adopt several types of both lagging and leading indicators. All of the lagging indicators focus only on events that pertain to process safety hazards (e.g., releases from pressure vessels and pipes), not general safety hazards. For leading indicators, the API did not stipulate which ones firms should use, but gave several examples, including whether various activities have been completed on schedule, fatigue risk management measures (e.g., overtime), completion of emergency response drills, safety critical equipment inspection and deficiency management.

RP754 *requires* each company’s facilities to report a summary of both lagging and leading indicators to the employees and their representatives. It also *requires* a summary of lagging indicators be provided to local communities and emergency management officials. It says that the Company *may* provide refinery-specific summaries of leading indicator data to the communities and EMS officials.

California should take advantage of the API’s increased commitment to the principle of reporting to the public. The Contra Costa ISO already does require more reporting than RP754. United Steelworker unions in Northern California have been considering which process measures should be reported. The State can bring union and management together statewide and use their recommendations to decide on a new set of measures that, ideally, are reliable, relevant, easy to measure, and auditable. The most important measures to focus on are the leading indicators,

because they can drive the auditing process. The lagging indicators of process safety events are likely to have low statistical power—that is, they are unlikely to be able to identify statistically significant changes at refineries and differences among refineries (Mendeloff et al. 2012).

Evidence of the Effectiveness of Alternative Regulatory Models

A study commissioned by the UK's Health and Safety Executive (HSE) in 2004 reviewed the evidence regarding the costs and benefits of the safety case approach (Vectra 2004). It found essentially no hard evidence on the net benefits of the policy. There was a great deal of opinion, most of it (but not all) suggesting that the policy had led to better hazard identification. There was also a good deal of questioning by industry about whether the program was worthwhile. Ian Travers indicated that there had not been any strong empirical work since that review that would alter the conclusion. Our review of the literature since 2004 did not find articles that suggest otherwise.

A review of the various sources of information about measures of process safety outcomes ("lagging indicators") that provide comparisons over time or across countries suggests the following points:

- The number of fatal process safety accidents at refineries in the US has declined from the level it had reached in the 1980s.
- The US Chemical Safety Board has stated that it believes that U.S. refinery safety is worsening. This view reflects, in part, the fact that, prior to 2007, only about 10% of the roughly 50 investigations carried out by the CSB involved refineries. Today, 6 of its 12 active investigations involve refineries.
- Swiss Re (2006), a large re-insurer, reports finding that refinery safety practices in the US make them less safe than those in Europe.
- The United States has a disproportionate share of the world's highest cost refinery disasters over the last 30 years, suffering half of the events despite having less than one-quarter of world's refineries and refining capacity. (Marsh and McLennan 2011)
- The lagging measure of the rate for process safety events reported by API for US refineries (for 2011) and by its European counterpart for European refineries (for 2010) show that the European rate was about twice as high. This result is fairly surprising because most Western European fatality rates are considerably lower than US rates across most industries (Mendeloff and Staetsky, 2012). We suspect that process safety events are underreported to a greater extent in the US.

Although uncertainty remains, we interpret the available data to indicate that process safety performance at US refineries is worse than it is in Europe. We think the evidence is mixed about whether US refinery safety has improved or declined during the last 30 years.

Summary and Recommendations:

We have found that:

- 1—US safety performance at refineries has not been good by international standards.
- 2—However, Cal-OSHA inspections of refineries typically find so few hazards that they contribute relatively little to refinery safety.

As a result, we make the following recommendations:

- 1—Place more responsibility on firms to lay out how they will ensure safety and have regulators focus on auditing their performance.
- 2—Adopt an incremental approach for making the transition from the current enforcement program to the one recommended.

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