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Regulatory Report of the Chevron Richmond Refinery Fire

(Please click on the name to be directed to the associated comments)

Comments from Najmedin Meshkati. PhD. CPE & Alvin Chin – January 3, 2014

Comments from Dr. Sam Mannan; Mary Kay O'Connor Process Safety Center – January 3, 2014

Comments from Carl Southwell – January 3, 2014

Comments from Tim Smith – January 3, 2014

Comments from Michael J. Wright, Director, United Steelworkers Health, Safety and Environment Department & Kim Nibarger, Specialist; United Steelworkers International Union – January 3, 2014

United Steelworkers Local 5 Comments on the CSB Regulatory Report from the Chevron Richmond Refinery Pipe Rupture and Fire.

The United Steelworkers Local 5 would like to thank the U.S. Chemical Safety Board for the opportunity to review and comment on the draft of the Regulatory Report. We appreciate the effort put into this draft report and look forward to the final regulatory report as well as the full Final Report on the Chevron Richmond Refinery incident.

2012-03-I-CA-R21

A "Safety Case" approach is definitely a goal that we would like to see the State of California set for itself. Understanding that it will take time and effort to get there, as well as many transition years. We believe that at the end of the day the workers and communities as well as the industry will be in a much better place.

In order for the Safety Case approach to be effective, there needs to be the tripartite model in place. The workers' and their representatives must have the ability to play an equal and essential role in the direction of preventing major accidents. Currently under PSM law, the workers have been minimalized and silenced when it comes to safety in the plants.

Everyday throughout refineries it is a constant struggle to not only play a role but even be invited to the table. Current employee participation language is not strong enough to make our participation mandatory, let alone have our voices heard as an equal party. There are refineries purposefully leaving the workers and their representatives out of investigations and MOC process, simply because they think it is easier without them. That lack of respect by the industry will need to change or be changed in order for the safety case approach to work effectively.

Another aspect that we appreciate about the safety case is that its takes the burden off underfunded and understaffed regulators and places it on the industry. Industry does have the resources to comply with the Safety Case requirements. Most of the refiners that we deal with, already comply with the approach in parts of the world where it is already in place.

The current system is truly a self regulated system, with the industry setting the rules, changing the rules, and monitoring themselves. The tide needs to shift and set the regulators up to be successful. For that to become reality, the compensation recommendation (2012-03-I-CA-R21(h)) is essential. This would help level that playing field and ensure that the right people are in the positions.

We understand that the "Safety Case" approach is not perfect, nor will it be an easy transition, but we do feel that given the FULL support and buy-in of the State Regulators, The Industry, and the Workers this system puts us in a better position to operate the refineries safer.

2012-03-I-CA-R22

Here in Contra Costa County the USW Local 5, CCC, and industry have been meeting around Process Safety Indicators for the past few months. The goal has been to come up with a list of indicators that industry collects and publically reports. This has been a challenge given the different types of industry here in Contra Costa County, different refining companies, and all parties having different goals.

Given our efforts around Indicators here, we fully support this recommendation to the State of California. We believe the tracking and reporting of Indicators will drive continuous improvement and help identify areas of concern for industry. We hope to see the State adopt the same approach that we are taking here in Contra Costa County, which is in line with this recommendation.

Once again we would like to thank the CSB for the opportunity to review and comment on the draft report.

REFINERY

ACTION COLLABORATIVE

SAN FRANCISCO BAY AREA

November 27, 2013

c/o The Refinery Action Collaborative – San Francisco Bay Area
2223 Fulton St. 4th Floor
University of California, Berkeley
94720-5120

Donald Holmstrom, JD
Director
Western Regional Office of Investigations
US Chemical Safety and Hazard Investigation Board
……..
Denver

Dear Director Holmstrom:

We are writing to support the U.S. Chemical Safety Board's draft of its second report on the Chevron Richmond incident.

We commend the report's accurate statement that Chevron management repeatedly neglected to respond to warnings, concerns and recommendations issued by the workers and technical staff at the Richmond facility. Even though Richmond Chevron's workers recommended employing inherently safer systems through the Management of Change process, Chevron management ignored these recommendations.

The Refinery Action Collaborative commends the report's acknowledgement that the California Process Safety Management (PSM) standard needs to be strengthened in order to prevent such disasters as the August 6, 2012 explosion from occurring again. For example, sulfidation corrosion of piping was not identified as a hazard in the 2009 Process Hazard Analysis (PHA) of the crude-unit. In failing to do so, Chevron was not required to prevent or effectively address the issue of sulfidation corrosion. Even if sulfidation corrosion was identified as a hazard, neither the federal nor the California PSM standards require the evaluation of hazard control effectiveness.

The Refinery Action Collaborative agrees with the report in that Cal/OSHA's ability to sufficiently inspect facilities and enforce regulations is hampered by severe understaffing and underfunding of the agency. The Refinery Action Collaborative believes a new regulatory framework with adequate financial and personnel resources, strong requirements for worker involvement, and a clear focus on goal than activity needs to be implemented in California in order to have satisfactory oversight of the state's high-hazard facilities.

Once again, we salute the leadership that you and the CSB have demonstrated in responding to both the Chevron Richmond disaster and to California's refinery safety issues as a whole.

The Refinery Action Collaborative will be sending more comprehensive and constructive comments in early December, which will include specific recommendations to further strengthen areas of the CSB report.

Best regards,

The Refinery Action Collaborative – San Francisco Bay Area

From:	Bell, John (HAYS)
To:	chevroncomments
Subject:	The Safety Case,case!.
Date:	Monday, December 16, 2013 6:30:11 PM
Attachments:	Final-the-Regulator-Issue-1-2013.pdf

Fellow practitioners,

The National system of Safety case in Australia has provided positive outcomes for those involved in the offshore oil and gas industry, unfortunately the safety case governing refineries in Australia is disjointed and falls under the auspices of DMP. This is another regulator covering mining, onshore and state waters, as well as dangerous goods including (MHF) major hazard facilities Refineries and like industry.

The regulator offshore National is NOPSEM in Australia. They present a tight ship as far as regulation goes, the process is a form of self-regulation overseen by site audit via the regulator, paid for by the operator so that staffing is not an issue.

Safety cases are often rejected, currently an operator has three attempts to achieve licences to operate from the regulator, No safety case approval no licence to operate!. This provides what I believe is required Globally, that's country to country and industry to industry. As we now realise that people have the right to work safely, with reduced risk and known risk that has been fully mitigated.

I think John Glen stated "A giant leap forward for mankind", no we are not on the moon, we are mere mortals at the work place . It's a long time since the industrial revolution, its taking a long time to offer workers surety of health and wellbeing at work-WHY?.

The attachment is a copy of The Regulator edited by NOPSEMA, this is what good looks like in Australia. The question is -: "Is it good enough?" the answer when people are no longer killed or maimed at work then its good enough!.

Thanks for the opportunity to make a Step Change in Safety

John Bell

A health and safety practitioner Perth Australia

NOPSEMA

the REGULATOR

Issue 1 : 2013

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"Liberty means responsibility. That is why most men dread it."

George Bernard Shaw

From the CEO

Like many of you, I relish the opportunity at the start of a year or planning cycle to take stock of objectives, question priorities and improve plans to deliver them. But even with the best intentions, our objectives and the way we pursue them will be influenced by other factors. Some factors will be beyond our control, many we will seek to influence and a few will spur us to do even better.

Australia's offshore oil and gas industry is rightly expected by government, shareholders and the wider community to develop oil and gas resources while building a reputation for safety and environmental responsibility. Industry leaders regularly share with their stakeholders how they are investing in more advanced systems, better training, safer working conditions and the least risky way of doing business offshore. They often share new data and insights on the environment in which they operate.

Operators have a responsibility to manage changes that occur routinely on their facilities, be it a planned change or response to an unforeseen development. There is also a clear expectation that the offshore industry, as a whole, should have a ready capacity to manage change in order to continuously improve the way they run their operations.

In light of the lessons from past experiences, the regulatory regime that NOPSEMA administers allows industry to manage risks within a flexible framework. This does not mean operators 'get off lightly' compared to those in more prescriptive regimes. Australia's regulatory framework encourages continuous improvement and avoids a focus on unnecessary prescriptive requirements which can stifle innovation. NOPSEMA expects operators to rise to the challenge and demonstrate how they are reducing risks for any petroleum activity offshore, be it a seismic survey, complex drilling activity or a long-term production project. In return, I welcome the challenge of meeting your high expectations of NOPSEMA in 2013. I am confident that, in the end, our mutual track records will speak for themselves.

Jane Cutler
CEO

Asset integrity management – changes in operating conditions

During an inspection of an offshore production facility, NOPSEMA examined the operator's response to a change in produced gas composition. The operator had initiated a review of materials compatibility against the new gas composition. The review, however, focused on the metallic constituent of the containment barriers. NOPSEMA recommended the operator also consider the type of materials used for seals across the facility. The further review identified a number of vessels, pumps and valves with seals that were incompatible with the produced gas, raising the risk of an unplanned hydrocarbon release (HCR).

The operator's initial approach is not an isolated case and the final findings demonstrate the value of a comprehensive review of seal materials following a change in gas composition. Furthermore, data from incidents reported to NOPSEMA since 2005 shows that seals and gaskets account for 14% of all unplanned hydrocarbon releases. NOPSEMA data shows that nearly 20% of the 1-300kg unplanned gas releases are linked to seal failures, of which 44% are due to incompatible seal materials with operating conditions.

The *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGSA) states that operators have a duty to take all reasonably practicable steps to provide and maintain a safe physical environment on a facility (OPGGSA, Sch 3, clause 9(2)(a)). Operators should ensure that all containment materials remain appropriate whenever a fluid composition changes or new chemical is used, or when any other operating conditions change, in order to reduce risks to as low as reasonably practicable. Seal materials can be susceptible to chemicals and operating conditions, including methanol, H_2S dry or wet, monoethanolamine (MEA), corrosion inhibitors (often amine based), triethylene glycol (TEG), temperature, explosive decompression and static/dynamic application. Operators should consider the implications of any significant change to these conditions, with the assistance of their suppliers.

Future issues of the *Regulator* will feature articles on other aspects of managing the risk of unplanned hydrocarbon releases.

Seal failures in unplanned hydrocarbon releases - 2005 to Nov 2012

Volume (kg/litre)	Number reported	Number involving seals/gaskets	% involving seals/gaskets
HCR 1-300 kg	129	25	19%
HCR >300 kg	21	1	5%
HCR 80-12500l	28	1	4%
HCR >12500l	1	0	0%


Courtesy of Woodside


Courtesy of the LA Times

Oil spill response planning: why wait?

Lessons from major oil spills in Australia and overseas document the advantages of preparing response scenarios ahead of a potential oil spill incident. Effective preparations will reduce pressure on the response team and achieve the best response outcomes in the critical hours immediately following an incident. Every decision that requires consideration during the incident has the potential to delay the response process, resulting in environmental impacts that could have been avoided.

The nature of offshore oil and gas activities offer an advantage for oil spill response planning, in particular obtaining regulatory approvals for the use of dispersants. Traditionally, lodging applications for such approvals has only been possible after an oil spill occurs. In the past this has not been appropriate for shipping spills, which involve a number of variables, such as the type of oil the vessel is carrying and the location of a possible spill. These variables cannot always be documented in a response plan and instead must be evaluated when an incident occurs.

In the case of planning and response for spills from offshore petroleum facilities or activities, however, there is more certainty around these variables. The location of the facility or activity and oil type are known, and an assessment of environmental impacts and risks is completed, well in advance of the activity commencing. This means the spill risk and response strategies can be more clearly defined based on situational data, allowing for a more timely oil spill response if the need arises.

Under the OPGGS Act and Environment Regulations, if an operator wishes to use dispersants as a management measure for oil spills, they are required to state their case within an oil spill contingency plan as part of an environment plan assessment by NOPSEMA. If proposing to spray dispersant, operators are required to demonstrate that the use of dispersant reduces overall risks to as low as reasonably practicable and to an acceptable level.

In addition to the OPGGS Act and Regulations, further information on oil spill planning is available on the "Environmental resources" page at nopsema.gov.au. These include GN 1074 – Guidance Note – Environment plan content requirements and GN 0940 – Guidance Note – Oil Spill Contingency Planning.

Information on competency assurance

Competency assurance is defined as the formal systems, tools, and processes which ensure that personnel are competent to complete assigned tasks to an expected standard. It is a critical aspect of risk management in the offshore petroleum industry. Competency assurance processes, when implemented, contribute to the management of safety and environmental risk. Furthermore, a competent workforce is a necessary component of any approach to reduce occupational health and safety, well integrity and environmental risks to a level that is as low as reasonably practicable (ALARP).

NOPSEMA has developed an information paper to assist responsible parties in the design and implementation of effective and robust competency assurance processes. The information paper is the first in a NOPSEMA series focusing on human factors. The series is designed to provide information and advice about the ways in which human factors tools and techniques can be applied to contribute to the reduction of risks to ALARP.

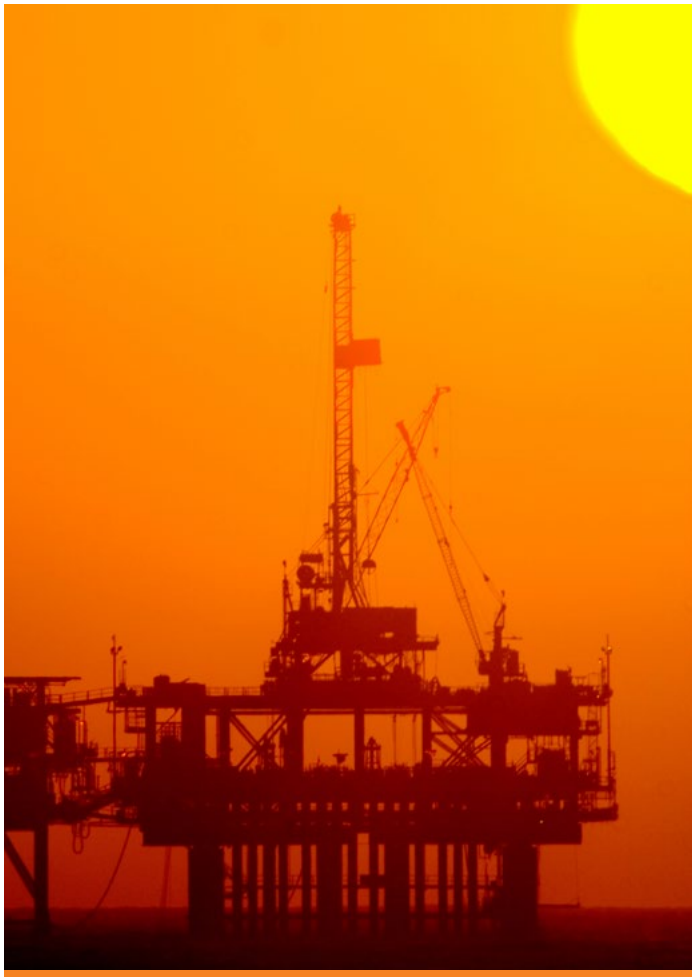
The competency assurance information paper is published on NOPSEMA's "Human factors" web page, which is accessible via the "Resources" menu at nopsema.gov.au.

Hand-arm vibration

Following a recent planned inspection, NOPSEMA made recommendations to a facility operator regarding the potential for workforce exposure to hand-arm vibration. The recommendations addressed the responsibilities of the operator to take steps to help prevent workers suffering injuries caused by vibration during the operation of tools and equipment.

Offshore workers who operate hand-held power tools and hand-guided equipment, such as angle grinders, needle guns, drills and impact wrenches, can suffer poor circulation and damage to nerves, tendons, muscles, bones and joints of the hand and arm. Reducing exposure to hand-arm vibration reduces the risk of these injuries occurring.

There are various control measures, such as effective equipment maintenance and using tools that are fit for purpose, which can help reduce the risk of hand-arm vibration injuries. Combining these with supervision and training will help promote workforce safety. Safe Work Australia has published information about the risks posed by hand-arm vibration and control measures at safeworkaustralia.com.au



What resources are available to you?

To assist operators and duty holders meet their obligations and fulfil their responsibilities in managing OHS and environmental risks under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* and associated Regulations, NOPSEMA continues to publish a collection of resources on safety, well integrity and environmental management at nopsema.gov.au

The series of resources available to industry include:

- **Policies**
- **Guidelines**
- **Guidance notes**
- **Information papers**

NOPSEMA also offers a free subscription service through the website to alert stakeholders to information, including guidance and safety alerts. For example, recently NOPSEMA alerted more than 800 environment specialists in industry by email to a series of new environmental management resources. Readers are encouraged to visit the website to access the full range of current guidance and information and to sign up to the subscription service via the home page.

Streamlining seismic survey environment plans

Operators are required to submit environment plans for seismic surveys to NOPSEMA for assessment prior to commencing these activities in addition to meeting other maritime legislation. Given shorter durations and less complexity compared to production, for example, some seismic operators are challenged by the time and effort required to have a plan accepted by NOPSEMA.

In 2012, NOPSEMA received 35 environment plans (EPs) for seismic surveys, with many submissions requiring the operator to modify and resubmit before the plan could be accepted. EPs accepted on first submission contained the following components that satisfied NOPSEMA that the risks had been adequately assessed. Including these components in an EP is likely to streamline submissions, reducing the effort required to submit a plan that complies with the Environment Regulations, and reducing the effort required by NOPSEMA to assess the EP.

- A well scoped, succinct yet comprehensive description of the activity
- A description of the local environment that may be affected including effects from routine and non-routine events
- A risk assessment informed by the specific circumstances of the activity

Although the impacts and risks from seismic surveys are comparatively low, there is risk associated with a 'cookie cutter' approach to environment plan preparation and risk assessment. This approach can generate anomalies and lead to inadequate deliberation of the consequence. For example, some EPs attempt to argue that oil spill risk from tank rupture, collision or grounding as not credible and excludable from the risk evaluation.

The Regulations encourage operators to undertake specific risk assessments that evaluate all the local environmental values proximate to the survey, such as world heritage areas, bird sanctuaries, fishing grounds and threatened turtle species, which directly influence the consequence component of risk. Operators who evaluate the consequences of their activities provide NOPSEMA with a more complete demonstration of an acceptable level of risk. Further, the results of this evaluation show suitability of selected control measures, which supports a comprehensive demonstration of reaching ALARP and appropriate environmental performance objectives and standards.

For example, in managing hydrocarbon spill risks environment plans sometimes utilise seismic vessels' shipboard oil pollution emergency plans (SOPEPs) as a surrogate for an oil spill contingency plan (required as part of the EP). SOPEPs detail the preventative control measures in place to limit the extent of the spill. An OSCP must include emergency response arrangements that should mitigate the impacts of a spill. NOPSEMA encourages operators to describe only features of the SOPEP that manage environmental impacts of a spill – instead of providing the SOPEP in full. Where operators' emergency response arrangements rely on AMSA to combat marine pollution the EP still needs to demonstrate that the national arrangements reduce the risks to ALARP in that circumstance.


Courtesy of Woodside

NOPSEMA Safety Alert 54 – scaffolding safety

What happened?

A scaffolder was dismantling a scaffold structure outboard of an offshore platform at a height of approximately 15 metres above the sea when a vertical scaffolding tube (a 'dropper') that was supporting him began to slowly slip. The tube was fixed in place with standard scaffold couplers and the tube was being pulled through these under the weight of the scaffolder.

The scaffolder alerted other workers in the vicinity but they could not reach the connection in time to tighten the coupler. The tube continued to slip through the coupler until the scaffolder fell. Fortunately, the inertia reel harness he was wearing arrested his fall. The scaffolder managed to keep hold of the dropper so that it did not fall into the sea, and was suspended over water for approximately seven minutes. A hook from a rescue winch was swung over to the scaffolder, who attached it to the fall arrest harness, to allow the scaffolder to be pulled up to the platform's walkway.

The investigation found that the scaffolding coupler holding the dropper in place was loose and that there was no check coupler fitted above the dropper tube. It was also found that the rescue equipment used was not suitably rated for the weight of the scaffolder and the associated scaffolding. In addition, some of the certification for the equipment being used during the rescue activities was found to be out of date.

During a subsequent inspection at the facility, a number of fall-protection devices were observed anchored to the bases of hand rail stanchions. The relevant standard on industrial fall-arrest systems and devices (AS/NZS 1891 series) specifies a minimum 15kN capacity for anchor points and it is considered poor practice in the wider industry to use hand rails or stanchions as anchor points.

What could go wrong?

If not for the inertia reel harness arresting the scaffolder's fall, the scaffolder could have fallen several metres to the sea along with other dropped objects, potentially leading to death or serious injury. In addition, deficiencies in equipment rating, certification and regular inspection could have contributed to further failures during rescue activities.

Key lessons

- **It is considered good practice to install check couplers above the suspension scaffolding coupler as described in AS/NZS 4576 Guidelines for scaffolding.**
- **The scaffold should be visually inspected by the work party prior to using the scaffold.**
- **Scaffolds should be inspected regularly by a competent person.**
- **Only equipment within its certification period should be used.**
- **Safety equipment should be suitably rated for the personnel using it.**
- **Fall arrest equipment should be anchored at a suitably rated anchor point.**
- **The rescue plan should reflect the hazards the job presents rather than using a generic rescue plan for all scaffold jobs.**

The legislation

As per Clause 9 of Schedule 3 to the OPGGS Act 2006: "Operators have a duty of care to take all reasonably practicable steps to ensure that the facility is safe and without risk to the health of any person at or near the facility." This includes an obligation to take all reasonably practicable steps to:

- Ensure that any equipment (including equipment to be used in emergencies) is safe [Clause 9(2)(c)]; and:
- Implement and maintain appropriate procedures and equipment for the control of, and response to, emergencies at the facility.

For further information please email alerts@nopsema.gov.au and quote Alert 54. NOPSEMA Safety Alerts are available on the website and through our electronic subscription service at nopsema.gov.au.

Changes to regulation in coastal waters

From 1 January 2013, NOPSEMA no longer has any responsibility in relation to the regulation of occupational health and safety (OHS) in the coastal waters adjacent to the Northern Territory, Queensland, Tasmania and South Australia. Coastal waters are the first three nautical miles seaward of the territorial sea base line. As such, NOPSEMA can no longer agree scopes of validation or accept submissions for safety cases, pipeline safety management plans, diving safety management systems or receive diving start-up notices for operations in these coastal waters.

This situation arose from amendments to the OPGGS Act which were implemented at the time of the establishment of NOPSEMA on 1 January 2012. These amendments specified certain limits on, and conditions for, the functions that can be conferred on NOPSEMA under the state or Northern Territory *Petroleum (Submerged Lands) Acts 1982* (PSLA). These changes included a requirement that functions relating to *both* OHS and structural (well) integrity regulation must be conferred on NOPSEMA in order for it to perform *either* of these functions. A twelve month grace period to enable states and the Northern Territory to confer structural integrity functions expired on 1 January 2013. Only the Victorian offshore legislation was amended within that period to confer structural integrity (as well as OHS) regulatory functions on NOPSEMA effective from 1 January 2013.

As a result of the above, industry now should contact the relevant state or NT resources department for any OHS regulatory matters in the coastal waters adjacent to the Northern Territory, Western Australia, Queensland, Tasmania and South Australia.

Validation of safety critical equipment

QUESTION ***If a piece of safety-critical equipment is to be installed on a facility, but is not intended to be used until a later stage in the life of that facility, does it need to be included in the scope of validation for that facility?***

Yes - 'Validation' is an independent assessment of the design, construction and installation of elements of a facility against appropriate standards. The transition from the construction and installation stages of a facility to the operations stage (including commissioning) generally does not carry a requirement for validation. Consequently, any safety-critical equipment needs to be validated before it is installed on a facility. Noting that the validation is in respect of the design, construction and installation of the facility, it is appropriate that safety-critical equipment is validated prior to installation.

Validation is separate from the verification process (i.e. ensuring that the safety-critical equipment is fit for its function and use when installed). Verification is generally not part of the validation required under the Safety Regulations. Verification generally occurs after the equipment is installed and a description of this verification process should be described in the facility safety case. The only triggers in the OPGGSA Act and Safety Regulations for validation are:

- a proposed facility (i.e. new to the regime), or
- the modification or decommissioning of an existing facility.

Visit the safety resources at nopsema.gov.au for more information about validation.

Ageing facilities – management of change

This article in our series on ageing facilities examines why management of change (MoC) is essential for reducing risks to as low as reasonably practicable. Regardless of the source of change on an ageing facility, operators are responsible for having sufficiently robust systems that recognise change and respond accordingly. NOPSEMA inspections have found that not all changes are necessarily captured by formal MoC processes which, typically, are geared towards engineered changes. However, it is important that non-engineering changes (e.g. organisational and procedural change) are also appropriately managed.

Change can arise from a number of sources and may represent a fundamental alteration to a facility's operations. Reduced flows or pressures due to field depletion or the introduction of additional wells or fields being brought on line can result in changes to the hazards originally identified for the facility.

Change does not always result in increased control measures. In some circumstances, particularly those involving reduced operating pressures, a review of existing control measures may indicate that some systems can be reduced or removed. For example, jet flame lengths or inventories may be reduced, making fire protection systems unnecessary. If a new field is brought on line through existing facilities however, *increased* controls measures may be required.

Advances in materials or a halt on manufacturing of parts may render existing fittings obsolete or less preferable. Operators may opt to change out existing equipment in order to take advantage of benefits offered by new materials. For example, many facilities are now using fibre-reinforced plastic (FRP) grating for walkways instead of steel grating. While FRP grating can provide benefits, particularly in relation to ease of installation and absence of corrosion, FRP gratings can also degrade in different ways to steel grating and the level of sustainable damage may also differ. New or revised control measures may be needed.

A major source of change on ageing facilities is damage which can occur from any combination of corrosion, erosion, microbiological attack, wear, impact and many other factors. All items should have some capacity to sustain damage and remain fit for purpose. Items such as pipes and structures are designed to have that capacity delivered through the application of safety factors such as corrosion allowances. Once any damage has been sustained, however, the item has *less* capacity to withstand further damage.

The next and final article in this series will review key points and focus on senior management's role in managing ageing facilities.

Building strong environmental foundations

Companies commence planning their engineered infrastructure for offshore petroleum development well in advance of construction proceeding. The need for this forward planning for complex and high risk offshore petroleum activities is well understood and accepted.

Compared with the level of planning for engineered infrastructure, the same level of effort is not always applied to building strong environmental foundations. This encompasses data collection and other information about the environment that operators gather to:

- support environmental approvals
- demonstrate readiness to mount appropriate responses to environmental emergencies, such as oil spill
- be able to measure their environmental performance throughout the activity.

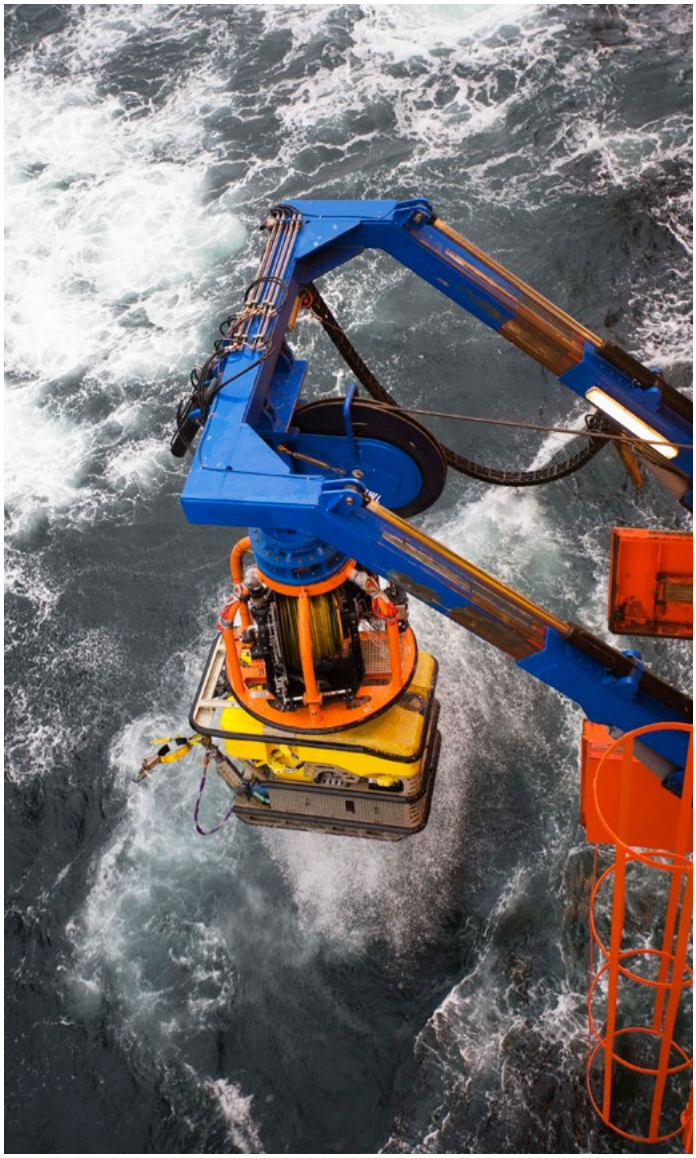
It is important to recognise that building a strong environmental foundation is not simply limited to data and information about the physical, biological and ecological features of the environment. It also encompasses information regarding the quality and societal values of the environment, such as its social, cultural economic and heritage features.

While some dedicated work is likely to be required, operators should consider opportunities to make the most of work they typically carry out to support planning for engineered infrastructure, to also build environmental foundations. Examples of where opportunities may exist include activities such as metocean, geotechnical and pipeline route surveys.

There are considerable benefits for the offshore petroleum industry and regulators alike associated with building strong environmental foundations. A strong foundation can allow operators to present scientifically sound arguments for the environmental acceptability of their activities. This in turn can lead to more efficient and timely environmental approval processes that deliver high standard outcomes for the environment.

Following the Montara blowout and spill in 2009, there are higher community expectations that industry is well prepared if things do not proceed as planned. Preparedness with respect to baseline environmental data and operational and scientific monitoring has been highlighted as an area for improvement. Completing this work could be viewed as an important step in the processes of building strong environmental foundations by the offshore petroleum industry.

Environmentally-responsible planning and management of operations is an ethic reflected in the environmental policies of many petroleum operators. Strong environmental foundations may serve broader purposes including demonstrating environmental stewardship to the broader community and in doing so helping to maintain the social licence to operate.



With the above in mind, operators are encouraged to plan for and build environmental foundations well in advance of lodging environmental approval documents and commencing activities that pose risk to the environment.

Activity and performance

As at 15 February 2013

Disclaimer: Data presented here may vary as further information becomes available.

Assessments

SUBMISSIONS		2012		2013
Assessment type	Subtype	Nov	Dec	Jan
ATBA access application	Not applicable	0	0	1
Diving safety management system	New	0	0	0
	Revision	1	0	0
Diving start-up notice	Not applicable	3	1	3
Environment plan	New	8	9	3
	Revision	3	1	0
PSZ application	New	1	0	0
	Renewal	0	0	1
Safety case	New	1	0	3
	Revision	6	6	4
Scope of validation	Not applicable	5	4	2
Well activity application	Not applicable	9	16	11
Well operations management plan	New	1	0	0
	Variation	0	1	0
	TOTAL	38	37	28

NOTIFICATION OF DECISIONS		Accepted / agreed / advised			Rejected / refused / not accepted / declined			% Notified within time regulations		
		2012		2013	2012		2013	2012		2013
Assessment type	Subtype	Nov	Dec	Jan	Nov	Dec	Jan	Nov	Dec	Jan
ATBA access application	Not applicable	0	0	1	0	0	0	-	-	100%
Diving safety management system	New	0	0	1	0	0	0	100%	-	100%
	Revision	0	1	0	0	0	0	-	100%	-
Diving start-up notice	Not applicable	2	0	1	0	0	2	100%	-	100%
Environment plan	New	3	3	4	0	0	0	100%	100%	100%
	Revision	1	0	0	0	0	0	100%	100%	100%
PSZ application	New	2	0	0	0	0	0	100%	-	-
	Renewal	1	0	0	0	0	0	100%	-	-
Safety case	New	0	0	2	1	0	0	100%	100%	100%
	Revision	8	3	5	2	0	1	100%	100%	100%
Scope of validation	Not applicable	4	3	4	0	1	0	100%	100%	100%
Well activity application	Not applicable	19	7	15	1	1	0	100%	100%	100%
Well operations management plan	New	1	1	0	0	0	0	100%	100%	-
Title activity application	Not applicable	1	0	0	0	0	0	100%	-	-
	TOTAL	42	18	33	4	2	3	100%	100%	100%

Note : In some instances, a single assessment may be submitted for multiple facilities.

ATBA – Area to be avoided

PSZ–Petroleum safety zone

Inspections

TYPE	2012												2013
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Facilities / activities inspected	5	7	11	7	13	19	5	50	5	20	13	5	7

Complaints

TYPE	2012												2013
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
OHS Complaints	1	2	0	1	2	1	2	0	0	0	0	3	0
EM Complaints	0	0	0	0	0	0	0	0	0	0	0	0	0

Injuries

TYPE	2012												2013
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Lost time injuries (LTI >1 day)*	0	0	1	3	1	2	2	6	2	1	1	1	#
Alternative duties injuries (ADI)	1	2	6	4	2	4	2	1	3	1	7	4	#
Medical treatment injuries (MTI)	4	5	2	1	4	4	2	0	4	4	6	2	#
Total recordable cases (TRC)	5	7	9	8	7	10	6	7	9	6	14	7	#

** LTI incl. lost time injuries less than 3 days*

As reported under OPGGS(S) Regulation 2.42. (injury summaries submitted not less than 15 days after the end of each month)

 # Data not yet available

Enforcements

Eight enforcement actions were taken against five operators in the last three months.

Enforcement action types	2012												2013
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Do not disturb notice	0	0	0	0	0	0	0	1	0	0	0	0	0
Improvement notice	4	2	1	2	6	3	0	1	5	23	3	0	0
Intent to withdraw WOMP acceptance	0	0	0	0	0	0	0	0	0	0	0	0	1
Prohibition notice	0	0	1	0	0	0	0	0	0	0	0	0	0
Request for revised SC	0	0	0	0	0	0	1	0	0	0	0	0	0
Request for revised EP	0	2	0	0	0	0	1	0	0	0	0	1	0
Verbal advice/warning	0	0	0	1	0	0	0	0	0	0	0	0	0
Withdrawal of acceptance	0	0	0	0	0	0	0	0	0	0	0	0	0
Written advice/warning	1	1	3	2	1	0	1	1	0	2	2	0	1
TOTAL	5	5	9	5	7	3	3	3	5	25	5	1	2

SC – Safety case

EP - Environment plan

WOMP - Well operations management plan

Incident notifications

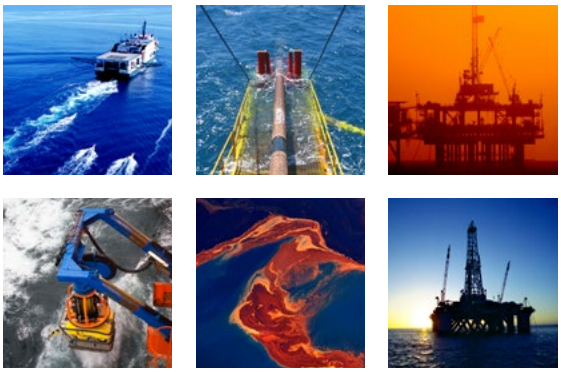
INCIDENT TYPE		2012 2013		
		Nov	Dec	Jan
Accidents and dangerous occurrences	Death or serious injury	0	1	0
	Incapacitation >= 3 days LTI	0	0	0
	Accidents total	0	1	0
	Could have caused death or serious injury	3	2	2
	Could have caused incapacitation >= 3 days LTI	2	1	0
	Fire or explosion	0	2	0
	Collision marine vessel and facility	1	0	0
	Uncontrolled HC release >1 - 300 kg	2	2	1
	Uncontrolled HC release >300 kg	0	0	0
	Uncontrolled PL release >80 - 12 500 L	0	0	0
	Unplanned event - implement emergency response plan	8	7	11
	Damage to safety-critical equipment	9	17	3
	Other kind needing immediate investigation	9	6	8
	Pipeline - kind needing immediate investigation	1	1	0
	Dangerous occurrences total	35	38	25
Accidents and dangerous occurrences total		35	39	25
Reportable environmental incidents	Hydrocarbon / petroleum fluid release	0	0	1
	Chemical release	1	0	0
	Drilling fluid / mud release	0	0	0
	Fauna incident	0	1	0
	Other	0	1	0
EM reportable incidents total		1	2	1
Recordable environmental incidents	Dropped object	2	2	Data not yet available
	Gas Release	1	3	
	Hazardous chemical spill	0	1	
	Oil spill < 80L	6	2	
	PFW- excess oil in water	1	0	
	Water spill	1	0	
	Non- HC Marine pollution	0	1	
	Other	0	3	
EM recordable incidents total		11	12	
Not reportable incidents	OHS Not notifiable	5	1	0
	OHS Exercise	0	1	0
	EM Not notifiable	1	0	0
	EM Exercise	0	2	0
Not reportables total		6	4	0
GRAND TOTAL		53	57	26

As notified under OPGGS(S) Regulation 2.41.

HC – Hydrocarbon
PL - Petroleum liquid
EM – Environmental management
OHS – Occupational health and safety
PFW – Produced formation water

Upcoming events

- 6 March 2013 — MarineSafe forum, Perth
- 7 March 2013 — DrillSafe forum, Perth
- 8 April 2013 — Offshore petroleum forum: spill preparedness and response, Cairns
- 8-12 April 2013 — SPILLCON conference, Cairns
- 26-29 May 2013 — APPEA annual conference and exhibition, Brisbane



Feedback

NOPSEMA welcomes your comments and suggestions. Please direct media enquiries, requests for publications, and enquiries about NOPSEMA events to communications@nopsema.gov.au. Operators and other employers are encouraged to circulate this newsletter to their workforce. Past issues of this newsletter are available from NOPSEMA's website at nopsema.gov.au.

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NOPSEMA has recently expanded its online subscription service. To receive the latest news and developments from Australia's national regulator for the oil and gas industry please complete the online *subscription form* NOPSEMA's services include news and information on environmental management news, HSRs, media releases, safety alerts and *the Regulator* newsletter.

Contact details

Perth Office

Level 8
58 Mounts Bay Road Perth
Western Australia

p: +61 (0) 8 6188 8700
f: +61 (0) 8 6188 8737

GPO Box 2568
Perth WA 6001

From:	Joshua Minor
To:	chevroncomments
Subject:	Comments on Chevron Regulatory Report Draft
Date:	Monday, December 16, 2013 7:58:52 PM

I support the proposed regulatory changes. The safety case regulatory regime appears to be a much better system than the current one.

Thank you,
Joshua Minor
El Cerrito resident

From:	Rowland, Jace
To:	chevroncomments
Subject:	US Refinery Regulations - Diesel Engine Runaway
Date:	Wednesday, December 18, 2013 4:00:01 PM
Attachments:	CSB_BLSR TX 2003.pdf Explosive-Detonation-Source Paper.pdf

Hello,

I scanned through the report from Chevron's Richmond refinery fire and I did not see any reference to diesel engine protection.

The attached CSB article in response to the BLSR fire in Texas (2003) identifies diesel engine runaway as a likely candidate for igniting the vapor cloud. This same situation came up again during the Texas City explosion in 2005, when a diesel engine went into overspeed and ignited the released vapor.

Diesel engines are commonly used in the oil and gas industry to power trucks, generators, welders, light towers, etc. The land-based drilling and offshore drilling/production operations include guidelines to protect their diesel engines (Reference List 1 below). Deepwater Horizon explosion has spark a large round of updates to safety regulations.

Canada has had government regulations in place for years that protect refineries from diesel engine runaway. All diesel engines located on the premises has to be equipped with an exhaust spark arrestor and air intake shutoff valve. (Reference List 2 below)

The US refineries still do not have requirements even though we have had multiple incidents over the past 10years that have resulted in loss of life. The technology is available to prevent runaway. The engine manufacturers are even offering this equipment as an option from the factory, because they are aware of the danger.

I think this opportunity at Richmond is a good way to get the safety standards in place and start preventing hazards in the US. Please contact me direct if you would like further clarification or there are comments.

List 1 – O&G Standards

- BSEE Section 250.405 – Diesel engines used on drill rigs must be equipped with air intake device to shut down the diesel in the event of a runaway.
- BSEE Section 250.856 – Diesel engines used in the production facilities must be equipped with air intake device to shut down the engine in the event of a runaway.
- ABS Modu Rules – part 4, Ch3, Sec 6.11
- API RP 54 – emergency shut-down devices that will close off the combustion air should be installed on all diesel engines.
- DNV D101, Ch2 Sec5, B200.202
- Cal/OSHA Section 6625.1

- Plus many more….

List 2- Canadian Regulations

- Petro-Canada – Refinery Requirements – 3.3.7.ix – Positive air shutoff devices are required on all diesel equipment.
- Enform Sanction IRP Volume 18

Jace Rowland
Diesel Engine Safety Solutions – AMOT | Chalwyn | Roda Deaco | Rigsaver
8824 Fallbrook Dr. Houston TX 77064
jace.rowland@amot.com | Cell (615) 498-3993

U.S. Chemical Safety and Hazard Investigation Board

CSB

An independent federal agency investigating chemical accidents to protect workers, the public, and the environment

CSB NEWS RELEASE

CSB Investigators Examining Source of Flammable Vapor Cloud in Fatal Houston Area Truck Fire

(Houston, TX - January 16, 2003) Investigators with the U.S. Chemical Safety and Hazard Investigation Board, accompanied by Board Chairman Carolyn W. Merritt, continue their investigation into the cause of a deadly flash fire at an oilfield waste recovery facility south of Houston, which killed two workers and injured three others on Monday, January 13, 2003.

The accident occurred at the BLSR Operating Ltd. petroleum storage and separation facility on Route 521 in Rosharon, TX. The CSB is an independent federal agency charged with determining root causes of chemical accidents and making recommendations to prevent their recurrence. CSB investigations generally take 6-12 months to complete, although safety alerts may be issued more rapidly as needed.

Investigators are now focusing their attention on interviewing the truck drivers, both of whom survived the accident, as well as plant employees and managers. They will also be analyzing residues of oil field waste material from the truck and the plant site to determine the source of highly flammable fumes that are suspected in the tragic accident.

"We are operating right now on the possibility that a flammable cloud formed over the two tank trucks shortly after their arrival at the site, causing what we call a 'deflagration' or flash fire of the vapor," said Chairman Merritt. Lead investigator John Vorderbrueggen noted that the incident was not technically an explosion, which generally occurs in an enclosed space. In this case, the fire occurred under an open-air shed. Eyewitnesses have confirmed that the truck diesel engines began racing moments before the deflagration, indicating that flammable vapors were entering the air intakes. The fact that the truck engines were running and serving as a potential ignition source is considered to be a significant issue in this investigation.

"We have located government records of other incidents in Texas and elsewhere where diesel engines revved up just before deadly fires and explosions due to the presence of flammable petroleum vapors," Chairman Merritt said. "We are concerned because of the widespread handling of oil and gas field wastes in Texas and nationwide, and our investigation will determine what further safety measures may be needed in order to prevent similar accidents in the future. In the meantime, it is important that all similar operations be aware of the potential danger of ignition from these waste products. Eliminating ignition sources during flammable waste handling operations is critical to safety."

Explosive detonation caused by diesel engines

by Stephen Gale, Chalwyn by AMOT

Safety devices are a first line of defense against the effects of engines going out of control if operated near potential sources of vapor leaks. This article discusses these valve solutions that help prevent explosions.

An increasing number of HSE Managers of international LNG production areas and terminals are recognizing the real threat of explosive detonation that can be caused by diesel engines.

The consequences of operating standard diesel engines in the petrochemical industries have included the fatal explosions at BP Texas City in 2005 and the Macondo Well, Gulf of Mexico 'Deepwater Horizon' offshore rig in 2010. In these accidents and others recorded in the oil & gas industry, leaking hydrocarbon gas was drawn into the intakes of running diesel engines, causing them to overspeed and 'runaway' out of control to such high speeds that the engine detonated the gas cloud with catastrophic results.

BP Texas City Refinery , 2005

Safety First

Solutions to prevent this risk were invented about 40 years ago with the patented Chalwyn automatic valve and related automatic overspeed shutdown systems. Now manufactured by AMOT in Bury St Edmunds UK, these lightweight metal valves respond automatically to positively close the engine's air intake as soon as any uncontrolled overspeed occurs. This cuts off the air and safely stops the engine.

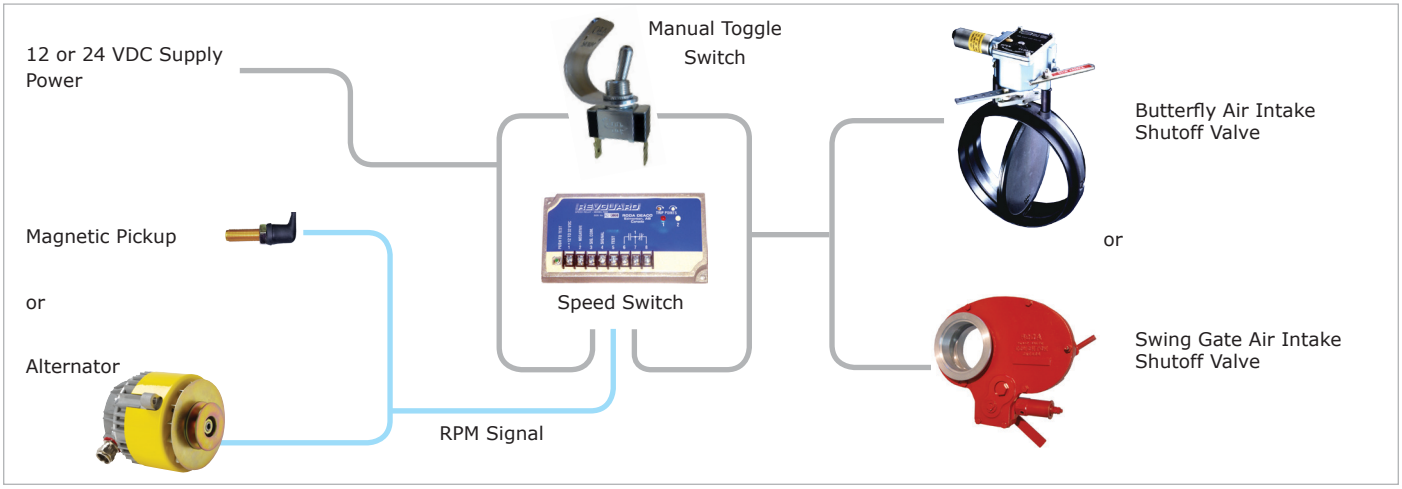
The LNG industry has been a strong advocate of these simple safety devices as a first line of defense against the effects of engines going out of control if operated near potential sources of vapor leaks. The world's largest gas plants within Ras Laffan Qatar all enforce safety policies requiring exhaust spark arrestors and Chalwyn safety valves to be fitted to all plant and vehicles entering the production areas.

Similar policies have recently been introduced in Canada, Oman and many other regions as a result of safety professionals now understanding that engine overspeed is often the first 'gas detector' with this runaway phenomenon happening at a fraction of the LEL (Lower Explosive Limit).

Additional products

AMOT has expanded its broad range of safety products to meet the needs of modern vehicles and engines. Their range of butterfly valves now includes an extra slim range of pneumatically operated PVA models with sprung automatic reset,

Automatic Shutdown System



ideal for modern 'cab-over' design of trucks. These utilize the vehicle's air system to close the valve when an electric sensor detects excess engine speed.

The company will also be offering high temperature silicone hose kits to complement their current range of speed switches an electric / air valves to help customers complete high quality installations.

Electrically operated AMOT 4261 and Chalwyn SVX valves for smaller vehicles and industrial equipment are available to suit intakes between 1.5" and 10", covering virtually all engines found in the LNG industry. This range will be extended in 2012 with a new 70mm 12 volt butterfly valve ideal for Toyota and other brands of light pickup vehicles where under bonnet space has become very limited.

Toyota Hi Lux install

The company's range of ATEX Certified Stainless Steel spark arrestors has been extensively revised for launch in mid-2012. The SSL range now extends up to 750 hp and 8" pipe size, with extra models in the popular 80 – 200 hp application range to give customer's more options and more compact installations as often needed on the latest vehicles.

For simple add-on spark arrestor installations, the revised range of SSE models now covers engines with outputs of up to 180 hp and 4" pipe diameter, while still complying to the strict no sparks test requirement of the defined EU standards (including offshore and defined 'zones').

Spark arrestors

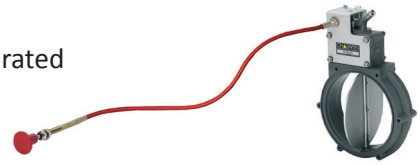
Valve Types

AUTOMATIC

- Electric
- Pneumatic
- Hydraulic
- Mechanical

MANUAL

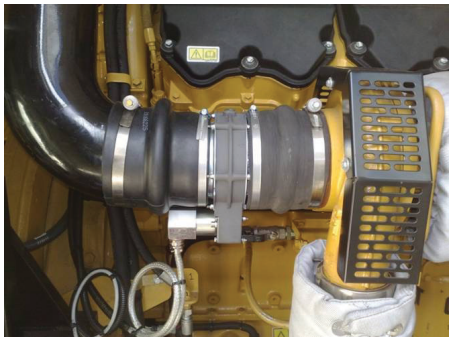
- Pull Operated



Although the UK LNG industry has long specified ATEX EN 1834 compliant cyclonic exhaust spark arrestors, there are many countries still using agricultural grade products that will pass small sparks that may cause an explosion in the event of a gas leak. These short cuts are often due to lack of knowledge of how spark arrestors work.

Into the future

Chalwyn's international distributor network teams will be visiting many LNG terminals this year to further explain about the risks from unprotected engines and best practices already employed in all of the UK receiving terminals.



SVX Failsafe Install

Countries as diverse as Nigeria, Yemen and Angola have started their own safety policies to prevent repeats of earlier explosions. LNG safety executives can't risk 'cutting corners' and welcome these latest technologies that help protect their facilities and employees.

About the author

Stephen Gale is a Business Development Manager at AMOT. For the past 11 years, he has been focused on diesel engine safety in his role of business development for Chalwyn and AMOT. He has presented on accident history, the lessons learned and safety regulation changes to the Texas City Safety Council, the ASSE in Kuwait, Texas A&M University (Doha)and several global oil and LNG companies including RasGas and Qatar Gas.

He graduated with a BSc in Mechanical Engineering from Bath University in 1977. He worked in the UK and US for Lister Diesels Inc. and later was in sales management for Deutz and Mitsubishi engines.

From:	thomas tereszkiewicz
To:	chevroncomments
Subject:	refinery safety
Date:	Wednesday, December 18, 2013 1:17:38 AM

Greetings.
I live in a community that is affected by refineries every day. I am glad that there will be more stringent and proactive measures to protect the health and safety of every one. The air in my community can be quite rancid and there is a high rate of asthma in the community. While refineries are a necessary industry, we do need to keep an eye on them as they are prone to cut corners if given the opportunity. Thanks again for your oversight in this regard.

Tom Tereszkiewicz
714 Port Street,
Crockett, CA 94525

From:	Irene Thompson
To:	chevroncomments
Subject:	Safety Case Regime
Date:	Thursday, December 19, 2013 7:32:56 PM

I was out walking with my three-year-old grandson when we saw that awful cloud and people began telling us to go inside. How do you tell a child that the sky is poison?

When I read on your web page that "However, none of these important regulatory recommendations have been implemented, and there have been no substantive changes made to the PSM or RMP regulations to improve the prevention of major accidents," in all those decades, I was dumbfounded. Please adopt the regime and take any and all actions you can to protect us. Thank you for all your work.

~~ Irene Thompson San Pablo CA

From:	Stephen Hughes
To:	chevroncomments
Subject:	Chevron Comment
Date:	Thursday, December 19, 2013 5:57:24 PM

The need for fast-paced adaptability in high risk industry with regards to regulation is needed, and can not rely on organizations to self-police while the laws and regulations are modified. Employee and public safety should not suffer while laws and regulations are modified at a slow pace.

Stephen Hughes, MS-OSH

From: Brabson, Jay (DNREC)
To: chevroncomments
Subject: delaware
Date: Monday, December 23, 2013 3:20:39 PM

I just read the recommendations from Chevron report, I don't really have any comments. It is very frustrating for me as a local regulator. I have 15 years experience in Delaware and 25 years working as engineer in industry and I would not want to be responsible for evaluating a refinery's 'safety case'. Admiral Hyman Rickover nailed it so many years ago. One of his teachings is work hard – there is no substitute and no silver bullet that will 'solve' process safety issues.
The Delaware oil refinery had a reputation as one of the worst safety cultures in the nation a decade ago. Now a little company, PBF, with no big corporate engineering staff has taken them to one of the best in the nation (along with Paulsboro NJ site). Whether you call it PSM/RMP, or Hyman Rickovers 'concept of total responsibility', or safety case, the key is including safety as a major company value along with reliability and efficiency and hard work. It's hard work to keep operators feeling ownership and accountability. A key to that is support by maintenance to promptly address operating issues and continuous improvement efforts towards reliability. Cheap ? No. (That is why efficiency is so important – you have to find ways to do more with less). Easy to do ? No. I appreciate that probably more than EPA or OSHA the CSB is above politics and wants to find methods to reduce industrial accidents. You have an open invitation to come to Delaware and see some best practices in action any time…I owe you that before I retire.
Regards,
Jay

Jay Brabson, P.E.
Environmental Engineer
State of Delaware 302-324-2050
Accidental Release Prevention Program

From: Delucca, Jorge - OSHA
To: chevroncomments
Subject: CSB Report on Chevron Refinery Accident Calls for Structural Changes to Regulations
Date: Monday, December 23, 2013 3:41:40 PM

When CSB says California OSHA "should commit "extensive resources to fund a regulator that has the requisite skills, knowledge, and experience to ensure petroleum refineries in the state continually assess their practices and reduce risks" I believe that you mean doing what OSHA Region 6 is basically doing. The Houston North Area Office has two Compliance Officers, a mechanical engineer and an industrial hygienist, dedicated to conducting PSM inspections region-wide in support of other Area Offices. These inspectors have accumulated a wealth of experience and have provided invaluable support to OSHA Region 6 Area Offices in conducting effective PSM inspections of refineries and chemical plants that have identified serious safety and health violations. The timely identification and mitigation of those violations have prevented catastrophic accidents.

Jorge A. Delucca, MS, MA, CAIH
Compliance Assistance Specialist
OSHA-Oklahoma City Area Office
(405) 278-9560, Ext. 227
Fax: (405) 278-9572
Mobile: (405) 308-7962

From:	Stephen Gill
To:	chevroncomments
Subject:	Public comment on draft Chevron report
Date:	Thursday, January 02, 2014 7:33:13 PM
Attachments:	Comment on CSB Chevron Regulatory Report Jan 2014.docx

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To whom it may concern:

Having read through the draft report of the 2012 Chevron pipe rupture and fire, I am very concerned with the recommendation for California to move to a Safety Case Regulatory regime.

These concerns come as a result of having worked as a technical professional in the industry for a number of years under the COMAH safety case regime in the UK.

While there are some advantages of the safety case approach, I believe that the underpinning structure and activities in the current PSM framework are fundamental to managing process safety risks and that any regulatory change that does not maintain those requirements is a significant step backward. While the current PSM legislation may be in need of an overhaul (which might include some of the safety case aspects), I think the recommendation to move away from it is ill advised.

I have attached a document with my comments.

Thanks,

Steve Gill

As a petrochemical and chemical industry technical professional with a strong interest in process safety and a number of years experience working in the UK COMAH safety case regulatory environment, I read the 16th Dec draft Regulatory Report on the Chevron Richmond Refinery Pipe Rupture and Fire with some serious misgivings. I am therefore taking the opportunity to comment as a private individual; the opinions expressed herein are my own and are not intended in any way to be the opinion of my current or past employers.

To summarize my viewpoint:

Much is made in the report about the safety case regulatory environment ensuring that all hazards are identified and controlled to be 'as low as reasonably practicable', with the implication that under this type of approach there would be a significant reduction in major hazard events. In my experience, while the written safety case provides an excellent summary for the regulator to understand the installation, hazards, and management systems of the operating company, the content of what is actually in the safety case *is the result* of the activities that are already required by the OSHA PSM framework. Moving towards a safety case regime without retaining the globally recognised framework provided within the PSM rule would in my view be a significant retrograde step.

I have spent considerable time and effort in installations covered under a safety case regulatory regime trying to improve the quality of what is in the safety case (and more importantly at the plant level where it can actually be effective in preventing incidents) by moving towards the activities and framework required under PSM.

Taking the key features of a safety case approach from page 36:

- Duty Holder Safety Responsibility, including a Written Case for Safety: In reality the risk is already with the operating company. The regulatory fines levied after an incident are typically insignificant when compared to the overall cost of the incident to the company. A written safety case does not necessarily improve safety—it only gives a clear window for the regulator to look into a particular installation. The actual activities and risk reduction efforts that are described in the safety case are the very things that are required in a PSM framework.

- Continuous Risk Reduction to ALARP: While this is an excellent concept and one that I am in favor of, it does require the regulator to provide a clear view of what risk levels are acceptable so that companies can compare additional risk controls to see whether the costs are 'grossly disproportionate'. If the regulator doesn't provide a consistent view, then each company is using it's own risk criteria to make judgements about whether hazards are adequately mitigated (which they already do under PSM). Changing the whole of the installed refinery base to use the same type and risk criteria is a massive undertaking and should not be done lightly.

- Adaptability and Continuous Improvement: This is a nice way of saying that the regulator can move the goal posts without having to go through a legal process. If OSHA (as criticized in this report) takes too long to make meaningful changes due to the heavy legal burden, the

adaptability of the safety case regime is the other end of the spectrum. The regulator can issue a guidance document, declare it to be 'Relevant Good Practice' and refuse to accept the safety case for an installation if they don't meet it (even if they can show by other means that the costs of meeting it a grossly disproportionate to the risk reduction). The post-Buncefield changes for gasoline storage in the UK were listed in this report as being a positive example of this adaptability. Having been somewhat involved in the outcome of that process I have a different view. Certainly in the early phases, the regulator was proposing significant changes for similar storage tanks that went well beyond the previous definitions of ALARP and where the costs would in fact have been grossly disproportionate to the risk reduction. While 'knee-jerk reaction' might be too harsh, I think it illustrates that the adaptability is a two edged sword. The adaptability and push for continuous improvement can also (in my experience) lead to very different outcomes for different installations. Much of the 'continuous improvement' is in fact a negotiation with the regulator on the value of what they are proposing. What is agreed isn't necessarily (or even likely to be) consistent across a sector or group of similar installations.

- Active workforce participation: In my view this has very little to do with whether the regulatory framework is based on the safety case approach or the current PSM framework. If the CSB feels that the workforce doesn't participate sufficiently, there is nothing from a PSM standpoint that says OSHA can't make it a focus area today. Employee participation is already one of the PSM elements—if it isn't being done effectively, make it a priority now.

- Process Safety Indicators that Drive Performance: Again, there is no inherent advantage in a safety case approach that makes process safety indicators more useful or a better regulatory fit than they would be within a PSM framework.

- Regulatory Assessment, Verification and Intervention: This is one clear advantage of the safety case that I do acknowledge. A written safety case (which for a refinery might be tens of thousands of pages) certainly gives clear visibility to the regulator as to what the hazards and risk mitigation approaches are for a given installation. It can become a very useful tool for communication between the regulator and the operator of an installation. However, the idea that the regulator will be able to spot the critical missing control that might prevent a major accident by readying through the safety case and saying 'ah-ha' is wildly optimistic. In addition, the written safety case is essentially a summary of what the company already knows and does (or at least thinks it knows and does). If there are unrecognised hazards or failures in a specific management system they can only be uncovered by a detailed look at what is happening at the plant level, not by flipping through the summary report.

- Independent, Competent, Well-funded Regulator: Again, this has very little to do with whether a safety case approach or the current PSM approach is followed. If you want a regulator to be effective, they must be independent, competent, and well funded regardless of the approach. This for me is much more about budgets and priorities than it is about whether the safety case is a better approach. For example, the report points out that OSHA had a National Emphasis Program for refineries from 2007 to 2011 and that it was the "most effective emphasis program in history, citing a disturbing number of issues and subsequent

citations". The NEP wasn't stopped because that level of oversight would only be useful under a safety case approach—it was a matter of cost and priority. You don't have to fundamentally change the regulatory approach to ask for a larger budget, pay higher salaries, and upskill the inspection workforce.

Some additional concerns and observations are below:

1) The wisdom of proposing a fundamentally different regulatory framework from OSHA Process Safety Management (PSM) specifically for the refining sector and specifically in California

   Why only refineries? The recommendation to the California State Legislature and the Governor of California is to develop a 'more rigorous framework for petroleum refineries in the State of California...'. Part of the justification for focusing on refineries is the observation on page 15 that the EPA has documented 234 recordable accidents between 2000 and 2010 while the much larger sector of chemical manufacturing only had 218 recordable accidents. While I can fully appreciate the extent and visibility and hence concern around the major refinery accidents, there is no practical legislative difference in how the risks in dealt with in refineries compared to the chemical sector. In addition, the hazards and approaches used by companies to manage those hazards in refining and many chemical production processes are similar—similar equipment, flammable and toxic materials inside of pipes and pressure vessels built to the same codes, similar corrosion and reactive chemical hazards, etc. I would have thought that understanding the difference in incident rates between the refinery and chemical sectors given the similarities would have been a much better starting point than proposing a fundamentally different regulatory approach for the refining sector. For example, is it the age of the assets (in which case providing additional focus on the existing mechanical integrity in PSM might be better)? There is a particular difficulty when it comes to regulating integrated refining and chemical companies. On the same site, for example, would you have a different regulatory structure for the "refinery units" and the "chemical units" even though the hazards and equipment are very similar and site management, maintenance and other services are all integrated? What about cases where certain technologies (e.g. reforming to make xylenes) are used in both refining (for octane in gasoline) and chemical production (to make paraxylene for PET and PTA)? Would the same equipment and hazards be regulated differently in a refinery than they would be on a chemical production site (either owned by the same company or different companies)?

   The problems with 'only in California': I understand that one of the strengths of a State/Federal system is that there is the opportunity for local optimization or experimentation in one state that can then be leveraged if appropriate to other states or included in federal statutes. However, one of the recurring themes in incident reports (including from the CSB) is the 'patchwork of legislation or regulation' which allows serious hazards to remain unidentified or under-mitigated because they fall between agencies or legislation. Having a different regulatory framework for one sector in one state surely makes that problem worse. If the California Legislature or Governor follow the recommendation

and develop an in-state regulatory framework based on the safety case approach for refineries, does that then supersede the existing PSM legislation for those facilities? Or do they have to meet the requirements of both? Is there then a separate regulatory body outside of OSHA that needs to be funded and trained and start working with the refinery operators? While it is potentially manageable for the refinery operators (many of whom deal with different regulatory environments in a number of countries), it certainly isn't ideal to be working on improving their management systems to deliver against their PSM obligations in one state while at the same time getting to grips with a fundamentally different approach in another state.

2) The use of this particular incident as a basis for moving to a safety case regulatory approach:

   It may be that the CSB had already come to the conclusion that there was a need to move the industry or OSHA towards a safety case approach, and that this incident just happened to be the convenient vehicle. In that case, the following section is irrelevant. However, I do not believe that a safety case approach has any particular inherent advantages over the current PSM approach in dealing with mechanical integrity issues such as the one described here.

   The failure was due to the fact that the company internal standards on inspection of piping prone to sulfidation corrosion weren't followed (e.g. 100% component inspection of vulnerable systems), and that the inspection data that was available from the other components did lead to the conclusion that a failure was likely. In this case, at least certain parts of the Chevron organisation understood the hazards and had specified controls for it. The fact that it fell between inspection departments, turnaround planning decision making, and other parts of the organisation are in my opinion just as likely to have happened in a safety case regime as they would in a PSM regime. Had a safety case been in place, it would likely have listed all of the inspection that was being done, the internal prioritization for evaluating vulnerable systems, etc. ALARP isn't terribly relevant here either—any ALARP analysis would have been done with the same assumptions that the piping was fit to last through the next overhaul and therefore the likelihood of a failure in service was acceptably low and that the costs of replacing the pipe spool prematurely would have been seen to be 'disproportionate' to the additional risk reduction.

3) Some practical challenges with a safety case regulatory environment:

   One clear advantage of a safety case approach is that is provides the regulator much better visibility of the hazards, controls, and management systems at a particular facility. Having a fairly exhaustive written safety case (often several thousand pages) gives the regulator a very good window to look through. Without such a written document, the regulator has to pick out the key information from a myriad of different documents: hazards study outcomes, management procedures, organizational charts, etc. In the current regulatory environment, there is no obligation on the company to update the regulator with changes that are made, where in a safety case environment the requirement to update the information on a

periodic basis and as changes are made is a valuable communication tool between the company and the regulator.

There are, however, some issues with the safety case approach:

Is what you see what you get? Having a multi-volume safety case with thousands of pages of information certainly gives the impression that all hazards have been identified and are well controlled. However, the safety case cannot be any better than a summary of what the company knows and thinks it does. Many serious incidents are either because a hazard is not recognised (in which case it wouldn't be in the safety report) or because it has been recognised but the management systems or controls are ineffective in delivering the expected prevention (in which case the controls would be well documented in the safety case, but ineffective in stopping the incident). Unless an external regulator was better versed in the technology, metallurgy, and management systems etc. than the company writing the report, it is very unlikely that they would be able to spot any significant gaps. If the Chevron refinery would have written a safety case, for example, it is likely that there would have been a section on sulfidation corrosion with a description of the inspection regime and decision making criteria for when piping components would be replaced. The fact that it didn't happen in practice and the turnaround decision making was disconnected from the inspection processes certainly wouldn't be evident by even a careful reading of the safety case.

An excellent communication tool, an unwieldy management tool: Again, a safety case is an excellent vehicle for communicating hazards and controls to the regulator and providing visibility. However, the reality is that the case is often written by safety specialists within the company or even by a contracted outside party and rarely by the people closely associated with the actual work processes. The emphasis in the PSM framework is on doing the activities that generate the hazard understanding and putting the controls in place; a safety case only summarises the output of those activities. One of the strengths of the PSM framework is that it is clear what the key activities are. In order for a safety case regime to be effective, it needs to define the key areas to be covered in the safety case anyway. While the safety case document is very useful to the regulator, it is far too large to be an effective management tool for the company. Maintaining the controls for the identified hazards and having robust management systems is the next level down in detail. The safety case therefore tends to be something that is discussed with the regulator, or updated (along with all of the other systems and documents) when a change is made. It doesn't lend itself to actually being a key management tool for the operator.

4) Some practical challenges with the concept of reducing risk to 'as low as reasonably practicable' (ALARP):

Much is made in the report about the safety case being a framework that requires risk to be reduced to 'as low as reasonably practicable'. Again, I am very supportive of the ALARP concept as a principle but when you get into the detail it is more challenging than it looks. Page 39 quotes the CCPS guidance that 'risk reduction efforts are continued until the

incremental effort to further reduce risk becomes grossly disproportionate to the level of additional risk reduction'. The question is how the regulator decides what is ALARP. The report goes on to detail two ways to demonstrate ALARP:

- Cost/Benefit type analysis (whether quantitative or qualitative)
- Compliance with Relevant Good Practice (UK terminology)

ALARP based on cost/risk reduction benefit: In order to make a judgement on whether a risk is ALARP, three factors need to be considered: the likelihood of the event occurring, the cost if the event occurs, and the cost and effectiveness of each incremental control or mitigation that could be added. At the moment, each company essentially develops their own risk criteria. In the litigious environment in the US, companies may be reluctant to express the risk in terms of an acceptable frequency or cost of preventing a fatality. As an alternative, the risk criteria may be based on the likelihood of the event that leads to loss of containment of hazardous material rather than the actual injury or fatality which may result. If the regulatory wants a common basis for determining ALARP, it needs to define the equivalent cost of a life or a major injury, and a frequency at which this would be considered 'unacceptable' or 'broadly acceptable' from a societal standpoint. This is the approach taken by the UK HSE in their guidance document 'Reducing Risks, Protecting People'. They essentially use the Department of Transportation criteria of how much they would be willing to spend to prevent a traffic fatality. This kind of cost/benefit analysis on the acceptable investment to prevent a fatality has actually been criticised in past media communications by the CSB itself. In the aftermath of the Texas City explosion, a criticism was levelled that the company had used different acceptable frequencies for an event happening based on day and night occupancies of certain buildings as part of their facility siting analysis. The comment was something along the lines that it wasn't acceptable for the company to accept a higher potential frequency just because there were less employees at night. That is exactly the kind of analysis that is required to show that a risk has been reduced to ALARP. In my view, the regulator either needs to be willing to set the acceptable limits (and recognise what a huge shift and cost that may be entailed for the industry to move to that definition), or be willing to accept each companies individual risk criteria (in which case what is considered to be ALARP will vary by company and the regulator will be accepting the safety cases against a variable definition).

ALARP based on Relevant Good Practice (UK terminology) or Recognized and Generally Accepted Good Engineering Practice (US terminology)

Page 43 of the report states that "The regulator may require the installation of an absent control if such a control is considered good industry practice". Page 40 quotes Dr. Hopkins as saying 'if an operator wishes to adopt a procedure or standard that falls short of good or best practice, the regulator can reject it on the grounds that it does not reduce risk as low as reasonably practicable'.

Essentially, this gives the regulator the power to reject a company's safety case unless they meet what is considered RGP or RAGAGEP.

My experience is that the use of relevant good practice as a measure of ALARP is quite challenging for a number of reasons:

- Relevant good practice or RAGAGEP isn't static. The codes, standards, and 'good engineering practice' that the plant was originally built to are not the same as the codes, standards, and good engineering practice today. How does the regulator (or company) determine which changes are material to process safety and which aren't? This can lead to some very protracted discussions with the regulator. Meeting good practice may add only marginal cost to include in a new build, but may be massively expensive to retrofit when required in an existing plant. The decision of what to retrofit and what not to retrofit essentially becomes a negotiation with the regulator. This is particularly difficult when the regulator takes the stance that compliance with the good practice is necessary to meet ALARP, and the company uses the risk criteria to show that the costs of meeting the best practice are 'grossly disproportionate' to the improvement in risk reduction and therefore the risks are ALARP without retrofitting. In my experience, these discussions are the norm and not the exception.
- Who decides what is relevant good practice? There are numerous industry guidance documents from different bodies such as the AICHE CCPS, API, ASME, NFPA, etc. In the report, OSHA is criticised for not having a catalogue of what it considers to be best practice. The list isn't complete in countries that operate a safety case regime either. I have had a number of regulatory conversations that went along the lines of "Here is industry document xyz; we've decided it is probably best practice. Please tell us why you aren't meeting it, and what you plan to do about it". This is particularly challenging when the document has been generated by the regulator themselves with limited industry input. See the comments above about the post-Buncefield review of storage tank overfill risks.

RAGAGEP is extremely important and companies base their approach and internal standards on these documents. In a safety case regulatory environment, however, it is very easy for a regulator to require a company to tie up a 'grossly disproportionate' amount of technical resource in defending their position (or making minor changes) against an ever widening library of good practice.

While I do actually see the benefits of an ALARP approach, I believe that this report significantly overstates the amount of improvement that would be made under a safety case regime compared to the current regulatory framework, and significantly understates the challenge for the regulator in giving a consistent view or standard which industry can use to determine whether the risks have been reduced to ALARP.

In conclusion, I believe that the regulator and industry time would be much better spent improving performance within the PSM framework than moving to the safety case approach. I am also concerned with the tone of the report which seems to be 'we told OSHA to update their approach and they didn't do it, so we've decided to ignore them and propose a whole new regulatory system'. Surely the workers and neighbours of the refineries would be much

better served if the CSB and OSHA were working in a complimentary rather than adversarial way?

From: magcope@aol.com
To: chevroncomments
Subject: Fwd: Comments on Chevron document
Date: Thursday, January 02, 2014 8:07:27 PM

Sorry the comments were from Mark George (Independence, Ohio)

-----Original Message-----
From: magcope <magcope@aol.com>
To: chevroncomments <chevroncomments@csb.gov>
Sent: Thu, Jan 2, 2014 8:15 pm
Subject: Comments on Chevron document

Thanks for the opportunity to comment. From my perspective the biggest hurdle with your study is documented on page 108 of the draft report (Has the safety case regulatory approach resulted in fewer major accidents?) There is no evidence to show the Safety Case will reduce accidents.

In addition I would like to make the following comments.

1. Page 14 – Introduction – The first paragraph is misleading. Since CSB's mission is too "independently investigate significant chemical incidents and hazards and…" of course CSB would see a lot of refinery accidents when compared to *thousands of industrial and chemical facilities*.

2. Page 14 – The analogy to the aviation industry is not valid. How would the aviation industry have the same type of accidents?

3. Page 14 – What is a "Significant Process Safety Incident?" How does CSB quantify these? You should provide a definition (maybe it is later on in the document). Is 125 a lot? How many is acceptable? What is the trend over the last 25 years? Is 17 too many for CA proportionally to the amount of refineries there?

4. Page 15 – The comment *'The U.S. Environmental Protection Agency (EPA) has also documented 234 recordable accidents at petroleum refineries between 2000 and 2010, which is more than any other industry*," is somewhat misleading. I could not locate this presentation. What is a recordable accident? Is this the same as an OSHA recordable? What industries did EPA look at? Is 234 a lot of recordable accidents? What should the number be? Please don't tell me zero

5. Page 15 - *The CSB concludes that the continuing occurrence of refinery accidents demonstrates the pressing need to examine the current regulatory structure in place in the US and, in light of the Chevron incident, in the state of California for petroleum refineries*. How did CSB make the jump from those numbers just presented to the need for more regulation? You are skipping over a lot here and just providing your opinion without any connection between more regulation and improving the numbers which may or may not be bad.

6. Page 15 – Most of Dr. Wilson's findings are not supported by any evidence and most recommendations appear to be just speculation. Recommendations are not clear or verifiable. This study does not really support anything.

7. Page 15 – What does "….*US has experienced **financial** losses from refinery incidents that are three times that of industry counterparts in countries*…" mean?

8. Page 28 – Please note that under 3.2.2.3 (The United States…) your note 117 appears to be quoting one person who does not appear to be in the US but the note refers to the text "*Despite this international shift to the safety case regime and even though major oil companies that operate globally both onshore and offshore have expressed their support for the safety case regime."* How can you use one person's quote to state "major oil companies" support this position?

9. Page 30 – What does your statement "*there is no general duty requirement under the PSM standard to reduce risks"* mean? You are inferring companies operating under PSM are not bound by the general duty clause which is simply not true.

10. Page 30 – Your comment that there is no requirement to reduce risks to an acceptable level is true but the standard clearly states

    The process hazard analysis shall be appropriate to the complexity of the process and shall identify, evaluate, and control the hazards involved in the process.

    I think if you will check you will find almost universally the process hazards analysis documentation for companies covered by the standard employ risk ranking techniques and/or LOPA for findings and recommendations. This is done specifically to reduce risks.

11. Pages 30-31 – I don't think your comment "*Historically, the MOC requirement has been treated and enforced as an activity-based requirement as well*" is accurate. Many facilities require PHA's for every MOC that is not a replacement in kind.

12. Page 37 – Not sure I understand your first sentence under 4.1. Aren't operating companies right now responsible for safety of hazardous facilities? What will change under the Safety Case? Also it appears you are mixing HSE requirements for new construction in Europe with 100 year old refineries in the US

13. Page 37 – Who determines what is ALARP? Maybe this is discussed later. It seems like you are depending on owner/operator to determine ALARP and provide case for getting there.

14. Page 38 – Much of the text is identical to the MOC requirement under PSM

15. Page 39 – What does the statement "*Under the PSM standard the employer has no general duty to continually reduce risk or prevent the occurrence of a catastrophic accident*" mean? That statement by CSB is simply ridiculous and you are losing credibility by leaving it in the document. Are you inferring we should have a regulation that states "No catastrophic accidents are permitted?"

16. Statement on top of page 40. "*….is that ALARP should result in the continuous reduction of risk and is not predicated on a specific risk acceptance target"* Does "should" mean you are not sure?

17. Page 43 – "*the regulator also has the ability under this regime to require facilities to go above and beyond good practices and standards to achieve ALARP without*

requiring rulemaking." How does that work? What kind of authority does the regulator have? Where are we going to find these regulators? They will have to be ex-refinery workers.

18. Page 70 – Incident Investigations – Statement "*Federal PSM does not require the development of recommendations or the prevention of future incidents*" is not true. See 1910.119(e)(3)(ii) & 1910.119(m). Why else would investigations take place but to develop recommendations and prevent recurrence?

19. Page 77 – What evidence does CSB have for the statement "…*process safety indicators are a significant element of process safety management systems <u>and are critical for reducing</u> process safety incidents*" Many of the references supplied provide the opinion that indicators are a good idea but no hard evidence to show leading indicators work.

Cheryl,

Could you please pass on my congratulations to the investigation team responsible for this Report. This is the first time I can recall a Report that succinctly captures the key features of the US regulatory system and compares them with the safety case approach - well done! This will prove a very useful reference document in addition to its main purpose.

On the attached note are a few very minor typos/misunderstandings.

regards

Peter

Notes on the "Regulatory Report Chevron Richmond Refinery"

Reference	**Wording**	**Comment**
Page 16, 2nd paragraph	"…world such as the United Kingdom (UK) and Australia to regulate high hazard…"	The legal regime is pretty good and homogeneous across all the State/Territory and Federal jurisdictions in Australia but the *quality* of the regulatory bodies varies significantly with only one or two States and the offshore petroleum regime (NOPSEMA) being comparable with UK/Norway. The others are less competent.
Page 23, foot note 77	"The Alexander Kielland was a *drilling rig*…"	Compare footnote 77 with 111. I think the latter is a more accurate description.
Page 40, last line	"…the CSB has found that the evaluation of ALARP has evolved, as the HSE now allows reliance upon qualitative assessments."	This does not quite capture the situation correctly. HSE has <u>always</u> allowed qualitative assessments. For many risks there is/was no other way. The concept of reducing risks as low as is reasonably practicable (ALARP) or "so far as is reasonably practicable" (SFAIRP) as written in the general duties section of the Health and Safety at Work etc Act 1974, are in essence exactly the same. See: http://www.hse.gov.uk/risk/theory/alarpglance.htm The concept of writing legislation requiring duty holders to reduce risks so far as is reasonably practicable predates the use of QRA, and to this day very many risks do not have adequate data to enable a valid quantified comparison. So qualitative assessment was and still is necessary. Arguably QRA was oversold and still has not met the high hopes of its advocates.
Page 63, footnote 345	"Mange Ognedal…"	Magne
Page 63, footnote	Peter Wilkinson	Very minor point but neither myself nor John Clegg

345	(Australia NOPSEMA) and John Clegg (Australia NOPSEMA)	worked for NOPSEMA. The next footnote #346 gives the correct title for Peter Wilkinson. A more accurate way of expressing this would be: *Peter Wilkinson, Manager Review Implementation Team, Offshore Safety Section, Australia Department of Industry, Tourism and Resources and "architect" of NOPSA.* For John Clegg: *John Clegg, inaugural CEO of NOPSA (forerunner of NOPSEMA)*

January 3, 2014

SUBMITTED VIA E-MAIL

U.S. Chemical Safety and Hazard Investigation Board
Office of Congressional, Public, and Board Affairs
2175 K Street, NW, Suite 650
Washington, DC 20037
By electronic submission: chevroncomments@csb.gov

Attn: R. Moure-Eraso

Interim Investigation Report: Chevron Richmond Refinery Pipe Rupture and Fire Regulatory Report

Dear Dr. Moure-Eraso:

The American Chemistry Council[1] (ACC) is pleased to provide a written response to the U.S. Chemical Safety and Hazard Investigation Board's (CSB) December 16, 2013, Regulatory Report of the Chevron Richmond Refinery Fire.

As you know, ACC and its member companies have a considerable interest in the CSB's work.

Safety has always been a primary concern of ACC members; both ACC and its individual companies have been recipients of and benefitted from CSB safety recommendations. We value CSB's independent and technical insight and we utilize the lessons learned from incidents to improve performance as well as standards and practices. The CSB investigation of the Chevron Richmond refinery accident and subsequent recommendations will be important to help determine what actions might be considered based on the root causes of this incident and will ultimately influence the direction of the regulated community in that regard.

ACC's comments focus on the agency's recommendations concerning the safety case regulatory regime. We have a number of strongly held concerns regarding the potential implementation of the safety case regime which we have highlighted in our attached comment letter.

[1] *ACC represents the leading companies engaged in the business of chemistry. ACC members apply the science of chemistry to make innovative products and services that make people's lives better, healthier and safer. ACC is committed to improved environmental, health and safety performance through Responsible Care®, common sense advocacy designed to address major public policy issues, and health and environmental research and product testing. The business of chemistry is a $760 billion enterprise and a key element of the nation's economy. It is the largest exporting sector in the U.S., accounting for 12 percent of U.S. exports. Chemistry companies are among the largest investors in research and development. Safety and security have always been primary concerns of ACC members, and they have intensified their efforts, working closely with government agencies to improve security and to defend against any threat to the nation's critical infrastructure.*

ACC also supports the separate comments filed by the American Petroleum Institute and the American Fuel & Petrochemical Manufacturers.

We hope that CSB will find our contribution helpful. Should you have questions about our input, please contact me by phone at (202) 249-6426 or by e-mail at Rachel_meidl@americanchemistry.com.

Regards,

Rachel A. Meidl
Director, Regulatory & Technical Affairs
American Chemistry Council
700 Second Street, NE
Washington, DC 20002

Jonathan L. Snare
Morgan, Lewis & Bockius LLP
1111 Pennsylvania Avenue, NW
Washington, DC 20004

January 3, 2014

U.S. Chemical Safety and Hazard Investigation Board
2175 K Street, NW
Washington, DC 20037

By electronic submission: chevroncomments@csb.gov

Re: Comment on Regulatory Report No. 2012-03-I-Ca, Draft for Public Comment, Chevron Richmond Refinery Pipe Rupture and Fire (December 2013)

The American Chemistry Council ("ACC") is America's oldest trade association of its kind, representing companies across the United States engaged in the business of chemistry. ACC appreciates and supports the U.S. Chemical Safety and Hazard Investigation Board's ("CSB's") efforts to protect the safety and health of workers, the public, and the environment from industrial chemical accidents. Furthermore, ACC shares the CSB's goals of ensuring that process safety is handled and implemented as safely as possible. CSB incident investigations can play a key role in understanding accidents at chemical facilities and refineries and ensuring that similar accidents are prevented in the future.

Workplace safety and process safety are top priorities of ACC and its members. To become a member of ACC, a company must commit to the highest standards for protecting health, safety, and the environment through participation in the Responsible Care® program. All ACC members are required to implement the Responsible Care® Process Safety Code of Management Practices, which specifically addresses process safety concepts such as leadership, accountability and culture in order to drive overall process safety performance improvement. This code complements existing regulatory requirements, such as the Occupational Safety and Health Administration's ("OSHA's") Process Safety Management ("PSM") standard and the Environmental Protection Agency's ("EPA's") Risk Management Plan ("RMP") rule.

While ACC shares the CSB's goals as described above, ACC has a number of concerns about the recommendations in the CSB's December 2013 Draft Regulatory Report for Public Comment (the "CSB Report") to the State of California regarding the establishment of a safety management regulatory framework based on "safety case" principles.[2] In particular, ACC believes that its members, through OSHA's current PSM standard and voluntary programs such as Responsible Care®, already address the continuous improvement goals detailed in the CSB Report. ACC further believes that the recommended safety case regulatory regime is not justified by the reasons articulated in the CSB Report, nor would the safety case framework actually achieve the desired results and benefits for covered workplaces. ACC also is concerned that the drastic changes contemplated by the recommended safety case framework would result

[2] ACC has similar concerns regarding the CSB's recommendations to OSHA, which are less defined than those to California, to the extent that the CSB suggests the implementation of a safety case regime. The safety case regime described by the CSB starkly conflicts with OSHA's performance-based PSM standard.

in a wide variety of practical problems if implemented. As outlined in detail below, ACC believes that certain recommendations in the CSB Report ultimately would detract from worker safety and create an atmosphere of uncertainty and confusion for employers and regulators alike.

A. The CSB's Proposed Safety Case Regulatory Regime Represents A Drastic Policy Change From The Current Regulatory Framework With No Corresponding Benefits For Workplace Safety

The CSB Report describes the safety case regulatory regime as a "rigorous prescriptive and goal-setting regulatory approach applied globally both onshore and offshore." *See* CSB Report at 9. Under this regime, "[a] written case for safety, known as the safety case report, is generated by the duty holder and is generally rigorously reviewed, audited, and enforced by highly technically competent inspectors with skill sets familiar to those employed by the industries they oversee." *See id.* Moreover, "[i]n order for the facility to begin operation or remain in operation, the regulator must 'accept' the facility's safety case report." *See id.* at 39.

This proposed framework shifts the burden to the regulator to review and evaluate a wide set of site-specific information, which regulators will be ill-equipped to handle, without any objective measures. ACC believes that the current framework of PSM is better suited to achieve the CSB Report's purported justification of improved workplace safety. Under the current well-recognized regulatory framework, which provides employers with the necessary discretion to tailor safety processes to the specific conditions of each worksite, ACC members supplement the PSM elements and implement a program that includes many of the elements in the safety case framework. For more details, see Section C below.

Under OSHA's PSM standard, an employer team with expertise in engineering and process operations must address the hazards of the process, identification of prior incidents that had potential for catastrophic consequences, engineering and administrative controls (and their interrelationships and the consequences of their failures, including a qualitative evaluation of possible safety and health effects on employees), facility siting, and human factors. *See* 29 C.F.R. § 1910.119(e)(3). After notice and comment rulemaking, OSHA modified Subsection 1910.119(e) "so that employers are not required to implement every recommendation offered by a Process Hazard Analysis Team," although employers must consider all recommendations. *See* Preamble to Process Safety Management of Highly Hazardous Chemicals, Explosives and Blasting Agents, 57 Fed. Reg. 6356-01 (Feb. 24, 1992) ("PSM Preamble") (emphasis added). As clearly stated in the PSM Preamble, "[i]t is critically important that a PHA Team have freedom to make broad recommendations, at risk of being wrong . . . . [W]hen a team recommendation is incorrect, the employer can analyze it and then document in writing why the recommendation is not being adopted or is being adopted with modification." *See id.* (emphasis added). OSHA intentionally delegated the responsibility to evaluate and reject or implement site-specific recommendations to the employer. The employer, after all, is most familiar with the site, safety concerns, and practical hurdles to and consequences of operational changes.

In contrast to the current OSHA (as well as California OSHA) programs, under the proposed safety case regime, regulators who are not intimately familiar with technical aspects of the worksite or involved in process safety analyses would make the ultimate decision to accept or reject a safety program. Again, the CSB Report's safety case regime requires up-front

"acceptance" from "highly technically competent inspectors with skill sets familiar to those employed by the industries they oversee." *See* CSB Report at 9. General industry knowledge from inspectors, however, may not be enough; ACC respectfully submits that individual facilities, with onsite safety experts and engineers who are intimately familiar with the jobsites, have the most sophisticated understanding of site-specific safety conditions. ACC is concerned that a safety case regulatory regime ultimately would deprive employers the necessary discretion over how best to handle safety on their particular worksites. Prior acceptance by inspectors with unknown backgrounds who are unfamiliar with the jobsites would impede an employers' ability to make safety decisions quickly and effectively. ACC believes that shifting responsibility to approve safety decisions from employers to inspectors, who inevitably will be less familiar with the jobsites, would be ill-advised.

In addition to practical and efficacy concerns, the safety case regime outlined in the CSB Report represents a major policy shift that would create significant legal issues if implemented by the State of California as recommended by the CSB. *See* CSB Report at 90-91. If implemented in California first, without any corresponding change to the federal system, the end result will be two completely different regulatory regimes governing process safety. On one hand, for the federal system, ACC members are (and would continue to be) subject to OSHA's PSM standard, which is a performance-based standard; yet, if California agreed to implement the CSB's recommendations, ACC members in that state would be subject to a completely different regulatory regime. *See* CSB Report at 90-91. Section 18 of the Occupational Safety and Health Act of 1970 ("OSH Act"), 29 U.S.C. § 667, allows states to develop and operate their own safety and health programs in the workplace with approval and monitoring from OSHA. OSH Act Section 18(a) permits states to assert their own standards in the absence of federal laws: "Section 18(a) has been consistently interpreted by OSHA and the courts to bar the exercise of state jurisdiction over issues addressed by an OSHA standard, even where the state law may arguably be more stringent or where OSHA has not explicitly addressed a provision." *N.J. State Chamber of Commerce v. New Jersey*, 653 F. Supp. 1453, 1464 (D.N.J. 1987) (citations omitted) (holding that a federal OSHA asbestos training program preempted a New Jersey program). ACC does not believe that California would have the legal authority to implement such a drastic change to the regulatory requirements for process safety—a change that is completely different from the federal regulation. If California did take steps to implement these recommendations, such a proposal likely would be pre-empted by federal OSHA. Simply put, any goal-oriented safety case regulatory regime in California would be on dubious legal footing, given OSHA's preemption of this area of law through the performance-based PSM standard.

Moreover, state plan state programs must be "<u>at least as effective in providing safe and healthful employment and places of employment</u> as the standards promulgated [by federal OSHA]." OSH Act Section 18(c)(2) (emphasis added). Thus, under the OSH Act, federal OSHA establishes the baseline for worker safety that state plan states must meet or exceed. Here, ACC does not believe that the safety case regime is as effective as the federal PSM program, and the CSB has cited little to no statistical or other evidence establishing that a safety case regime would be as effective as the PSM. In fact, the CSB Report itself laments that "[u]nfortunately, there have been few objective studies conducted on the impact of the safety case regulatory approach on safety performance onshore and offshore." *See* CSB Report at 109. Indeed, the ACC has identified studies that seriously call into question the efficacy of the safety

case regimes. *See, e.g.*, Nancy Leveson, MIT White Paper on the Use of Safety Cases in Certification and Regulation (2011) (see sections on Potential Limitations of Safety Cases, Experience with Safety Cases, and Practical Considerations in the Use of Safety Cases). The CSB Report itself acknowledges many of these widely documented problems with the implementation of the safety case regime. *See* CSB Report, Appendix B at 110-12. Thus, any safety case regime implemented by the State of California would be subject to legal challenges under Section 18 of the OSH Act on that basis as well. Note that additional legal issues with the safety case regime, such as the use of vague and subjective evaluative criteria and the lack of objective benchmarks for employers to follow, and the resulting lack of notice to employers for compliance purposes, are discussed in greater detail below.

Finally, ACC believes that the CSB has grossly underestimated the budget and personnel resources necessary to implement a safety case regime, not to mention the resource commitment required to ensure that such a regime is in any way effective. The CSB Report does state that the safety case regime could only succeed if the relevant state or federal agency undertook significant commitments to its implementation, including:

- an "independent, well-funded, well-staffed, technically competent regulator"; and
- a compensation system to ensure that the regulator can attract employees "with the necessary skills and experience to ensure regulator technical competency."

See CSB Report at 90-91 (outlining recommendations to California and OSHA). The CSB essentially admits that the program could only work if fully staffed with experts to implement the regime's procedures and set its limits, including staff with appropriate technical backgrounds and industry experience to evaluate and approve Safety Case Plans. Yet, at the same time, the CSB acknowledges that programs with similar upfront inspection goals have failed due to resource limitations, such as, for example, the inability of the EPA to conduct proactive audits of RMPs. *See* CSB Report at 62-63 (the "EPA has not effectively implemented the audit and inspection elements" of RMP; according to IG report, 50 percent of high-risk RMP sites have never received an on-site inspection and over 65 percent of all RMP sites have never received an on-site inspection since the program began in 1999). ACC understands that there are approximately 14,000 RMP sites in the United States, and ACC believes that the number of refineries and other facilities envisioned to be covered under the CSB's proposed safety case regime would be even greater. Taking these numbers as a baseline, ACC finds it difficult to believe that there is any realistic way for the federal government to find and hire sufficiently trained inspectors to handle the duties envisioned by the CSB. This same concern applies equally to the CSB's proposal for California, as the same resource constraints would apply in proportion to the number of covered sites in that state.[3] At the end of the day, ACC believes that the lack of staff sufficiently trained to properly evaluate and enforce such complex regulatory requirements would lead to a chaotic and ineffective regulatory regime, and would doom this program to failure.

In summary, ACC believes that the current framework under the PSM standard with performance-oriented requirements best addresses process safety management objectives. A dramatic shift to an entirely new regulatory framework is neither warranted nor justified. At this point, OSHA is in the process of undertaking a review of PSM to follow up on Executive Order

[3] ACC notes that it already implements a program that involves third-party audits under its Responsible Care® program (in addition to the continuous and ongoing efforts on process safety undertaken by ACC members at their facilities), as discussed in more detail in Section C of this letter.

No. 13650 (August 1, 2013) through the Request for Information ("RFI") on Process Safety Management and Prevention of Major Chemical Accidents (RIN 1218-AC82) issued on December 9, 2013. ACC looks forward to participating in the RFI and working with OSHA on these issues in a transparent Administrative Procedure Act ("APA") rulemaking process in the near future.

B. Regulators' Review Of Subjective Criteria Without Objective Benchmarks Under The Recommended Safety Case Framework Would Be Practically Difficult To Implement And Follow

The safety case regime described in the CSB Report would require inspectors to review a safety case for "acceptance" through use of subjective criteria that lack objective benchmarks. Although the Report calls for "highly technically competent inspectors with skill sets familiar to those employed by the industries they oversee," inspectors' ability to accurately evaluate these factors, and to do so consistently across local offices of regulators and facilities, is questionable. These factors are inherently subjective and difficult to review without extensive training and knowledge of the site, the organization, and its history.

Allowing inspectors to evaluate such subjective criteria raises practical issues over what various regulators will require. Currently, the standard that would be imposed by investigators for approval is vague and provides little notice of what constitutes compliance. For example, the anticipated application of the As Low As Reasonably Practical ("ALARP") standard by regulators is extremely unclear – how will inspectors evaluate whether a facility has satisfied the "reasonably practical" standard? Will different offices of the regulatory agency (such as Cal-OSHA under the proposed recommendations) have differing positions on what is required to be in compliance with these inherently subjective factors? Would the State of California or OSHA be willing to define the criteria for what is reasonably practical, and publish this for use among all the facilities to ensure that consistent criteria are applied? How would an inspector be able to ascertain ALARP standards without a roadmap for tracing the unit's assessment process for each element under question? An employer, and not a regulator, is in the best position to know what is reasonably practical within the framework of its own risk evaluation process, experience, incident history, engineering assessment, and other self-analytical tools.

Along the same lines, the CSB does not explain what standard a regulator must follow before an employer's safety case is "accepted." Unless quantified and/or delineated criteria are published, the regime will be ineffective and provide little notice as to what is actually required of employers. There will be a strong risk that disparate, incongruous "acceptable" solutions will exist, depending on the individual inspectors involved, simply because there are no set standards. In short, the safety case framework purports to be a prescriptive regime that requires employers to meet a minimum benchmark of acceptability, yet the CSB Report fails to set forth any clear benchmarks or articulate how such benchmarks would actually be developed and ultimately communicated to stakeholders.

This uncertainty created by the CSB proposal raises legal issues as well. A regulation is "unconstitutionally vague under the due process clause of the Fifth or Fourteenth Amendments if it 'forbids or requires the doing of an act in terms so vague that men of common intelligence must necessarily guess at its meaning and differ as to its application.'" *Ga. Pac. Corp. v.*

Occupational Safety & Health Review Comm'n, 25 F.3d 999, 1005 (11th Cir. 1994) (citation omitted) (finding the phrase "obstructs forward view" to be insufficiently defined, and therefore unconstitutionally vague); *see also Diamond Roofing Co. v. Occupational Safety & Health Review Comm'n*, 528 F.2d 645, 649 (5th Cir. 1976) ("[A]n occupational safety and health standard must give an employer fair warning of the conduct it prohibits or requires."). ACC believes that the elements of the safety case regime that an employer is required to follow before the safety case is "accepted" by the regulator (to allow the employer to use or operate its facility) are unacceptably subjective and unclear. The essence of the CSB proposal for safety case is succinctly stated on page 37 of the Report: "the onus is on the duty holder [i.e., employer] to prove to the regulator that the company's processes, methodologies used to assess risks, and reasoning for choosing one control over another have substantially reduced risks to as low as reasonably practicable (ALARP), or equivalent." *See* CSB Report at 37 (emphasis added). In practical reality, employers would simply not have notice as to what is required of them. Employers – including ACC members – would be subject to oversight by a regulator (no matter how well trained) with less of an understanding of its particular site on the wide range of complex issues at stake in the development of the appropriate process safety.

ACC submits that it is impractical for the CSB to expect California (or any other regulatory agency, federal or state) to be in a position to issue sufficient guidance to enable stakeholders to understand what would be expected of them for compliance purposes under this regime. Rather, ACC believes that if such a proposal were enacted, the result would be confusion, inconsistent application, and delays for stakeholders before taking necessary steps forward in process safety (as any decision such as the follow-up to a process hazard analysis ("PHA") or a Management of Change would be subject to review by the regulator under this system). Ultimately, any discretion present in the current performance system under PSM would be eliminated, along with the flexibility normally envisioned with performance-oriented regulatory systems.

C. Employers – Not Regulators – Are In A Better Position To Implement Many Of The Elements Of These Recommendations

The CSB justifies its recommendations for the safety case regulatory framework based on an assumption that the current PSM framework is "reactive" and "activity based," and that the PSM has become static and does not address the development of new technology, new safety approaches, and "advancing best practices." *See* CSB Report at 9. The CSB contends that the current system is so focused on specific tasks and activities that it does not drive the achievement of continuous risk reduction. *See id.* Thus, the CSB advances the argument (relying on an unsupported third party report) that the PSM system is a "minimum cost" and "compliance based approach," in which employers purportedly take the approach that if it is not a "regulatory requirement," then they will not actually comply. *See id.* at 30. The CSB also raises the concern that the PSM regulatory framework does not direct employers to develop a holistic safety management system approach to process operations. *See id.* at 29-32.

In the alternative, the CSB outlines what it describes as the "key features" of an "effective major accident prevention" approach such as the safety case regime: (1) duty holder safety responsibility, including a written case for safety; (2) continuous Risk Reduction to ALARP; (3) adaptability and continuous improvement; (4) active workforce participation;

(5) Process Safety Indicators that drive performance; (6) regulatory assessment, verification and intervention; and (7) an independent, competent, well-funded regulator. *See* CSB Report at 36.

ACC strongly disagrees with these purported observations and conclusions. The chemical industry, without the direction of regulators, continues to challenge its understanding of process safety through the ongoing development of hazard identification and analysis tools. For example, the industry has gone beyond the requirements of PHA through enhanced self-analytical processes with layer of protection analyses ("LOPAs"), fault tree and event tree analyses, as well as full-blown quantitative risk analyses.

Since promulgation of the PHA and PSM, the chemical industry continues to strive for improvement. For example, ACC and its members already have taken the lead in developing a new paradigm of process safety that not only complements the current regulatory structures (PSM and RMP), but goes beyond the current regulatory requirements to require the broad framework of a safety management system. This system results in a culture of continuous improvement, all without the intervention of a regulator and under the discretion of the employer who has better understanding of the specific workplace conditions. ACC requires each member to achieve certain goals in the Responsible Care® Management System and the RC14001® Technical Specifications, including the following: (1) to make continual progress toward the aim of no accidents, injuries, or harm to human health or the environment; (2) to design and operate facilities in a safe, secure, and environmentally sound manner; (3) to install a culture throughout all levels of member organizations to continually identify, reduce, and manage process safety risks; (4) to support research on the health, safety, and environmental effects of member products and processes; and (5) to communicate product, service, and process risks to our stakeholders. Conformance to these goals and practices is confirmed through third party audits conducted on ACC members.

Specifically, each ACC member must commit to implementing and adhering to the following process safety management practices:

> (1) Leadership and Culture – Senior management and leadership are committed to establishing and communicating process safety as a core value and enforcing high standards of performance at all levels within the organization. Company leadership also promotes and develops a process safety culture within the organization, encouraging openness to raise concerns and identify opportunities for improvement.
>
> (2) Accountability – Process safety roles and responsibilities across the organization are clearly defined and include an expectation to identify, and authority to respond to, process safety concerns. Senior leaders are held accountable for process safety performance, while employees understand the importance of process safety as it applies to their jobs and are responsible for following and contributing to the work processes to achieve improvement in company process safety performance.
>
> (3) Knowledge, expertise and training – Process safety competency requirements are established and executed for management, engineering, and operational

personnel, as well as contractors and third-party service providers, commensurate with the activities performed.

(4) Understanding and prioritization of process safety risks – Member companies identify and understand the hazards and risks of their processes and implement systems for documenting and accessing comprehensive and current information on process-related hazards and risks to enable informed decision-making.

(5) Comprehensive process safety management system – Member companies design systems to manage and mitigate identified risks with adequate safeguards. Management of process safety considers: passive controls; engineering controls; operational controls; inherently safer approaches; inspection, maintenance, and mechanical integrity programs; management of change procedures; and scenario planning.

(6) Information sharing – Member companies establish processes fostering two-way flow of information between management, employees, contractors and other stakeholders to share process safety information, ensuring that experiences from process safety reviews, inspections, audits, and incident and near-miss investigations are shared, as relevant, across the company in a timely manner.

(7) Monitoring and improving performance – Senior management and leadership continually monitor process safety performance through routine evaluation of process safety management systems, independent of regulatory audits, to confirm that the desired results are achieved, using appropriate leading and lagging indicators. Results are reviewed at planned intervals to determine progress against process safety performance expectations and to take action to improve performance when needed.

Under the Responsible Care® program, each ACC member is required to demonstrate compliance with each of these elements. Thus, members not only already implement so-called "key features" identified by the CSB as the justifications for the safety case proposal, but, in fact, go beyond what the CSB suggests in its safety case proposal.

For example, the CSB states that one of the "key strength[s]" of the safety case regime is that it provides the regulator "with the tools to drive continuous improvement" to reduce risks to ALARP, rather than "focusing on compliance with activity-based regulatory requirements." *See* CSB Report at 43. Yet, ACC members already implement a wide variety of steps to achieve the goal of continuous improvement and risk reduction to ALARP; those steps include the development and implementation of a comprehensive process safety management system to manage process risks and the development of a safety culture to manage those same risks. ACC members already undergo third-party audits to demonstrate compliance with this program. ACC believes that its members are best situated to take the lead role in developing and overseeing programs suited for their particular facilities, rather than the approach envisioned by the safety case regime where the regulator (without any history or knowledge of a particular facility) must review and oversee the program. Further, ACC does not agree with the CSB regarding the need to completely redesign the approach to process safety where ACC members already have a program in place addressing the "key features" cited by the CSB to justify the safety case regime.

D. The ACC Has Significant Legal Concerns (Including Due Process Concerns) Regarding The Recommendations To Implement New Requirements Without The Need For Rulemaking

ACC is concerned that the safety case regulatory regime opens the door for backdoor rulemaking without the required notice and comment. Specifically, the CSB Report includes the following recommendation: "Ability to adapt and implement safety requirements in response to newly identified hazards, advances in technology, lessons learned from major accidents, and improved safety codes without the need for new rule-making." *See* CSB Report at 90 (emphasis added); *see also id.* at 89 ("The safety case provides the adaptability necessary to keep current with improving standards and advancing technology, without requiring lengthy and often unproductive rulemaking on the part of the regulator." (emphasis added)); *id.* at 48 ("The cumbersome rulemaking process and lack of flexibility that has resulted in stagnant and static OSHA standards can be contrasted with the structure of the safety case regulatory regime, which facilitates adaptability and enables the regulator to improve industry safety performance and practices without requiring a major rule change." (emphasis added)).[4]

The CSB press release issued on December 16, 2013 in connection with the release of the Report provides further clues as to this approach: "Under a safety case system, changing safety standards, new technologies, and findings from accident investigations are required to be incorporated by facilities." The CSB further states in this press release that one of the justifications for this approach is that it has issued a number of process safety regulations from its investigations, yet "none of these important regulatory recommendations have been implemented." *See* CSB Press Release (Dec. 16, 2013). In effect, the CSB approach would grant unprecedented leeway in setting requirements beyond the current legislative checks and balances, and opens the door for short-circuiting the rulemaking process altogether.

This recommended back-door rulemaking is of grave concern to ACC and the general public. ACC members would be faced with the obligation to implement "advances in new technology" without any regulator having to determine through APA rulemaking whether there is significant risk and without having to establish the necessary feasibility requirements. ACC members would then be obligated to follow these new requirements without the opportunity to participate in the APA rulemaking process (and presenting any input and/or practical issues with any such proposal). ACC has the same concerns regarding the obligation to implement

[4] The CSB goes on to argue that the safety case "essentially provides the regulator with the tools to recognize more rigorous standards and practices that exist and drive a company to implement those practices to further reduce risks, as well as work with industry to improve existing standards and practices if necessary. It also enables companies to implement new, more efficient or safer technologies that do not necessarily meet strict prescriptive regulation, but that drive risk reduction." *See* CSB Report at 48. In addition to the obvious concern of ACC that the CSB's proposition would end-run the current APA regulatory requirements (creating a number of legal and due process issues discussed throughout this comment), ACC notes that its members already take steps to implement "new," "more efficient," and "safer" technologies under the current regulatory regime, without any regulatory requirement to do so. Moreover, as discussed in Section B herein, ACC is greatly concerned regarding the inherent confusion of the safety case regime as to exactly what would be required in terms of such "new," "more efficient," and "safer" technologies, and exactly how the benchmark for compliance would be determined and justified.

"improved safety codes" or "changing safety standards" without the regulator establishing the need for such requirements under APA rulemaking.

The CSB Report suggests that any employer subject to the recommended safety case framework, if implemented, would automatically be required to follow a wide variety of new requirements without the opportunity to participate in any transparent rulemaking process, and without clear direction as to which of the new technology, accident, or safety recommendations would actually have to be implemented by employers. If this regime were implemented without rulemaking, employers would not know who sets deadlines for implementation and compliance. Also unclear is what agency would enforce the regime and evaluate compliance with these recommendations. Furthermore, ACC cannot be required to follow each prescriptive requirement from consensus standards without the opportunity to participate in the rulemaking process. Without proper rulemaking procedures, employers would not know who would decide what consensus standards, if any, would need to be followed, or what recommendations in the CSB Report are mandatory, given the CSB's lack of enforcement mechanisms.

ACC completely disagrees with the discussion in Appendix B to the CSB Report wherein the CSB contends that the safety case regime would allow changes to process safety requirements without APA notice and comment rulemaking. *See* CSB Report at 105-06. It is one thing for an agency to issue guidance to provide more details on compliance to existing regulatory requirements, and yet another to suggest (as the CSB does in its Report) that completely new substantive requirements, based on new technology, incident investigation reports, and safety codes (such as consensus standards) could be imposed on employers without the opportunity and due process rights to participate in its development. ACC further disagrees with the CSB's conclusion in Appendix B that the safety case regime (as proposed by the CSB) is somehow consistent with the Regulatory Flexibility Act and its underlying principles. The purpose of the Regulatory Flexibility Act is to ensure adequate opportunity to participate in transparent rulemaking. *See* 5 U.S.C. §§ 601 et seq.

E. The Basis And Justifications For The Application Of The Safety Case Regulatory Regime Are Not Applicable To ACC Members' Workplaces

The incidents listed in the CSB Report as justifications for the imposition of the safety case regime largely involve accidents that are in dispute and/or otherwise inapplicable and insufficient to support the shift to this completely different regulatory approach.

For example, the CSB Report Appendix A lists "Significant Petroleum Refinery Incidents in 2012," yet ACC remains skeptical that this list appropriately captures so-called significant petroleum refinery incidents. Based on information provided by our members, we understand that several incidents listed are minor or highly disputed. ACC would like more information regarding how the list was compiled and the extent to which it influenced policy and/or supported an argument for a safety case regime. ACC believes that these incidents cannot support the imposition of the burdensome safety case regulatory regime.

Moreover, the CSB Report maintains that "regulatory approaches similar to the safety case regulatory regime, which require risk reduction to ALARP or equivalent, have been implemented in the nuclear sector by the Nuclear Regulatory Commission (NRC) and the

aerospace sector by NASA." *See* CSB Report at 11; *see also id.* at 34-35 (explaining that (1) the NRC has adopted a performance oriented regulation with a license requirement that includes overall goals to reduce risks to as low as reasonably achievable, or ALARA, and (2) NASA utilizes the goal of a safety system that reduces risk to as safe as reasonably practicable, or ASARP). Drawing conclusions for chemical facilities and refineries from NASA and/or the NRC's experiences with safety case regimes, however, is inappropriate. NASA and the NRC deal with extremely narrow and specific technologies, equipment, and operations, involving high consequence of failure on a scale completely different than that presented by the chemical industry. NASA and NRC's coverage is in sharp contrast to the broad-base and wide range of facilities of ACC members, with vast differences in size, scope and operation. What might work in a narrowly defined operation such as NASA's role in space exploration or the NRC's role in oversight of the nuclear power industry simply would not work in the environment within which ACC members operate.

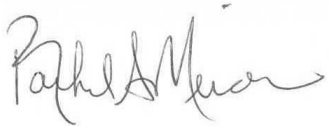
CONCLUSION

While ACC supports the general goals articulated in the CSB Report, ACC has major concerns with the implementation of a safety case regulatory regime which, as previously noted, would represent a drastic and unnecessary change in policy from the current regulatory framework in place governing process safety. ACC strongly believes that the recommended safety case regime would create significant practical problems as well as legal issues without any corresponding benefit in workplace safety.

Instead, ACC recommends that the CSB present its concerns regarding the current framework in the ongoing RFI issued by OSHA (as triggered by Executive Order No. 13650 "Improving Chemical Facility Safety and Security") to review the PSM standard. OSHA will have ample opportunity to undertake such a review and analysis of the current PSM framework in this transparent APA rulemaking process before any effort is made to promulgate an entirely new regulatory approach such as the recommended safety case system.

Finally, given our strongly held concerns, ACC believes that before any regulatory agency considers the merits of such a dramatic shift, sufficient objective data would need to be gathered and analyzed before determining what regulatory approach makes sense consistent with such objective data and the demonstrated need for any type of new regulatory regime. ACC hopes that the CSB will proceed deliberately in this regard and continue to allow interested parties the opportunity to comment and work together constructively on this effort consistent with our comments.

Respectfully submitted,



Rachel A. Meidl
Director, Regulatory & Technical Affairs

American Chemistry Council
700 Second Street, NE
Washington, DC 20002
Rachel_meidl@americanchemistry.com

Jonathan L. Snare
Counsel for American Chemistry Counsel
Morgan, Lewis & Bockius LLP
1111 Pennsylvania Avenue, NW
Washington, DC 20004
jsnare@morganlewis.com

Susan Yashinskie
Vice President,
Member Relations &
Development

American
Fuel & Petrochemical
Manufacturers

1667 K Street, NW
Suite 700
Washington, DC
20006

202.457.0480 office
202.552.8478 direct
202.457.0486 fax
Susany@afpm.org

January 3, 2014

U.S. Chemical Safety and Hazard Investigation Board
2175 K Street, N.W., Suite 650
Washington, D.C. 20037

Attn: Comments on Report No. 2012-03-I-CA Chevron Richmond Refinery Regulatory Report

AFPM, the American Fuel & Petrochemical Manufacturers, is a trade association representing high-tech American manufacturers of virtually the entire U.S. supply of gasoline, diesel, jet fuel, other fuels and home heating oil, as well as the petrochemicals used as building blocks for thousands of products vital to everyday life. AFPM members operate facilities that are subject to the Occupational Safety and Health Administration's (OSHA) Process Safety Management standard and therefore are impacted by the CSB's recommendations to amend applicable OSHA regulations.

Thank you for the opportunity to provide input on the Chemical Safety and Hazard Investigation Board's (CSB) December 16, 2013 notice and request for comments on its draft Regulatory Report: Chevron Richmond Refinery Pipe Rupture and Fire (Report No. 2012-03-I-CA).

The Safety Case Regulatory Regime

Included in the Regulatory Report is a recommendation that the state of California "develop and implement a step-by-step plan to establish a more rigorous safety management regulatory framework for petroleum refineries in the state of California based on the principles of the 'Safety Case.'" AFPM is very concerned by the lack of factual basis and data supporting the CSB's claims regarding the benefits of the Safety Case. As the Regulatory Report itself notes, there is no evidence that the Safety Case approach to process safety reduces risk and increases safety, as "there have been few objective studies conducted on the impact of the safety case regulatory approach on safety performance." (*See* Regulatory Report, p. 108.)

Advocating sweeping regulatory change based only on conjecture is inconsistent with the objective, fact-based approach required of the CSB in conducting its investigations and making recommendations. The CSB instead is using separate process safety incidents, each having their own independent causal factors, to arbitrarily suggest a pattern invalidating an entire regulatory regime. Such an approach is not a scientific or technical inquiry, and side steps the harder analysis required to improve existing aspects of management system performance and technical process safety.

The federal OSHA Process Safety Management of Highly Hazardous Chemicals (PSM) standard represents a consistent and well-understood and established framework that has been incorporated into thousands of PSM regulated manufacturing facilities throughout California and the rest of the United

States for over two decades. Changing the approach to the Safety Case will add complexity and uncertainty with no demonstrated benefit. This added complexity may even increase risk due to conflicting priorities created by the potential overlay of new regulations.

A better approach to improving process safety performance would be to leverage the industry's substantial investment and commitment to the existing regulatory regime. Federal OSHA has already begun their process to enhance and improve the PSM standard. On December 9, 2013, OSHA's Request for Information regarding potential revisions to the PSM standard was published in the *Federal Register* (PSM RFI) 78 Fed. Reg. 73756. This initiative is the first step in what likely will be notice and public comment rulemaking to amend and enhance the PSM standard. Efforts by OSHA to improve the existing regulatory program should be pursued before advocating for the wholesale introduction of an entirely new and different regulatory approach.

While the PSM RFI and other efforts are underway, the CSB should continue to study and analyze the different regulatory regimes and develop meaningful data on which it can then base a recommendation or provide other input to OSHA as part of the PSM RFI. This approach is expressly contemplated by the agency's enabling statute, the federal Clean Air Act:

> The [CSB] is authorized to conduct research and studies with respect to the potential for accidental releases, whether or not an accidental release has occurred, where there is evidence which indicates the presence of a potential hazard or hazards. To the extent practicable, the [CSB] shall conduct such studies in cooperation with other Federal agencies having emergency response authorities, State and local governmental agencies and associations and organizations from the industrial, commercial, and nonprofit sectors.

42 U.S.C. § 7412(r)(6) (F).

The Importance of Effectively Managing Organizational Change

The addition of the Safety Case approach to existing requirements would be a massive organizational change for regulators and for industry. The CSB recognizes that it is good practice to apply change management procedures to organizational changes which requires "the right people and resources to review the situation . . . [and] identify potential hazards, develop protective measures, and propose a course of action." *See* CSB Safety Bulletin No. 2001-04-SB, "Management of Change," August 2001, at pp. 1, 2. The CSB has also cited guidelines issued by the U.K. Health and Safety Executive (HSE) on this subject. The HSE's admonitions about effectively managing organizational change are relevant to the proposed change that the CSB appears determined to recommend. *Id.* The HSE warns that "[o]rganisational change should be planned in a thorough, systematic, and realistic way." *See* HSE Information Sheet, "Organisational change and major accident hazards," Chemical Information Sheet No. CHIS7, p. 2

> A central consideration of management of change is ensuring that, following the change, "the organisation will have the resources (human, time, information etc.), competence and motivation to ensure safety without making unrealistic expectations of people." *Id.* Further, "[t]he

process of organisational change should involve all those concerned from an early stage . . . [t]hose making decisions should be careful to analyze all information and views carefully, and be made aware of their own potential lack of objectivity . . . . " *Id.* at 3. Crucially, "[i]nvolvement in this context means active participation in decisions, not just passive consultation." *Id.*

The CSB should not recommend such a sweeping regulatory change until it has considered the requirements of organizational change such as resource availability and participation by stakeholders.

AFPM believes engagement of key stakeholders on issues such as these would be appropriate, relevant, and beneficial. Such engagement, coupled with appropriate objective data on the efficacy of the Safety Case, would allow meaningful consideration of the benefits of this new approach.

Conclusion

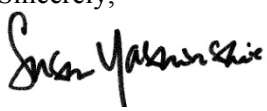
AFPM appreciates the opportunity to comment on the CSB regulatory report. Our members remain committed to focusing on efforts to improve process safety performance.

CSB's recommendation to adopt the Safety Case approach is not based on the fact-based approach typically employed by the CSB. We believe that introducing an entirely new regulatory scheme in this already heavily regulated space would be a distraction for regulators and industry, and certainly should not be considered without a thorough and rigorous analysis of the organizational change aspects of the recommendation on regulators and the regulated parties. Efforts to have covered employers follow both the Safety Case and the PSM standard will add complexity and uncertainty without any clear evidence of a corresponding benefit.

For these reasons, AFPM opposes the CSB recommendation that California implement the Safety Case regulatory framework.

If you have any questions or comments, please contact me at 202.457.0480 or susany@afpm.org.

Sincerely,



Susan Yashinskie
Vice President, Member Relations & Development
APFM

January 3, 2014

U.S. Chemical Safety and Hazard Investigation Board
2175 K Street, NW
Suite 400
Washington, DC 20037

Re: American Petroleum Institute and Western States Petroleum Association Comments on U.S. Chemical Safety and Hazard Investigation Board's Regulatory Report on Chevron Richmond Refinery Pipe Rupture and Fire

To The U.S. Chemical Safety and Hazard Investigation Board:

On December 16, 2013, the U.S. Chemical Safety and Hazard Investigation Board (CSB) requested public comments on proposed recommendations for substantial changes to how refineries are regulated in California. A draft reported entitled "Regulatory Report: Chevron Richmond Refinery Pipe Rupture and Fire," recommends that California replace its current process safety management regulatory system with an alternative regulatory regime known as the "Safety Case." The American Petroleum Institute (API) and the Western States Petroleum Association (WSPA) appreciate the opportunity to comment on the CSB draft report and to address the current and alternative regulatory approaches.

API represents more than 550 companies involved in all aspects of the oil and natural gas industry including exploration, production, refining, marketing, pipeline, and marine transporters, as well as service and supply companies that support all segments of the industry. WSPA represents companies that account for the bulk of petroleum exploration, production, refining, transportation and marketing in the six western states. API and WSPA members are significantly affected by the efforts of the CSB and are regularly called upon to respond to and implement the CSB's recommendations.

API and WSPA believe the current OSHA Process Safety Management (PSM) regulatory approach is effective and that an overhaul of the PSM standard is unwarranted. The PSM standard represents a consistent and well-understood framework that has been used by manufacturing facilities throughout California and the rest of the United States for over two decades. Changing the current regulatory approach to Safety Case will add complexity and uncertainty with no demonstrated benefit. This added complexity may even increase risk due to conflicting priorities created by the potential overlay of new regulations.

Even now, federal OSHA is working to enhance and improve the existing PSM standard. On December 9, 2013, OSHA issued a Request for Information (RFI) requesting information from stakeholders regarding potential revisions to the PSM standard. This RFI is usually the first step

in what may be rulemaking to amend the PSM standard. Efforts by federal OSHA to improve the existing PSM regulatory program should be explored before aggressively pursuing the introduction of an entirely new and different regulatory approach.

Of concern to API and WSPA is the lack of meaningful data that demonstrates that the Safety Case approach produces better process safety performance than the PSM standard. In fact, on page 105 of the CSB draft regulatory report, the CSB acknowledges that "there have been few objective studies conducted on the impact of the Safety Case regulatory approach on safety performance onshore and offshore." The CSB draft report also recognizes, via many references, that the existing data mainly relates to offshore operations which increase API and WSPA's concern about applying Safety Case to refineries. If Safety Case or other regulatory regimes are to be considered, all the relevant U.S. regulatory bodies should first collect broad and meaningful data that can be used to justify further consideration of regulatory alternatives.

In fact, there are examples showing that the Safety Case approach is not the panacea that the CSB believes it to be. For example, in the early hours of Sunday, December 11, 2005, a number of explosions occurred at Buncefield Oil Storage Depot, Hemel Hempstead, Hertfordshire. At least one of the initial explosions was of massive proportions and there was a large fire, which engulfed a large portion of the site. Over 40 people were injured. According to the Hertfordshire Resilience report, *Buncefield Multi-agency Debrief Report and Recommendations*, the Buncefield site was operating under a "safety case." According to this report, the worst case scenario outlined in the site operators' safety case was a single tank fire; the safety case did not contemplate the incident that actually occurred.

Another example, while not related to the petroleum industry, is that of the Royal Air Force (RAF) Nimrod. On September 2, 2006, RAF Nimrod was on a routine mission over southern Afghanistan when it suffered a catastrophic mid-air fire after completing air-to-air refueling, leading to the total loss of the aircraft and the death of all fourteen on board. As discussed in a paper prepared by Professor Nancy Levenson of MIT, a safety case had been prepared for the RAF Nimrod. The accident report concluded that the quality of that safety case was gravely inadequate. The Nimrod report noted that the Safety Case Regime has lost its way and has led to a culture of "paper safety" at the expense of actual safety.

The safety concepts of the OSHA PSM regulations and the Safety Case approach are in fact very similar. They both require that facilities be able to demonstrate that the site knows the hazards associated with operating the facility, understands the risks associated with those hazards and describes the controls in place to manage those risks.

One difference in the two programs is the role of the regulator – for OSHA, the regulator performs more of an enforcement role whereas in the Safety Case approach, the regulator performs an "acceptance" or "permissioning" role whereby a site's "case" is accepted by the regulator. Significant organizational change and cost would be required for regulators and industry without and clear, corresponding benefit. The Safety Case approach requires significantly more technically competent, well-resourced regulators to review the hazards identified in the site's "case" and to evaluate the effectiveness of the controls used to manage the risks for the facility. This difference in roles would be very difficult to implement in California

or more broadly in the U.S. In either case, it is the operator of the site that ultimately determines how to ensure safe operations.

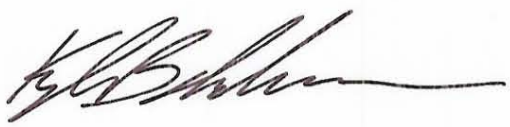
Another difference between the two programs is the availability of chemical information for public consideration. U.S. regulations such as the Emergency Preparedness and Community Right- to-Know Act require reporting on hazardous and toxic chemicals to help increase the public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment. In contrast, safety cases are usually kept in confidence and are only available to top level management, the assigned agency official, and the consultants used in the development of the safety case.

As the CSB correctly notes in the draft report, Safety Case is not perfect and that no regulatory system will be perfect in its implementation. In light of this acknowledgement, while API and WSPA support the CSB's efforts to fulfill its core mission by conducting investigations of accidental releases and timely sharing of its findings with the public, API and WSPA respectfully suggest that the CSB should focus its limited resources on this core mission rather than expending resources advocating for new regulatory programs.

In conclusion, API and WSPA believe the current PSM program is effective and that the OSHA RFI needs to be carried out and the results analyzed which may lead to potential improvements in the PSM standard. Additionally, API and WSPA believe there are insufficient factual bases and data to support the adoption of the safety case at this time. The effectiveness of any safety program is only as good as the commitment made to its preparation, implementation and execution and the site operator is ultimately responsible to ensure safe operations. The development of a safety case, does not, in and of itself, improve safety. To the extent the CSB sees areas for improvement, API and WSPA encourage the CSB to continue its focus on enhancements to the current PSM standard and not on alternatives to replace it.

If you have any questions about these comments, please contact Ron Chittim, at 202/682-8176 or Chittim@api.org.

Sincerely,



Kyle Isakower
Vice President
Regulatory and Economic Policy
American Petroleum Institute

Cathy Reheis-Boyd
President
Western States Petroleum Association

Process Safety Risk Assessment LLC
79 N. Tamarac Drive
Shepherdstown
WV 25443

January 3, 2014

VIA ELECTRONIC MAIL
U.S. Chemical Safety and Hazard Investigation Board
2175 K Street, N.W., Suite 650
Washington, D.C. 20037

Re: CSB Draft Regulatory Report, Report No. 2012-03-I-CA

Ladies and Gentlemen:

On December 16, 2013, the U.S. Chemical Safety Board ("CSB" or "Agency") issued for public comment its draft Regulatory Report, Report No. 2012-03-I-CA ("Report") relating to the August 6, 2012 incident that occurred at the Chevron U.S.A. Inc. ("Chevron USA") Richmond Refinery. I write in response to your request for public comments on the Report. At the outset and for the purposes of complete candor, please know that I am advising Chevron USA with respect to process safety and other matters. Nevertheless, the opinions set forth in this letter are based solely upon my own professional experience and technical judgment.

As you know, I have experience with process safety matters both in industry and with the United States government. For over thirty years, I worked for a large chemical manufacturer in a variety of disciplines, including process engineering, environmental compliance, project management, and operations. Beginning in 2002, I had the privilege of serving the CSB for ten years, first as a Board Member and then as its Chairperson. I also have worked as a Senior Advisor, Office of Prevention, Pesticides and Toxic Substances, for the U.S. Environmental Protection Agency, and as a staff consultant for the Center for Chemical Process Safety ("CCPS") of the American Institute of Chemical Engineers. I am currently associated with the Mary Kay O'Connor Process Safety Center at Texas A&M University where I support students working towards a PhD in Chemical Engineering with a focus on chemical plant and refinery process safety. In all of these roles, my efforts have focused on effective ways to prevent or minimize the consequences of process safety incidents, such as fires, explosions, and toxic releases.

My background has informed my concerns regarding the Report's recommendation issued to the State of California to "develop and implement a step-by-step plan to establish a more rigorous safety management framework for petroleum refineries in the state of California based on the principles of the 'safety case' framework." Report, p. 13. My reservations regarding the CSB's pending Safety Case recommendation are primarily rooted in the fact there is no empirical evidence demonstrating that the Safety Case regime is more effective than any other regulatory

scheme, including the existing federal Process Safety Management ("PSM") standard, codified at Section 1910.119 of Title 29 of the Code of Federal Regulations.[1] I also am concerned that efforts to implement sweeping regulatory changes will introduce significant uncertainty and potentially degrade safety performance without any corresponding assured benefit.

No Evidence that the Safety Case is a Better Approach

Any incident investigation must ground its examination in "rigorous scientific and engineering principles" to "establish the credibility of its findings and recommendations." *See, e.g., Space Shuttle Columbia STS-107 Tragedy: Columbia Accident Investigation Board (CAIB) Final Report, Gehman Board Report to NASA*, Vol. I, p. 6 (August 2003). CCPS guidance for performing incident investigation echoes this sentiment providing that "technical rigor" for incident investigations should be demanded. CCPS, *Guidelines for Risk Based Process Safety*, Version 2007, Chapter 19, Section 19.2.3—Use of Appropriate Techniques to Investigate Incidents, p. 559. Notably, CCPS' incident investigation guidelines provide:

> Technical rigor refers to the thoroughness of arguments used to support the causes and recommendations identified by the investigation team. In most cases, the team will have some preconceived notions regarding the causes of an incident. In some cases, team members may have recommendations in mind before the analysis even begins. As a result, the team often examines data with a tainted view. Techniques that encourage the team to not only look at the data that support its preconceived ideas but also consider data that refute or disprove its theories tend to result in more rigorous investigations. This approach improves acceptance of…recommendations…because it allows…the validity of the conclusions [to be assessed] in light of all the available data, not just the data that support the team's preconceived ideas.

Id. at p. 560. The guidelines further admonish that "[p]erforming an investigation without collecting all of the required data often results in the identification of incorrect causes and the development of ineffective recommendations." *Id.* at 559.

With the foregoing in mind, as the CSB acknowledges in the Report, "there have been few objectives studies conducted on the impact of the safety case regulatory approach on safety performance." Report, p. 108. As a result, the CSB is left to promote the benefits of a regulatory regime unfamiliar to U.S. regulators and industry alike through what is little more than a limited survey of anecdotal reports and studies and selected quotations from individuals commending the Safety Case approach and the regulators who oversee it in their respective jurisdictions.

Even the CSB's survey of the limited available literature is incomplete as the CSB does not even note, let alone discuss, any divergent views on the Safety Case. For example, Dr. Nancy

[1] As you know, the State of California administers its own workplace health and safety regulatory program. The California "state plan," however, essentially adopts the federal PSM standard. *See* California Code of Regulations, Title 8, Section 5189.

Leveson[2] of the Massachusetts Institute of Technology—a recognized expert in the field of safety and regulation—recently published a paper questioning the ability of the Safety Case to promote and improve process safety. Dr. Leveson has unambiguously asserted that "[t]he use of performance-based regulation has not necessarily proven to be better than the other approaches in use," because "careful evaluation and comparison between approaches has not been done." Nancy Leveson, *The Use of Safety Cases in Certification and Regulation*, p. 6.[3] Dr. Leveson further notes, "[m]ost papers about safety cases express personal opinions or deal with how to prepare a safety case, but not whether it is effective. As a result, there is no real evidence that one type of regulation is better than another." *Id.* The Report suffers from the very limitation observed by Dr. Leveson in that the CSB offers little more than a collection of "personal opinions" in support of the Safety Case.

Dr. Sam Mannan, of the Mary Kay O'Connor Process Safety Center at Texas A&M University, has echoed similar sentiments in another study that the CSB has not referenced. Specifically, Dr. Mannan opines that "considering the big difference between OSHA PSM and HSE Safety Case, we should be very cautious to make any immediate change and analyze this issue deeply in multiple aspects." Sam Mannan, *The Pros and Cons of Performance-Based Regulatory Models*, p. 2.[4]

The CSB's description of the Safety Case suggests it is a cure-all against process safety incidents. As observed by Dr. Leveson, however, the poor use of safety cases has been implicated in various accident reports. Among a lengthy list of criticisms of the Safety Case detailed by Dr. Leveson are that "[t]he Safety Case has lost its way . . . led to a culture of 'paper safety' at the expense of real safety," and that "[s]afety cases are compliance-driven, i.e., written in a manner driven by the need to comply with the requirements of regulations, rather than being working documents to improve safety controls." *The Use of Safety Cases in Certification and Regulation*, p. 6. These complaints echo ones the CSB has directed at the PSM standard. Dr. Mannan also has detailed limitations of the Safety Case. Sam Mannan, *The Pros and Cons of Performance-Based Regulatory Models*, pp. 3-6.

The few studies or reports cited by the CSB also suffer from conformational bias. Dr. Leveson describes conformational bias as:

> [A] tendency for people to favor information that confirms their preconceptions or hypotheses regardless of whether the information is true. People will focus on and interpret evidence in a way that confirms the goal they have set for themselves. If the goal is to prove the system is safe, they will focus on the evidence that shows it is safe and create an argument for safety. If the goal is to show the system is unsafe, the evidence used and the interpretation of available evidence will be

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[2] Dr. Leveson served as a member of the BP U.S. Refineries Independent Safety Review Panel (often referred to as the Baker Panel), which was established in response to an urgent recommendation from the CSB in the aftermath of the Texas City incident in 2005. She also previously served as an advisor and consultant to the Columbia Accident Investigation Board.

[3] Available at sunnyday.mit.edu/safer-world/safety-case.doc. A copy is attached.

[4] A copy is attached.

quite different. People also tend to interpret ambiguous evidence as supporting their existing position.

The Use of Safety Cases in Certification and Regulation, pp. 4-5. Dr. Mannan has offered even more pointed comments, remarking that "performance data should be collected adequately and uniformly under consistent incident reporting system. Otherwise, biased data collection will always lead to incorrect conclusions." *The Pros and Cons of Performance-Based Regulatory Models*, p. 22. In my opinion, the CSB's single-minded advocacy of the Safety Case demonstrates this type of biased data collection. The Report, for example, cites favorably a study released by the Labor Occupational Health Program at the University of California, Berkeley School of Public Health, Center for Occupational and Environmental Health ("LOHP Report"). *See* Michael P. Wilson, *Refinery Safety in California: Labor, Community and Fire Agency Views*; Summary Report for Office of Governor Jerry Brown, Interagency Task Force on Refinery Safety. March 27, 2013. The CSB repeatedly references Dr. Wilson's findings as support for the Agency's Safety Case recommendation. However, Dr. Wilson's conclusions are drawn almost exclusively from the CSB's *first* Interim Report into the August 6th incident that also alleged concerns regarding the California process safety regulatory program. *See* the CSB's Interim Investigation Report: Chevron Richmond Refinery Fire.[5] An echo chamber of successive reports, each favorably citing to the other, is far removed from the type of "rigorous scientific" examination extolled by the Columbia Accident Investigation Board or endorsed by CCPS.

Also of concern is the manner in which the Report endeavors to use a 2006 study by Swiss Re[6] ("Swiss Re Study") as a surrogate analysis detailing the effectiveness of different safety regulatory regimes. *See* Ernst Zirngast, *Selective U/W in Oil-Petro Segment: Loss Burden in Different Regions, USA vs. Rest of the World, History of Selective U/W, Cause of Losses* (draft extract). June 16, 2006. In advocating for the Safety Case, the CSB quotes the LOHP Report and observes that "Dr. Wilson noted that ['US cluster' refineries have] experienced financial losses from refinery incidents that are three times that of industry counterparts in countries within the 'EU Cluster.'" Report, pp. 15-16. The CSB then notes that the LOHP Report recommends to the State of California that it adopt the Safety Case. The clear implication is that the Swiss Re Study supports such a view. This conclusion not only is incorrect, but Agency critics may see it as an intentional attempt to mislead. Nothing in the Swiss Re Study cited by the CSB suggests that the author was intending to pass judgment on the efficacy of the Safety Case as compared to the PSM standard. The Swiss Re Study instead evaluates whether premium rates in liability underwriting should take into consideration that the "loss burden" for refining and petrochemical manufacturing apparently varies by global region.

The CSB's discussion of the Swiss Re Study is especially troublesome because it omits a key fact when it singles out the "US cluster" as having higher financial losses than the "EU cluster." The "US cluster" as defined by the Swiss Re Study includes two countries (in addition to the United States and Canada) that have adopted the Safety Case: the United Kingdom and Australia. Swiss Re Study, p. 3. The Swiss Re Study therefore cannot stand for the proposition that the Safety Case is a better approach because the Swiss Re Study does not account for different regulatory regimes in the various jurisdictions encompassed within the "US cluster."

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[5] Available at: http://www.csb.gov/assets/1/19/Chevron_Interim_Report_Final_2013-04-17.pdf

[6] Swiss Re is a global reinsurance and financial services company.

The Swiss Re Study also acknowledges there are different factors that may impact loss burden, including differences among the clusters in business insurance coverage levels and operating plant complexity.[7] *Id.*

In contrast, relying on actual statistical Process Safety Performance data as opposed to financial losses, Dr. Mannan concluded that "based upon statistics from the UK HSE and U.S. API, it is hard to tell whether the statistics show any real upwards or downward trend." Sam Mannan, *The Pros and Cons of Performance-Based Regulatory Models*, p. 7. Dr. Mannan continued that "[i]f there is a trend, upward or downward, it would also be very difficult to tell whether it was due to the regulatory regime or whether it was a function of some other factor (*e.g.,* an increase in minor accidents due to better reporting or a decrease in major accidents due to more of them being reported as significant)." *Id.* at 8. As such, Dr. Mannan concludes that "regulatory bodies would have to prove that these gains that other industries and other countries are making are not just 'smoke and mirrors' based on other influencing factors." *Id.*

Dr. Mannan has commented that "[in] order to advance the use of performance-based regulations in the US Oil and Gas Industry…[t]here must be convincing statistical evidence that performance-based measures will outperform the prescriptive-based measures they are replacing." *Id.* at 6. In this regard, nothing in the Report, nor the underlying studies the CSB references, answers the fundamental question of whether the Safety Case regime is more effective at preventing process safety incidents than other regulatory approaches, including the PSM standard. The Report's omission in this regard is not only troubling, but inexplicable. In my experience, having served in various capacities at the Agency, the perfunctory analysis underpinning the recommendation on the Safety Case represents a marked departure from the Agency's historically objective and technically-based approach to investigations. I am concerned that the CSB may undermine its reputation for technical expertise if it forges ahead with a recommendation, the benefits of which have yet to be methodically and objectively scrutinized by anybody, including, most importantly, the Agency.

A Different Regulatory Approach May Diminish Safety Performance

The CSB states that the Safety Case program represents a "fundamental change" to the existing process safety regime. News Release issued by the CSB on December 16, 2013.[8] The Agency further acknowledges "significant challenges" posed by a transition to the Safety Case. Report, p. 111. I completely agree with these assessments. Among the challenges posed by such a change is the significant uncertainty that will develop within the California regulatory environment as refiners, employees, contractors, and regulators attempt to learn, develop, and implement an

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[7] There are other possible explanations that may account for differences in refinery losses including differing legal frameworks between regions. *See* Swiss Re Report, p. 8. For example, while common law regimes such as the United States routinely allow for the award of compensatory and punitive damages, civil law jurisdictions—which predominate in continental Europe—generally disfavor the award of punitive damages and generally limit liability to restitution damages. Some jurisdictions also have a reputation for being more litigious. These differences may help account for dramatic differences in liability costs from refinery incidents.

[8] Available at: http://www.csb.gov/in-wake-of-chevron-2012-pipe-rupture-and-fire-in-bay-area-csb-draft-report-proposes-overhaul-of-refinery-industry-regulatory-system-in-california-and-urges-adoption-of-the-safety-case-regime-to-prevent-major-chemical-accidents/.

entirely new approach. What the Report fails to consider, however, is the very real potential for diminished safety performance during such a transition.

As the CSB knows, the Baker Panel observed that it is "especially challenging to make dramatic and systemic changes in short timeframes" Baker Panel Report, p. xviii. The Baker Panel also cautioned against the dangers of "initiative overload" when too many competing efforts (even if well-intentioned) overwhelm individuals and organizations resulting in degraded safety performance. The CSB is remiss in recommending such a "fundamental" regulatory overhaul without at least identifying and considering the attendant burdens and potential consequences imposed.

Implementing such a fundamental change cannot just be achieved by executive directive. At both the state and federal levels, it would require notice and public comment rulemaking pursuant to laws and statutes governing administrative procedures.[9] Some changes may require amendments to existing legislation or revisions to local ordinances.[10] Proposed regulations and guidance will need to be drafted, reviewed, and then issued. Agencies will need to retrain inspectors, develop forms, and publish instructions.

The Report concedes that regulators play a dramatically different role in the Safety Case, which requires "rigorous review and oversight by a technically competent regulator to ensure effective implementation." Report, p. 20.[11] The CSB acknowledges that "[i]f a competent regulator is not in place, then the safety case report equates to nothing more than a lifeless document sitting on a shelf, and the criticism of self-regulation becomes valid." Report, p. 104. The Report, however, lacks any discussion on the availability of the infrastructure and resources necessary to implement the Safety Case.

Efforts to meaningfully adopt the CSB's recommendation will take years and come at a tremendous cost. Every dollar spent by the State of California to implement the Safety Case approach is a dollar that is not spent on other efforts, including existing process safety programs. Every hour spent by a governmental inspector learning how to implement the Safety Case is an hour not spent on an on-site inspection. Such tradeoffs might be acceptable if there was an assured benefit. However, the lack of any clear, empirical data showing that a new approach is more effective at reducing the frequency or severity of process safety incidents precludes a reasoned analysis of options. In effect, the CSB is asking the State of California, its citizens, employers, and workers to simply trust the CSB's unsupported opinion. Such an approach is

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[9] The draft Report describes the challenges that the CSB has confronted in getting other federal agencies, including the federal Occupational Safety and Health Administration ("OSHA") to implement the Agency's recommendations. Report, pp. 43-48. It also recites the challenges that OSHA faces in issuing new standards. As a former CSB Board member, I uniquely appreciate the Agency's frustration. It is unlikely, however, that a recommendation advocating wholesale regulatory change to the Safety Case stands any greater likelihood of implementation. Such major rulemaking would likely proceed at an even slower pace than regulatory revisions that represent a more moderate approach.

[10] The 1990 Amendments to the Clean Air Act, for example, specifically directed OSHA to promulgate the PSM standard. It is possible that OSHA could not replace the PSM standard with the Safety Case regime in the absence of legislative changes.

[11] While the Report fails to acknowledge this issue, it is clear that an equivalent level of expertise will be required at refineries. While this may be developed over time at large refining companies, smaller operators may not have similar resources.

unacceptable for an agency entrusted with the important mission of thoroughly investigating chemical accidents and making recommendations based on technical analysis to prevent a reoccurrence.

Furthermore, the Report fails to acknowledge that the "review and oversight" by individual regulators will almost certainly negatively impact the consistency of process safety standards in California. The Report comments that a regulator may unilaterally "require that the facility take additional steps to further reduce risk without needing to propose and adopt a new rule or regulation to address it." Report, p. 105. Accordingly, the Safety Case necessarily relies on the subjective judgment of different regulatory personnel, each holding their own biases and perspectives on what are acceptable levels of safety, which may vary from regulator to regulator and from facility to facility. When inconsistent and potentially arbitrary personal judgments are determinative of whether a refiner can operate, normative standards and external benchmarks against which safety performance can be measured will likely become more difficult to develop. *See, e.g.,* Sam Mannan, *The Pros and Cons of Performance-Based Regulatory Models*, pp. 4-5.

An Alternative Approach

As the CSB recognizes, "no regulatory system will be perfect." Report, p. 110. However, alleged gaps in the existing regime are not a sufficient justification for jettisoning it and starting over. Dr. Mannan has similarly reflected that because "it is difficult to judge which regulatory regime is more effective...we should figure out how to improve our existing program instead of changing the whole system and allow time for existing regulations (*e.g.,* PSM) to be implemented properly." Sam Mannan, *The Pros and Cons of Performance-Based Regulatory Models*, pp. 22-23.

In this vein, as the CSB is aware, federal OSHA is working to improve the PSM standard. In fact, on December 9, 2013, OSHA published a Request for Information ("PSM RFI") regarding potential revisions to the standard. *See* 78 Fed. Reg. 73756. There is a strong likelihood that this represents the first step in what will likely lead to notice and public comment rulemaking to modify the PSM standard.

In addition, on August 1, 2013, President Obama signed an Executive Order establishing a federal multiagency Chemical Facility Safety and Security Working Group ("Working Group") with a mandate to "further improve chemical facility safety and security in coordination with owners and operators." The Working Group is broadly tasked with identifying or developing measures to: (1) improve operational coordination with state, local, and tribal partners (including facility owners and operators); (2) enhance federal interagency coordination; (3) enhance interagency information collection and sharing; (4) modernize key policies, regulations, and standards; and (5) identify, in conjunction with key stakeholders, best practices to reduce safety and security risks. Consistent with remarks made by CSB Chairperson Rafael Moure-Eraso, the Working Group presents an opportunity to "spur development of regulation and enforcement..." and to strengthen the "EPA's [RMP] and OSHA's [PSM] standard." August 1, 2013 Statement

from Chairperson Rafael Moure-Eraso on Executive Order Improving Chemical Facility Safety and Security.[12]

With the PSM RFI and the Working Group underway, the CSB should use these opportunities to *study* the different regulatory regimes and develop meaningful data on which it can then base a recommendation or provide other input to OSHA or the Working Group. This approach is expressly contemplated by the agency's enabling statute, the federal Clean Air Act:

> The [CSB] is authorized to conduct research and studies with respect to the potential for accidental releases, whether or not an accidental release has occurred, where there is evidence which indicates the presence of a potential hazard or hazards. To the extent practicable, the [CSB] shall conduct such studies in cooperation with other Federal agencies having emergency response authorities, State and local governmental agencies and associations and organizations from the industrial, commercial, and nonprofit sectors.

42 U.S.C. § 7412(r)(6)(F). The resulting data from a thoroughly and properly conducted evaluation would allow the CSB to make a reasoned and informed recommendation.

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In conclusion, there are insufficient factual bases and data to support the CSB's recommendation that California adopt the Safety Case approach. Such a fundamental change will result in significant uncertainty in California's regulatory environment as refiners, employees, contractors, and regulators attempt to learn, develop, and implement an entirely new approach. The Report also fails to consider the financial costs to the State of California of such a change, including the potential for diminished safety performance during such transition. These tradeoffs might be acceptable if there was an assured benefit. The lack of any clear, empirical data showing that a new approach is more effective at reducing the frequency or severity of process safety incidents precludes a reasoned analysis of options.

In my opinion, the implementation of the Safety Case would hinder, rather than help, efforts by multiple stakeholders in industry, organized labor, and governments at the federal, state, and local level to improve process safety performance. For these reasons, I respectfully oppose the CSB recommendation directed to the State of California to implement the Safety Case. In the absence of empirical data showing that the Safety Case regime is a better approach, the CSB should support efforts to improve the existing PSM program before advocating the wholesale adoption of an entirely new regulatory scheme.

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[12] Available at: http://www.csb.gov/statement-from-chairperson-rafael-moure-eraso-on-executive-order-improving-chemical-facility-safety-and-security/

Very truly yours,

John S. Bresland
President

The Use of Safety Cases in Certification and Regulation[1]

Prof. Nancy Leveson
Aeronautics and Astronautics/Engineering Systems
MIT

Introduction

Certification of safety-critical systems is usually based on evaluation of whether a system or product reduces risk of specific losses to an acceptable level. There are major differences, however, in how that decision is made and on what evidence is required. The term Safety Case has become popular recently as a solution to the problem of regulating safety-critical systems. The term arises from the HSE (Health and Safety Executive) in the U.K., but different definitions seem to be rife. To avoid confusion, this paper uses the term "assurance cases" for the general term and limits the use of the term "safety case" to a very specific definition as an argument for why the system is safe. This paper examines the use of safety cases and some dangers associated with their use.

The first important distinction is between types of regulation.

Types of Regulation

Safety assurance and certification methods differ greatly among industries and countries. Safety assurance methods commonly used can be broken into two general types, which determine the type of argument used in the assurance or certification process:

1. **Prescriptive**: Standards or guidelines for product features or development processes are provided that are used to determine whether a system should be certified.
    a. Product: Specific design features are required, which may be (a) specific designs as in electrical codes or (b) more general features such as fail-safe design or the use of protection systems. Assurance is usually provided by inspection that the design features provided are effective and implemented properly. In some industries, practitioners are licensed based on their knowledge of the standards or codes of practice. Assurance then becomes the responsibility of the licensed practitioner, who can lose their license if they fail to follow the standards. Organizations may also be established that produce standards and provide certification, such as the UL rating.
    b. Process: Here the standards specify the process to be used in producing the product or system or in operating it (e.g., maintenance or change procedures) rather than specific design features of the product or system itself. Assurance is based on whether the process was followed and, sometimes, on the quality of the process or its artifacts. The process requirements may specify
        i. General product or system development processes and their artifacts, such as requirements specifications, test plans, reviews, analyses to be performed, and documentation produced.
        ii. The process to be used in the safety engineering of the system and not the general development process used for the product.
2. **Performance-based or goal-setting approaches** focus on desired, measurable outcomes, rather than required product features or prescriptive processes, techniques, or procedures. The certification authority specifies a threshold of acceptable performance and a means for assuring that the threshold has been met. Basically, the standards set a goal, which may be a risk target, and usually it is up to the assurer to decide how to accomplish that goal. Performance-based regulation specifies defined results without specific direction

[1] This paper will appear in the Nov/Dec 2011 issue of the Journal of System Safety.

regarding how those results are to be obtained. An example is a requirement that an aircraft navigation system must be able to estimate its position to within a circle with a radius of 10 nautical miles with some specified probability.

While in the past most assurance was prescriptive (either product or process), there has been interest in performance-based regulation and assurance by government agencies, starting in the U.S. during the Reagan administration, often spearheaded by pressure from those being certified. A similar movement, but much more successful, was started in Great Britain around the same time, some of it stemming from the Cullen report on the Piper Alpha accident [2].

Certification in the U.S. primarily uses prescriptive methods, but mixes the two types (product and process). Commercial aircraft, for example, are certified based on airworthiness standards requiring specific features (e.g., oxygen systems and life preservers), and more general features such as fail-safe design. Certification also requires the use of various types of safety analysis techniques, such as Fault Hazard Analysis, and general engineering development standards. NASA also uses both product and process standards.

While the Nuclear Regulatory Commission requires prescriptive assurance for nuclear power plants, the American Nuclear Society in 2004 called for the use of risk-informed and performance-based regulations for the nuclear industry, arguing that

> "Risk-informed regulations use results and insights from probabilistic risk assessments to focus safety resources on the most risk-significant issues, thereby achieving an increase in safety while simultaneously reducing unnecessary regulatory burden produced by deterministic regulations" [1]

Similar arguments have been made about FAA regulations and procedural handbooks being inflexible and inefficient and rule-making taking too long. Recommendations have been made to redesign the rulemaking process by moving to performance-based regulations where appropriate, but this type of certification is controversial, particularly with respect to how the performance goals are set and assured.

Assurance Cases

Often, certification is a one-time activity that follows the development process and occurs before the product or system is allowed to be marketed or used. For complex systems, such as aircraft and nuclear power plants, certification may involve both initial approval and oversight of the operational use of the system. Changes to the original system design and certification basis may require recertification activities.

All certification is based on "arguments" that the certification approach has been followed. Inspection and test may be used if the certification is based on following a product standard. If the certification is based on the process used, engineering artifacts or analyses may be required and reviewed. Performance-based regulation may require a particular type of analysis (such as the use of specific types of probabilistic risk assessment) or may allow any type of reasoning that supports having achieved a particular performance goal.

As an example, the U.S. Department of Defense in Mil-Std-882 [18] uses a prescriptive process that details the steps that must be taken in the development of safety-critical systems to ensure they are safe. The purpose of the SAR (safety assessment report), which is used as the basis for certification, is to describe the results of the prescribed steps in the standard. The SAR contains the artifacts of the prescribed process, such as a Safety Plan (which must be approved by the DoD at the beginning of the development of the system), a Preliminary Hazard Analysis, a System Hazard Analysis, a Subsystem Hazard Analysis, an Operating System Hazard Analysis, etc. The DoD evaluates the quality of the process artifacts provided in the SAR as the basis for approving use of the system.

While NASA has recently been influenced by the nuclear power community emphasis on probabilistic risk analysis, traditionally it has taken (and continues to emphasize) an approach

similar to the U.S. DoD. The U.S. FAA (Federal Aviation Authority) approach for civil aviation has also been overwhelmingly prescriptive and the initial certification based on the quality of the prescribed process used to develop the aircraft and the implementation of various airworthiness standards in the aircraft's design. Operational oversight is based on inspection as well as feedback about the safety of the operations process. Recently, the FAA has moved to create a requirement for a safety management system by those developing or operating aviation systems in order to shift more of the responsibility for safety to the airframe manufacturers and airlines.

The type of evidence required and assurance arguments used are straightforward with prescriptive regulation, but performance-based regulation requires a more complex argument and evaluation strategy. While the term "safety case" may be used in prescriptive regulation, it is more commonly used in a performance or goal-based regulatory regime.

Performance-Based Regulation and Safety Cases

Government oversight of safety in England started after the Flixborough explosion in 1974, but the term *safety case* seems to have emerged from a report by Lord Cullen on the Piper Alpha disaster in the offshore oil and gas industry in 1988 where 167 people died. The Cullen report on the Piper Alpha loss, published in 1990, was scathing in its assessment of the state of safety in the industry [2]. The Cullen report concluded that safety assurance activities in the offshore oil industry were:

- Too superficial;
- Too restrictive or poorly scoped;
- Too generic;
- Overly mechanistic;
- Demonstrated insufficient appreciation of human factors;
- Were carried out by managers who lack key competences;
- Were applied by managers who lack understanding;
- Failed to consider interactions between people, components and systems.

The report suggested that regulation should be based around "goal setting" which would require that stated objectives be met, rather than prescribing the detailed measures to be taken [21], i.e., performance-based rather than prescriptive. In such a regime, responsibility for controlling risks shifted from government to those who create and manage hazardous systems in the form of self-regulation. This approach has been adopted by the British Health and Safety Executive and applied widely to industries in that country.

The British safety case philosophy is based on three principles [9, 17]:

- Those who create the risks are responsible for controlling those risks
- Safe operations are achieved by setting and achieving goals rather than by following prescriptive rules. While the government sets goals, the operators develop what they consider to be appropriate methods to achieve those goals. It is up to the managers, technical experts, and the operations/maintenance personnel to determine how accidents should be avoided.
- All risks must be reduced such that they are below a specified threshold of acceptability.

When performance-based or goal-based certification is used, there are differences in how the performance or goals are specified and how the evaluation will be performed. In 1974, the creation of the Health and Safety Executive (HSE) was based on the principle that safety management is a matter of balancing the benefits from undertaking an activity and protecting those that might be affected by it, essentially cost-benefit analysis (CBA). The HSE also instituted the related concept of ALARP or "as low as reasonably practical" and widely used probabilistic risk analysis as the basis for the goals. Each of these is controversial.

The nuclear power industry was probably the first to use probabilistic risk analysis as a basis for certification. In the United Kingdom, the Nuclear Installations Act of 1965 required covered facilities to create and maintain a safety case in order to obtain a license to operate. The nuclear industry has placed particular emphasis on the use of Probabilistic Risk Assessment (PRA) with the use of techniques such as Fault Tree and Event Tree Analysis. Because of the use of standard designs in the nuclear power community and very slow introduction of new technology and innovation in designs, historical failure rates are often determinable.

Other potentially high-risk industries, such as the U.S. nuclear submarine community, take the opposite approach. For example, SUBSAFE does not allow the use of PRA [12]. Instead, they require OQE (Objective Quality Evidence), which may be qualitative or quantitative, but must be based on observations, measurements, or tests that can be verified. Probabilistic risk assessments, for most systems, particularly complex systems, cannot be verified.

A second unique aspect of the British approach to safety assurance and required by the HSE is argumentation and approval based on whether risks have been reduced as low as is reasonably practicable (ALARP). Evaluating ALARP involves an assessment of the risk to be avoided, an assessment of the sacrifice (in money, time and trouble) involved in taking measures to avoid that risk, and a comparison of the two. The assumed level of risk in any activity or system determines how rigorous, exhaustive and transparent the risk analysis effort has been. "The greater the initial level of risk under consideration, the greater the degree of rigor required to demonstrate that risks have been reduced so far as is reasonably practicable." [7].

The application of ALARP to new systems, where "reasonably practical" has not yet been defined, is questionable. Not increasing the accident rate in civil aviation above what it is today does seem like a reasonable goal given the current low rate, for example, but it is not clear how such an evaluation could be performed for the new technologies (such as satellite navigation and intensive use of computers) and the new and very different procedures that are planned. There are also ethical and moral questions about the acceptance of the cost-benefit analysis underlying the ALARP principle.

While none of these more controversial aspects of assurance and certification need to be present when using a "safety case" approach, they are part and parcel of the history and foundation of safety cases and performance-based regulation.

Potential Limitations of Safety Cases

A "safety case" may be and has been defined in many ways. In this paper, the term is used to denote an argument that the system will be acceptably safe in a given operating context. The problem is that it is always possible to find or produce evidence that something is safe. Unlike proving a theorem using mathematics (where the system is essentially "complete" and "closed," i.e., it is based on definitions, theorems and axioms and nothing else), a safety analysis is performed on an engineered and often social system where there is no complete mathematical theory to base arguments and guarantee completeness[2]

The main problem lies in psychology and the notion of a mindset or frame of reference.

> "In decision theory and general systems theory, a *mindset* is a set of assumptions, methods or notations held by one or more people or groups of people which is so established that it creates a powerful incentive within these people or groups to continue to adopt or accept prior behaviors, choices, or tools. This phenomenon of *cognitive bias* is also sometimes described as *mental inertia*, *groupthink*, or a *paradigm*, and it is often difficult to counteract its effects upon analysis and decision-making processes." [22]

An important component of mindset is the concept of confirmation bias. *Confirmation bias* is a tendency for people to favor information that confirms their preconceptions or hypotheses

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[2] Even with such a mathematical basis, published and widely accepted mathematical proofs are frequently found later to be incorrect.

regardless of whether the information is true. People will focus on and interpret evidence in a way that confirms the goal they have set for themselves. If the goal is to prove the system is safe, they will focus on the evidence that shows it is safe and create an argument for safety. If the goal is to show the system is unsafe, the evidence used and the interpretation of available evidence will be quite different. People also tend to interpret ambiguous evidence as supporting their existing position [3].

Experiments have repeatedly found that people tend to test hypotheses in a one-sided way, by searching for evidence consistent with the hypothesis they hold at a given time [10, 13]. Rather than searching through all the relevant evidence, they ask questions that are phrased so that an affirmative answer supports their hypothesis. A related aspect is the tendency for people to focus on one possibility and ignore alternatives. In combination with other effects, this one-sided strategy can obviously bias the conclusions that are reached.

Confirmation biases are not limited to the collection of evidence. The specification of the information is also critical. Fischoff, Slavin, and Lichtenstein conducted an experiment in which information was left out of fault trees. Both novices and experts failed to use the omitted information in their arguments, even though the experts could be expected to be aware of this information. Fischoff *et al* attributed the results to an "out of sight, out of mind" phenomenon [4]. In related experiments, an incomplete problem representation actually impaired performance because the subjects tended to rely on it as a comprehensive and truthful representation—they failed to consider important factors omitted from the specification. Thus, being provided with an incomplete problem representation (argument) can actually lead to worse performance than having no representation at all [20].

These problems are not easy to eliminate. But they can be reduced by changing the goal. The author's company was recently hired to conduct a non-advocate safety assessment of the new U.S. Missile Defense system for the hazard "inadvertent launch," which was the major concern at the time [15]. The system safety engineers conducting the independent safety assessment did not try to demonstrate that the system was safe, everyone was already convinced of that and they were going to deploy the system on that belief. The developers thought they had done everything they could to make it safe. They had basically already constructed a "safety case" argument during development that would justify their belief in its safety. By law, however, the government was required to perform an independent risk analysis before deployment and field testing would be allowed. The goal of our independent assessment was to show that there were scenarios where inadvertent launch could occur, not to show the system was safe. The analysis found numerous such scenarios that had to be fixed before the system could be deployed, resulting in a six month delay for the Missile Defense Agency and expenditure of a large amount of money to fix the design flaws. The difference in results was partly due to a new, more powerful analysis method we used but also involved the different mindset and the different goal, which was to identify unrecognized hazards rather than to argue that the system was safe (that inadvertent launch could not occur).

Engineers always try to build safe systems and to verify to themselves that the system will be safe. The value that is added by system safety engineering is that it takes the opposite goal: to show that the system is unsafe. Otherwise, safety assurance becomes simply a paper exercise that repeats what the engineers are most likely to have already considered. It is for exactly this reason that Haddon-Cave recommended in the Nimrod accident report that safety cases should be relabeled "risk cases" and the goal should be "to demonstrate that the major hazards of the installation and the risks to personnel therein have been identified and appropriate controls provided" [5], not to argue the system is safe.

A final potential problem with safety cases, which has been criticized in the off-shore oil industry approach to safety cases and with respect to the Deepwater Horizon accident (and was also involved in the Fukushima Daichi nuclear power plant events), is not using worst-case analysis [8]. The analysis is often limited to what is likely or expected, not what could be

catastrophic. Simply arguing that the most likely case will be safe is not adequate: Most accidents involve unlikely events, often because of wrong assumptions about what is likely to happen and about how the system will operate or be operated in practice. Effective safety analysis requires considering worst cases.

But while theoretical arguments against safety cases are interesting, the proof is really "in the pudding." How well have they worked in practice?

Experience with Safety Cases

The use of performance-based regulation has not necessarily proven to be better than the other approaches in use. One of the most effective safety programs ever established, SUBSAFE [12], which has had no losses in the past 48 years despite operating under very dangerous conditions, is the almost total opposite of the goal-based orientation of the British form of the safety case. The spectacular SUBSAFE record is in contrast to the U.S. experience prior to the initiation of SUBSAFE, when a submarine loss occurred on average every two to three years. SUBSAFE uses a very prescriptive approach as does the civil aviation community, which has also been able to reduce accident rates down to extremely low levels and keep them there despite the tendency to become complacent after years of having very few accidents.

Unfortunately, careful evaluation and comparison between approaches has not been done. Most papers about safety cases express personal opinions or deal with how to prepare a safety case, but not whether it is effective. As a result, there is no real evidence that one type of regulation is better than another.

The use or at least poor use of safety cases has been implicated in accident reports. The best known of these is the Nimrod aircraft crash in Afghanistan in 2006. A safety case had been prepared for the Nimrod, but the accident report concluded that the quality of that safety case was gravely inadequate [5]:

> ". . . the Nimrod safety case was a lamentable job from start to finish. It was riddled with errors. . . Its production is a story of incompetence, complacency, and cynicism … The Nimrod Safety Case process was fatally undermined by a general malaise: a widespread assumption by those involved that the Nimrod was 'safe anyway' (because it had successfully flown for 30 years) and the task of drawing up the Safety Case became essentially a paperwork and 'tickbox' exercise."

The criticisms of safety cases contained in the Nimrod report include:

- The Safety Case Regime has lost its way. It has led to a culture of 'paper safety' at the expense of real safety. It currently does not represent value for money.
- The current shortcomings of safety cases in the military environment include: bureaucratic length; their obscure language; a failure to see the wood for the trees; archaeological documentary exercises; routine outsourcing to industry; lack of vital operator input; disproportionality; ignoring of age issues; compliance-only exercises; audits of process only; and prior assumptions of safety and 'shelf-ware'.
- Safety cases were intended to be an aid to thinking about risk but they have become an end in themselves.
- Safety cases for 'legacy' aircraft are drawn up on an 'as designed' basis, ignoring the real safety, deterioration, maintenance and other issues inherent in their age.
- Safety cases are compliance-driven, i.e., written in a manner driven by the need to comply with the requirements of the regulations, rather than being working documents to improve safety controls. Compliance becomes the overriding objective and the argumentation tends to follow the same, repetitive, mechanical format which amounts to no more than a secretarial exercise (and, in some cases, have actually been prepared by secretaries in outside consultant firms). Such safety cases tend also to give the answer that the customer or designer wants, i.e. that the platform is safe.

- Large amount of money are spent on things that do not improve the safety of the system

Haddon-Cave, the author of the Nimrod accident report, concluded that safety cases should be renamed "risk cases" and made the following recommendations (among others):

- Care should be taken when utilizing techniques such as Goal Structured Notation or 'Claims-Arguments-Evidence' to avoid falling into the trap of assuming the conclusion ('the platform is safe'), or looking for supporting evidence for the conclusion instead of carrying out a proper analysis of risk. (Note the similarity to the concerns expressed in earlier about mindset and confirmation bias.)
- Care should be taken when using quantitative probabilities, i.e. numerical probabilities such as 1×10^{-6} equating to "Remote". Such figures and their associated nomenclature give the illusion and comfort of accuracy and a well-honed scientific approach. Outside the world of structures, numbers are far from exact.
- Care should be taken when using historical or past statistical data. The fact that something has not happened in the past is no guarantee that it will not happen in the future. Piper Alpha was ostensibly "safe" on the day before the explosion on this basis. The better approach is to analyze the particular details of a hazard and make a decision on whether it represents a risk that needs to be addressed.
- Care needs to be taken to define the process whereby new hazards can be added to the Risk Case, incorporated in the Hazard Log, and dealt with in due course, and how original assumptions about hazards or zones are to be re-examined in light of new events.
- Once written, the safety case should be used as an on-going operational and training tool. There are all too many situations where a comprehensive safety case is written, and then it sits on a shelf, gathering dust, with no one paying attention to it. In such situations there is a danger that operations personnel may take the attitude, "We know we are safe because we have a safety case".

Conclusions

To avoid confirmation bias and compliance-only exercises, assurance cases should focus not on showing that the system is safe but in attempting to show that it is unsafe. It is the emphasis and focus on identifying hazards and flaws in the system that provides the "value-added" of system safety engineering. The system engineers have already created arguments for why their design is safe. The effectiveness in finding safety flaws by system safety engineers has usually resulted from the application of an opposite mindset from that of the developers.

Whatever is included in the assurance case, the following characteristics seem important:

- The process should be started early. The assurance case is only useful if it can influence design decisions. That means it should not be done after a design is completed or prepared in isolation from the system engineering effort. If safety cases are created only to argue that what already exists is safe, then the effort will not improve safety and becomes, as apparently has happened in the past, simply paper exercises to get a system certified. One result might be unjustified complacency by those operating and using the systems.
- The assumptions underlying the assurance case should be continually monitored during operations and procedures established to accomplish this goal. The system may be working, but not the way it was designed or the assumptions may turn out to be wrong, perhaps because of poor prediction or because the environment has changed. Changes to the system and its environment may have been made for all the right reasons, but the drift between the system as designed and the system as enacted is rarely if ever analyzed or understood as a whole, rather than each particular deviation appearing sensible or even helpful to the individuals involved.

- To make maintaining the assurance case practical, the analysis needs to be integrated into system engineering and system documentation so it can be maintained and updated. Safety assurance is not just a one-time activity but must continue through the lifetime of the system, including checking during operations that the assumptions made in the assurance argument remain true for the system components and the system environment. In the author's experience, the problems in updating and maintaining safety assurance do not arise from the form of the assurance documentation or in updating the argument once the need for it is established, but in relating the assurance case to the detailed design decisions so that when a design is changed, it is possible to determine what assumptions in the safety analysis are involved.
- The analysis should consider worst cases, not just the likely or expected case (called a *design basis accident* in nuclear power plant regulation).
- The analysis needs to include all factors, that is, it must be comprehensive. It should include not just hardware failures and operator errors but also management structure and decision-making. It must also consider operations and the updating process must not be limited to development and certification but must continue through the operational part of the system life cycle.
- To be most useful, qualitative and verifiable quantitative information must be used, not just probabilistic models of the system.
- The integrated system must be considered and not just each hazard or component in isolation.

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The Pros and Cons of Performance-Based Regulatory Models

Dr. M. Sam Mannan, PE, CSP, DHC

Regents Professor and Director
Holder of T. Michael O'Connor Chair I
Mary Kay O'Connor Process Safety Center
Artie McFerrin Department of Chemical Engineering
Texas A&M University System
(979) 862-3985
e-mail: mannan@tamu.edu
URL: http://process-safety.tamu.edu

Expert Forum on the Use of Performance-Based Regulatory Models in the U.S. Oil and Gas Industry, Offshore and Onshore

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1. Introduction

As presented by May [1] a regulatory regime must provide a framework with a perfect equilibrium between control, accountability for results, and flexibility to achieve this results. Prescriptive regulatory system [2] "sets specific technical or procedural requirements that must be complied with by regulated entities". Performance-based regulatory (PBR) system [2] which is also referred to as goal-based, "identifies functions or outcomes for regulated entities but allows them considerable flexibility to determine how they will undertake the functions and achieve the outcomes".

After a series of accidents that occurred in the US, such as the 2005 Texas City Explosion and the 2010 Deepwater Horizon incident, recommendations have been made to adopt thorough performance-based regulatory regimes and develop a proactive and risk-based performance approach, taking the example of UK HSE Safety Case. However, considering the big difference between OSHA PSM and HSE Safety Case, we should be very cautious to make any immediate change and analyze this issue deeply in multiple aspects. This paper provides perspectives in the following fields: comparison of advantages and limits of performance-based regulatory approaches, how to advance of the use of performance-based regulations in the US, the status of effectiveness of current US agencies oversight and how to improve it, multiple agency jurisdiction issues and risk assessment application suggestions.

2. Advantages and Limits of Performance-Based Regulatory Approaches

Prescriptive regulatory approaches emphasize control and accountability, and performance-based regulatory approaches promote flexibility with accountability for results. These features must be acknowledged as integral parts of the discussion regarding the advantages and limits for adapting performance based regulations. The debate must consider two main points: the possibility for a long-term hazard reduction (Health, Safety and Environmental) and the utilization of resources. Based on this, Section 2.1 provides a summary of the advantages of performance-based regulatory regimes while Section 2.2 presents a review of the limits that their application implies.

2.1 Advantages of Performance-Based Regulatory Approaches

Numerous authors have provided discussions concerning the advantages of the use of performance-based regulatory regimes. The key points raised can be summarized as follows:

- Innovation and adoption of new technologies [3-7]

  The flexibility that accompanies performance-based regulations allows for a continuous improvement by means of the implementation of new technologies as they become available. This is a desired feature in order to keep up with a complex and continuously changing industry and market, where unique situations often occur. Moreover, contrary to what is a common belief, opportunities for innovation arise not only for the regulated entities, but also for the regulatory agencies. According to EPA [8], regulatory agencies are granted discretion to set performance targets within broad policy areas and to experiment with means to achieve them.

- Goal-oriented risk management system[7-8]

  The implementation of a performance-based regulatory system is accompanied by a goal-oriented risk management system. There is a more clear quantification of the performance, and any decision must then be based on the assessment of the hazards implied. Moreover, this management system will be common to all participating companies, thus allowing for unification in the objectives, communication, planning, and response to HSE-related issues.

- Safety ownership, responsibility and pro-activity [7-12]

  By means of the joint responsibility generated, traditional distinctions between regulated entities, regulatory agencies and regulation beneficiaries become fuzzier [12]. It results in a further understanding of the involvement and support necessary, and a wider use of the industry knowledge [11, 13-14]. The ownership of risk and the generated responsibility switch the focus to company's HSE objectives, abolishing dedication limitations. This provides plenty of opportunities for independent assessment and actions that go beyond minimum performance objectives.

- Potential for more efficient utilization of resources [1, 7-8, 11, 14-15]

  As a consequence of the flexibility to achieve results, the cost-effectiveness of the compliance strategies is stimulated. Companies are encouraged to innovate with cost-effective solutions [15] and proven successful alternatives applied in different locations of the world [7]. In the long-term, this will not only benefit the companies, but also their workers and the public in general.

2.2 Limits of Performance-Based Regulatory Approaches

The Regulatory Policy Program of the Center for Business and Government at Harvard University organized a workshop on May 2002, to discuss performance-based

regulations. Several government agencies and researchers from a variety of areas participated in the workshop. From the workshop, it was concluded that some of the most important criteria to consider when determining or selecting the regulatory approach include the effectiveness, efficiency, equity, clarity, and the ease and accuracy of enforcement [18]. The discussion provided in this section goes along the lines of the aforementioned report, but it also incorporates other literature sources.

- Cost increase pitfalls for companies and regulatory agencies [11, 13,14,16, 17]

  Apart from the obvious overwhelming task that the application of performance-based regulations implies, and the associated economic burden, several possible pitfalls can be identified for both the regulators and the industry. Several authors assure that an increased cost to regulators is unavoidable due to number of trained personnel that a more active regulator will demand. Some authors even point out monitoring compliance being too costly as a factor for failure [11].

- Lack of suitable metrics to ensure compliance

  One of the most widely debated issues about performance-based regulations is the lack of performance indicators for both regulators and regulated entities to measure the outcomes. Dave Drummond from the University of Wisconsin-Madison states that as long as the outcome cannot be measured, performance-based regulation should not be used [19]. He provides the diagram shown in Figure 1 to determine if performance-based regulation should be used, based on the ability to measure the outcome. However, even if the outcome can be measured, the measurements or indicators must be adequately reliable in order to provide appropriate feedback. For this purpose, performance-based regulation may be accompanied by appropriate prescriptive requirements for measuring, reporting, recordkeeping and data management [20].

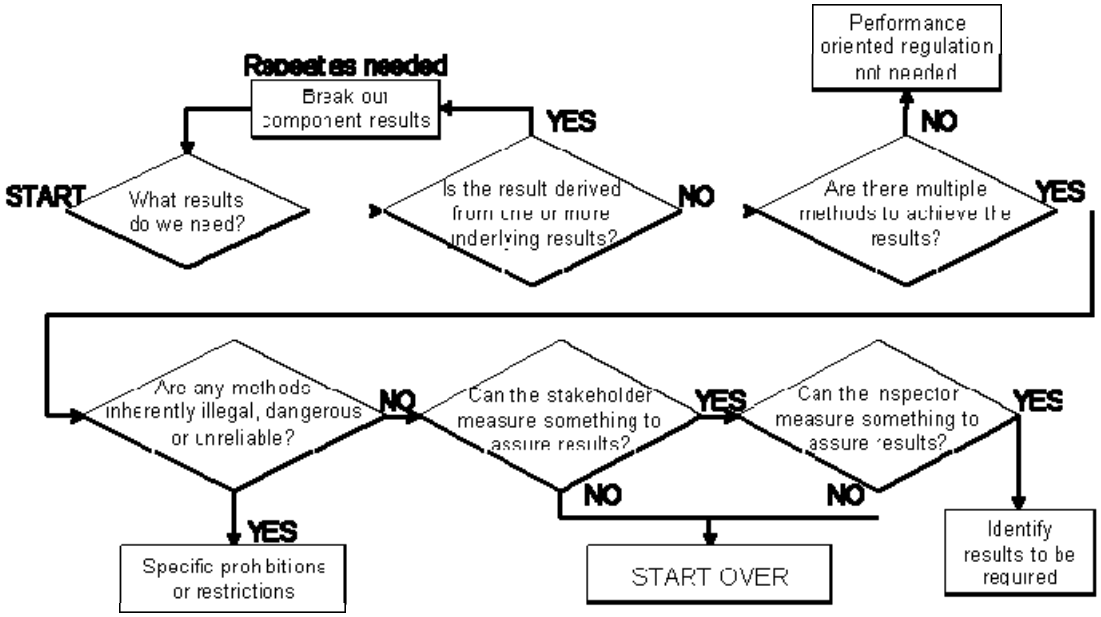

Figure 1 Process to establish performance-based regulations [19]

- Performance may be difficult to measure directly for rare and catastrophic events

  Performance-based regulations might be difficult to implement when the consequences of poor performance are very serious. In that case, the regulation must be formulated very carefully. Youngblood and Kim [20] recommend the use of objectives hierarchy for the selection of performance measurements and establishment of performance criteria. These measurements and criteria should focus on levels of performance in which the failure to meet a criterion or a given target will not lead to severe consequences or immediate safety concerns [20].

  Performance-based regulations are less desirable when used to address rare catastrophic events, such as big fires, explosions or toxic releases, as it is almost impossible to measure performance for this type of events. Instead, performance must be predicted, which causes uncertainty and difficulties in the implementation [18].

- Small companies having limited expertise or capacity for innovation

  With regard to the size of the company, performance-based regulation is usually more difficult to implement in small companies. Medium and large companies have a larger availability of resources to create customized programs to achieve the desired outcomes. They also have the capacity of developing innovative, efficient and cost-effective solutions to meet performance goals [21]. Instead, smaller companies may not have the resources to develop new programs or

processes or invest in innovation [21]. Some small companies would rather be told the process they have to follow to achieve the desired outcome instead of creating one on their own [18].

- There is no detailed understanding of the problem

  Performance-based regulations can be either tightly or loosely specified, depending on the level of discretion provided to the regulator and the regulated entity [18]. For tightly specified performance-based standards or those where a quantitative threshold is provided, it is necessary to understand in detail the cause-effect or dose-response relationships between the sources and the final objective in order to establish optimal thresholds [18]. Lack of understanding of the problem or loosely specified requirements including words such as “adequate” or “effective” [22], cause difficulty in the implementation and enforcement of the regulation.

  It is worth pointing out, that the workshop at Harvard University [18] was conducted 10 years ago. However, the challenges, and difficulties to implement performance-based regulation remain more or less the same. More research is needed to obtain data on the effectiveness of performance-based regulation as compared to prescriptive regulation in order to determine the best approach for each industry / situation.

  Overall, it is desirable to use a combination of performance-based and prescriptive regulations, in order to address a specific issue or problem [21].

3. Advancement of the Use of Performance-Based Regulation in U.S.

In order to advance the use of performance-based regulations in the US Oil and Gas Industry, several criteria must be met. The main factors in whether or not the programs are accepted and successful include the following:

- There must be convincing statistical evidence that the performance-based measures will outperform the prescriptive-based measures they are replacing.
- There must be a fair way to implement these performance-based measures in relation to the prescriptive-based measures (not overregulated, not too much burden on companies to comply too quickly) as well as in relation to the differences in situations that the companies currently have (large vs. small, no one taking advantage of rules).

- There must be an economic benefit to the switch where the financial sunk costs and operating cost increase is counterbalanced by a tangible economic benefit, whether that benefit is decrease in incidents/fatalities or a decrease in cost through more efficient use of resources and innovation.

These concepts are graphically represented in the following flowchart.

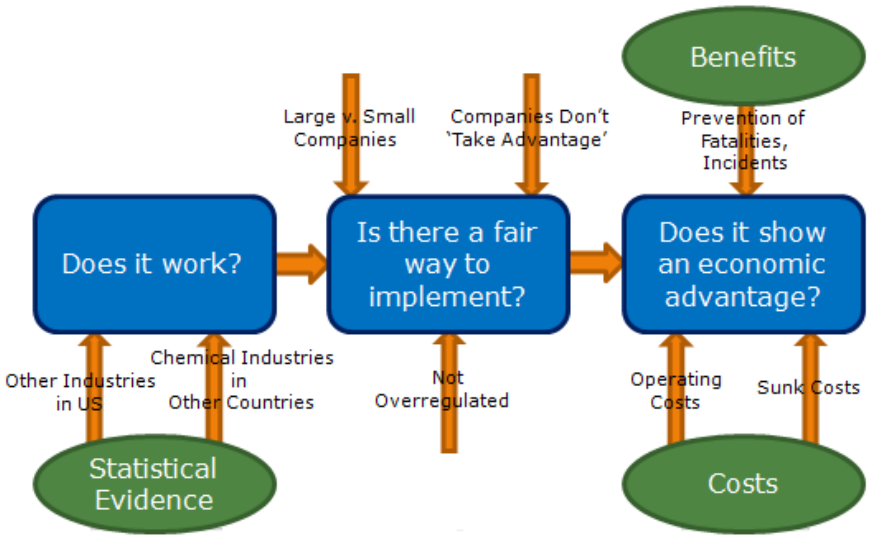

Figure 2. Advancement of performance-based regulation

These points are further discussed in the paragraphs that follow.

Statistical evidence

It is simple human nature to resist change if the change proposed does not fulfill the need it is intended to satisfy. So, it is natural to expect resistance to change from the current types of regulation if it cannot be proven that the safety performance stands a significant chance of improving. There is precedent for the advancement of performance-based regulation, both in other industries in the United States (nuclear industry and their Performance-Based and-Risk Informed regulation), and in the oil and gas industry in Europe (UK and Norway).

The question becomes, then, have these industries seen any tangible increase in safety statistics by either PSM or Safety Case? Unfortunately, the answer to this question is that it is hard to tell for several reasons (Figure 3 and Figure 4). Based upon the statistics from the UK HSE [23] and U.S. API [24], it is hard to tell whether the statistics show any real upward or downward trend.

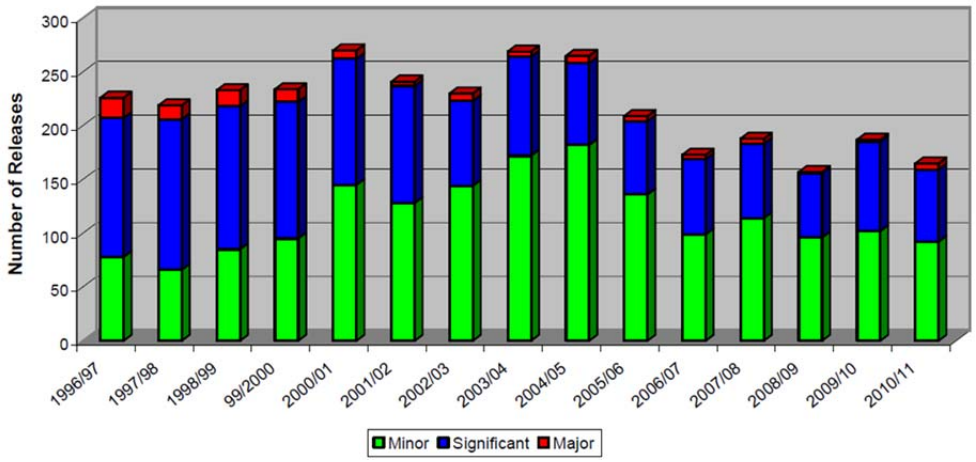

Figure 3: HSE data for offshore hydrocarbon releases in the period from 1996-97 to 2010-11[23]

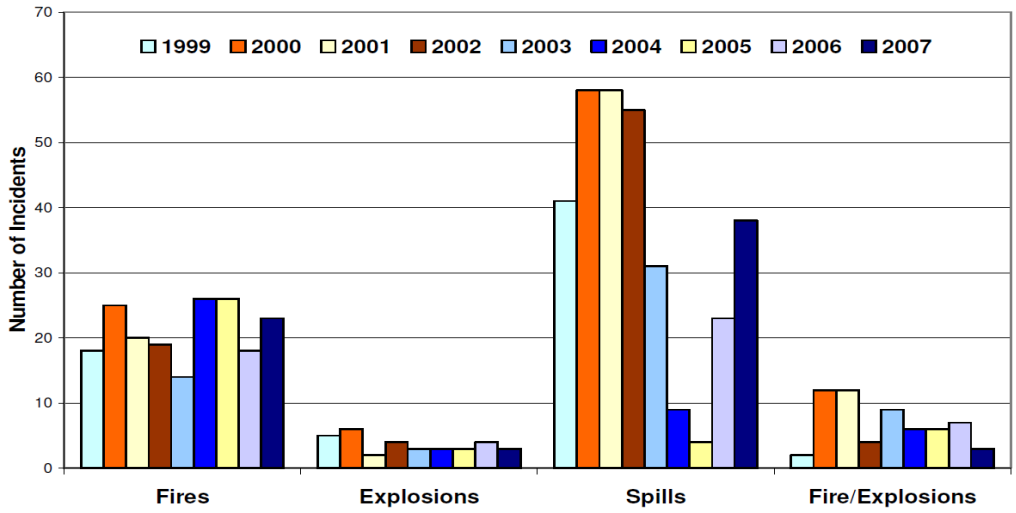

Figure 4: API Process Safety Performance Measurement Report 1999-2007[24]

If there is a trend, upward or downward, it would also be very difficult to tell whether it was due to the regulatory regime or whether it was a function of some other factor (*e.g.,* an increase in minor accidents due to better reporting or a decrease in major accidents due to more of them being reported as significant. As such, the regulatory bodies would have to prove that these gains that other industries and other countries are making are not just “smoke and mirrors” based on other influencing factors.

Finally, it is difficult to say that any trends can be taken from a mere 15 years of data, especially when the goal of the regulation is to decrease significant events that may happen once every 10, 25, or even 50 years. Furthermore, an extended amount of time

may be needed to get the programs fully implemented and working properly before results can be seen. Thus, many years of data collecting may be needed before one can conclusively state that the program is working as intended.

Is there a fair way to implement?

When PSM was first implemented and RMP was on the horizon, industry had several doubts and fears for the two seemingly overlapping regimes with new procedures for compliance. In the two decades since, many of the same fears would apply to the advancement of new regulation.

Not overregulated [25]: When PSM started and RMP was around the corner, one of the main concerns that industry had was whether or not they would be overregulated by the dual regulations. Since PSM and RMP have different aims (occupational vs. environmental), there was concern that each would be quite different although aimed at basically the same end. Thus, Andrews, speaking for industry through his paper, made several key requests:

- EPA chemicals be a subset equal to or less than the chemicals in OSHA PSM
- EPA threshold quantities be greater than or equal to the threshold quantities of PSM, arguing that if they were less, it would effectively extend PSM to operations that OSHA didn't deem it necessary for PSM to be extended to
- Exclusions for certain (unmanned low-hazard) facilities
- Recognition that compliance with PSM would constitute compliance with RMP

This shows the level of concern with what industry saw as "fairness" in overregulation. They wanted two mutually inclusive regulations that would not increase their burden, even though the regulations had different goals.

Companies don't take advantage [26]: companies, under a performance-based regime, since it is not as concrete as a prescriptive-based regime, may attempt to take advantage of the added flexibility (not in an innovative way, but in a way such that they would be 'cheating' the system).

May and Koski [26] suggest that extra education could be a helpful way to keep this from happening, basically arguing that it will lead to the owners, operators, and engineers 'owning' safety, thus making it so that they will not be morally capable of cheating. However, they also note that due to differing capabilities and willingness to learn, this may not be the most effective method.

The second method suggested was to hold engineers (and whomever does safety reviews, tests, etc.) responsible for the accuracy of the results, saying that if it is found that anything is forged or unreal they can be held legally responsible. They also take it one step further and say that engineers could be held liable for performance (whether they did a good job complying with the regulation or not). They admit that this may cause insurance costs for liability to go too high to afford, causing engineers and consultants to charge more, possibly pricing them out of a job.

The third method mentioned was a sort of peer-review process where documents are reviewed by others for adequacy. The quality of results would depend on the quality of the reviewer and how enthusiastic they are about making suggestions and questioning safety cases presented.

Large vs. Small Companies [18]: Small companies face their own specific set of challenges in the move to performance-based regulation. Coglianese, Nash, and Olmstead [18] posit that small firms may not have the resources to look for a way to achieve a performance-based goal and that it is oftentimes easier for them to do what they are told to do rather than innovate for the simple reason that they may not have the money, manpower, or time to find a better way than the prescribed method. They also point out that it is the job of the government and industry to work together so that the government can understand exactly how difficult it could be for a small firm to implement a performance-based regulation and their possible preference for a prescriptive-based regulation. In such a way, the large companies must help to protect the smaller companies from unduly strenuous regulation by an open communication with those creating the regulation.

Does it show an economic advantage ?[25]

It is simple economics that, above all else, a company (whose motive is to maximize economic return -- without that they will not stay in business) needs to see an economic benefit in order to accept new regulations. Andrews specifically mentions that many in industry believe that OSHA underestimated the cost of compliance with the new PSM system (OSHA said $810 million per year for the first five years, while Andrews argued it would be 5 times that). He also argues that though there will obviously be some economic benefit through lower fatality rates and incidents and increased reliability, industry was still concerned about trying to gain a competitive advantage (being able to gain a competitive advantage means being able to maximize economic benefit) in the face of such a large resource investment.

4. Effectiveness of U.S. Agencies Oversight

Before we transition from one regulatory regime to another, we should first ask this question: if the performance is not good enough, is it because current regulatory regime is not good or the current one has not been fully complied with? Until now, nearly every incident investigation has indicated that one or more PSM elements haven't been complied with well enough. Therefore, the first priority should be consideration of how to improve the implementation of the existing regulation oversight.

In order to improve oversight effectiveness, it is essential to identify the challenges that government agencies are facing to enforce performance-based regulations. In this section, we will discuss enforcement mechanisms and oversight effectiveness of different government agencies. Then, we will discuss potential opportunities to improve enforcement and oversight strategies for agencies using performance-based regulations, including the Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), the Pipeline and Hazardous Materials Safety Administration (PHMSA), U.S. Coast Guard (USCG), Bureau of Safety and Environmental Enforcement (BSEE) and Bureau of Ocean Energy Management (BOEM).

Occupational Safety and Health Administration (OSHA)

In 1992, OSHA established the process safety management (PSM) rule to prevent and minimize consequences of catastrophic accidents [27]. PSM provides 14 elements as guidance for the standard compliance and the company has the freedom to select the method to meet those requirements [28]. To ensure compliance, OSHA performs different type of inspections [29], including, routine inspections, screening inspections, and inspections due to an employee complaint or due to catastrophic incidents. The effectiveness of the PSM program is closely dependent on the quality of these inspections.

Beneficial effects of PSM standard have been discussed by some reports, given that the number of fatal or catastrophic events have declined from 24 in 1994 to 5 in 2005 [30]. However, it is unclear if this evident reduction on catastrophic accidents can be specifically attributed to the PSM program. Different conclusions about the standard effectiveness can be obtained depending on how the data is reported. For example, D. Weil showed that until 1993, causes of accidents were in poor agreement with the type of OSHA citations [31]. The Chemical Safety Investigation Board (CSB) has also reported failures on OSHA inspections. For instance, based on the CSB's incident report issued in 2007 [32], OSHA performed several inspections before the BP Texas City accident; however, they did not identify the likelihood for a catastrophic accident. On the other hand, H. Luo [27], showed an increased agreement of OSHA PSM inspection citations and the cause of accidents found by CSB, using data from 1992 to 2006. In general, the lack of adequate data and proper process safety indicators complicates the assessment of the effectiveness of the regulation [33].

Even if it is agreed that the effectiveness of, for example, the PSM regulation has increased over the years [27], and more training and guidance is provided to OSHA's compliance officers to perform their audits [30], some issues that still need more attention as follows:

- Improved training for OSHA compliance officers is essential to ensure quality of inspections;
- Increased inspections frequency [33]. For example, the percentage of complaints and incident-related inspections had reached almost 75% [27]; however, the percentage of programmed inspections should also increase to a larger percentage;
- Improved tracking and resolution of violations [34];
- Establish a more severe citation strategy, small penalties can reduce the incentive to accomplish standard requirements [33]; however, this should be done in conjunction with an increased correlation of citations with the actual incident and/or the potential for catastrophic incidents;
- Expand coverage of the standard enforcement, not only focus on facilities at the greatest risk of catastrophic accidents, but also include inspections of companies having a potential for accidents with high consequences and low probability [27];
- Perform a conscientious data analysis to evaluate more objectively the performance of the regulation.

The Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA) has implemented the Risk Management Plan (RMP) Rule to prevent releases of hazardous substances into the environment [28]. Using numerical risk thresholds or ranges of tolerable risk [35], this agency set the minimum requirements for developing risk management programs and the plant is responsible to define the strategy to achieve those requirements and prevent toxic releases [28]. To ensure compliance, EPA uses a variety of methods including, checklists, surveys, pre-tests and post-tests [36]. In addition, EPA has a policy called “Incentives for Self-Policing: Discovery, Disclosure, Correction and Prevention of Violations”. This policy was created to encourage the regulated entities to voluntarily discover, disclose to EPA, correct, and prevent recurrence of the environmental violations [35]. Despite EPA’s efforts to ensure effective oversight, based on the report No.12-P-0113 issued by the Office of Inspector General (OIG), EPA should improve oversight of State enforcement” [37]. EPA lacks national baselines and it has 10 regional independent enforcement programs rather than one single national workforce strategy, leading to inconsistent interpretation and enforcement actions throughout the country [37].

Additional issues of EPA oversight include the lack of details in their check lists, which can reduce the efficiency of EPA inspections [37]; delayed document and data review of state programs which can limit the use of the results for decision making at national level [37], financial challenges in some states on long-term maintenance and monitoring [37], and poor collection and maintenance of workload data/cost accounting system which can make difficult resources planning [37].

After OIG comments, EPA developed a Strategic Plan (2012–2016), to promote economy, efficiency, effectiveness, and prevent and detect fraud, waste, and abuse through independent oversight of the programs and operations of the EPA [38].

Pipeline and Hazardous Materials Safety Administration (PHMSA)

In order to monitor and ensure compliance with pipeline safety regulations, PHMSA has implemented the Pipeline Safety Enforcement Program. Compliance is monitored through federal and state inspections of pipeline operator programs, facilities and construction projects [39]. In case a violation is identified, PHMSA uses a variety of enforcement mechanisms to ensure operators take appropriate and timely corrective actions [40]. The federal government develops, issues, and enforces pipeline safety regulations, while states assume intrastate regulatory responsibilities, inspections and enforcement under an annual certification [41].

After concerns resulting from pipeline incidents in San Bruno, California on September 9, 2010, and in Marshall, Michigan on July 26, 2010, the Office of Inspector General (OIG) conducted an audit to evaluate the effectiveness of PHMSA's oversight of pipeline safety. In particular, the audit assessed inspection and enforcement activities, requirements for non-line pipe facilities and data management and analysis capabilities [42]. The audit revealed that in spite of PHMSA's inspection and enforcement program accomplishments, there are multiple issues that must be resolved in order to achieve more effective oversight. Some of the issues identified in the audit include: accumulated backlog of integrity management (IM) inspections, insufficient onsite visits to facilities, less stringent IM requirements for non-line pipe facilities, data management and quality deficiencies, lack of systematic data analysis to identify pipeline safety and accident trends, lack of capability to identify high-risk pipelines by linking data to geographic location and lack of performance metrics to monitor IM program's effectiveness.

United States Coast Guard (USCG)

In order to ensure the security of Outer Continental Shelf (OCS) facilities and deepwater ports, the USCG conducts security inspections and reviews security plans written by operators and owners of OCS facilities. During the inspections the inspector interviews security officers and ensures that appropriate security measurements are in place. Any deficiencies identified during the inspection, as well as appropriate enforcement actions

to ensure compliance are recorded in the Marine Information for Safety and Law Enforcement (MISLE) database [43].

After the *Deepwater Horizon* incident in 2010, the US Congress requested the US Government Accountability Office (GAO) to conduct an assessment of Coast Guard actions to ensure the security of OCS facilities and deepwater ports and determine additional actions necessary. This assessment also determined the limitations in oversight authority of the USCG to ensure security [43]. According to the report provided by the GAO to Congress, the USCG has conducted only one-third of the annual OCS security inspections required from 2008 through 2010 and during the same period of time, it has only inspected one deepwater port [43]. Additionally, the assessment identified serious deficiencies in the database used by the USCG to record inspections data. These database deficiencies not only limit the use of data as a tool for decision making, but they also make difficult to determine whether deepwater ports are complying with maritime security requirements or not [43]. Another issue discussed in the GAO report is the limited authority of USCG over Mobile Offshore Drilling Units (MODUs) registered to foreign countries [43]. However, after the Deepwater Horizon incident, the USCG has implemented a policy to conduct additional inspections of high-risk MODUs. This policy will increase oversight over foreign flag MODUs operating in US waters [44].

With regard to the inspections conducted by the USCG, it appears that enforcement of performance-based regulations, such as maritime security regulations, are being subject to prescriptive regulation enforcement methodologies, such as checklists [19]. Moreover, some inspectors request amendments to security plans based on their personal opinion and without appropriate justification. This is mostly due to lack of training and experience of inspectors, which has led to inconsistent interpretations and enforcement of the regulation [45].

Bureau of Safety and Environmental Enforcement (BSEE) and Bureau of Ocean Energy Management (BOEM)

BOEM and BSEE are two interdependent agencies that officially replaced Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) [46, 47]. BOEMRE had implemented a variety of measures and metrics to evaluate overall regulatory compliance performance of offshore oil and gas program. After the Macondo blowout, the offshore oil and gas industry has been moving toward performance-based regulations. On October 2010, BOEMRE adopted the safety and environmental management system (SEMS elements) based on the API RP 75 [48], except that the audits are performed by third parties. SEMS is a non-prescriptive approach[49] with the main purpose of improving safety of operations to reduce human and organizational errors and prevent accidents and oil spills [48]. In this case, one of the main challenges to ensure effective oversight is the proper development of guidelines for risk assessment and risk management. If a risk-based approach is followed, scenarios that

pose a risk with low probability and high consequences may be ignored, so the allocation of resources and planning may be insufficient if that catastrophic accident occurs. Additional issues with the SEMS enforcement effectiveness are related to the lack of numeric thresholds for unacceptable, tolerable and acceptable risk during planning and setting of standards [35], and deficient inspector training to promote safety [50].

Recommendations to improve the effectiveness of oversight

Based on the discussion presented here, some general recommendations to improve the effectiveness of oversight systems are mentioned below:

- Increase inspectors training and experience
- For overlapping regulations (*e.g.,* PSM, RMP, SEMS), develop expertise in only one agency (so that adequate number of highly trained and knowledgeable personnel are available). This would definitely lead to more effective oversight but also has the potential to reduce cost in that multiple agencies would not have to hire and train experts.
- Develop a clear enforcement methodology in order to avoid prescriptive regulation enforcement methodologies to be used for performance-based regulatory systems
- Develop performance indicators that evaluate objectively the effectiveness of regulation or oversight programs
- Target available resources based on risk of each facility
- Use special government employees (SGE's) for incident investigations, compliance enforcement and other regulatory activities
- Develop and use a carefully monitored system for certified third-party auditors
- Use of expert panels by the agencies to help facilitate the review of the effectiveness or regulations and enforcement methods

Finally, one of the most important issues identified across different agencies is related to data management deficiencies. Agencies must be able to effectively collect and analyze relevant data in order to identify trends, assess program effectiveness and provide enough information to decision makers. In this respect, a carefully planned national database system for collecting and tracking incidents is recommended.

5. Multiple Agency Jurisdiction Issues

5.1 Duplication of regulations

Reduction of regulatory overlaps is a theoretically attractive way to streamline operations and simplify compliance for industry where there may currently be situations in which similar hazards are managed in seemingly different ways. The following paragraphs explain the origin of some overlaps, advantages that could possibly be gained as well as the disadvantages that may be created in the elimination of regulatory overlap.

Origins:

Aagaard [51] has presented several ways in which regulatory overlap could occur. Overlap can occur organically, as a function of the growth of a regulatory body or as an attempt to gain more power, prestige, or oversight for a body, either because they want the extra power or because they believe they can do a better job or fill some gaps in the regulation. It can happen arbitrarily, when two regimes' missions somewhat overlap, giving them both the power to regulate like areas. It is possible that overlap may arise intentionally, such as with OSHA PSM and EPA RMP, where Congress specifically mandated that both be developed in conjunction with one another, or unintentionally when the delegating bodies are unsure which regulatory body should be responsible for what, or if there is political conflict. It could also arise from overlapping legal fields, which is difficult to avoid and nearly impossible to change in hindsight. For example, OSHA regulates employee health while EPA regulates environmental and public health. Their legal fields necessarily overlap because in many cases what is dangerous to a worker is dangerous to the public or environment, so the legal overlap could not have been avoided, nor can it be eliminated.

In some ways, this overlap could be used to the advantage of the regulators, specifically when the overlap is intentional and is meant to fill gaps in between regulatory bodies that may have similar fields but differing missions. In other ways, the overlap could be destructive, particularly when it is inadvertent and causes conflict in how to deal with compliance in industry. Thus, when handled properly, overlap can be a powerful tool in making sure that regulations cover the largest span possible while causing minimum inconvenience to industry, who must comply, report, and improve.

Disadvantages:

It is obvious that disadvantages would arise from overlap, mostly because of efficiency issues. The extent of these disadvantages depends mainly on the coordination between the regulatory bodies and the degree of the overlap. Four categories were identified by Aagaard [51] as the classical arguments against overlap:

- Duplication – a waste of resources if the functions can be consolidated or eliminated from one of the overlapping bodies, though it is not a complete waste if there is benefit to the duplication

- Conflict - opportunities for conflicting regulations, whether directly conflicting (cannot satisfy both) or indirectly conflicting (can comply with both with increased effort)

- Coordination – necessity of increased coordination between the regulatory bodies

- Complexity – difficult to monitor who is in charge of what, or assign blame for failures, etc.

Rectanus and Natalicchio [52] further posit that overlap may have harmful effects during regulatory functions such as incident investigation, stating that regulatory bodies may prefer to independently work on investigations so as not to get delayed by other bodies. They state that it may be difficult or time-consuming to have to coordinate investigations and in the end the regulators may not be able to obtain all of the necessary information or work on the timeline of another regulator. Thus, they trade the inconvenience to the operator (having multiple investigations, procuring the same documents multiple times, etc.) for the convenience of being able to work on their own terms. Other overlaps exist, such as creation and administration of training materials, development of emergency response procedures, and record-keeping.

Industry itself has also expressed concern over some of the disadvantages of duplicative and inconsistent regulation. For example, Andrews [25] in his paper on industry views of regulation in the early days of PSM stated that if a regulation (RMP) was implemented after and in conjunction with PSM and included PSM controlled chemicals at lower than PSM threshold values, it would effectively be extending PSM to sites that OSHA did not deem appropriate. This is an example where, with poor coordination, industry could have been severely affected by an overlap in regulation. Thus, care must be taken in the implementation of closely-related regulations so that a regulation is not inappropriately extended into a realm where it is not necessary.

Advantages

Perhaps counter-intuitively, there are also advantages that can be gained by these overlaps, particularly when they are intentional, well-thought out, and allow opportunity for collaboration between regulators that work in similar areas, but have differing missions and expertise.

Rectanus and Natalicchio [52] found that advantages could be gained in precisely these areas through overlap. They state that it is often reasonable to have some degree of

overlap in such closely related fields, and that it is not necessarily a bad thing if it allows for competition between agencies, better service delivery, or emergency backup. They do; however, state that overlap must be properly managed in order to retain these advantages. Aagaard [51] further states that overlap can increase reliability by reducing the number of errors in action (regulators don't act when they should have acted) and can foster policy innovation where regulators have a heightened sense of what other bodies are doing and can thus act in a more informed manner, such as making better policy decisions in conjunction with one another, and learning from the successes and mistakes of others.

Should Overlap Be Eliminated?

It is intuitive to want to eliminate as much overlap as possible, especially from the industry standpoint where this elimination could possibly result in less work, greater efficiency, and less confusion over compliance. However, care must be taken to avoid eliminating overlap that was put in place intentionally to gain the possible benefits of competition and collaboration. Thus, much as one would perform a risk analysis in a hazardous process if they were considering making a change, if overlap is to be eliminated, it must be as a result of careful analysis of the risk of the elimination.

5.2 Implement PBR uniformly by multiple agencies

Initially, it is important for every agency to determine how they are going to implement performance-based regulations individually and then uniformly across the industry. Primarily, agencies will have to develop strategic plans that cover the functions and operations of the agencies; then, they will have to identify the strategic goals and objectives. Further, a detailed description of the required resources and processes needed to fulfill the goals and objectives. Later on, the agencies will have to identify which are the factors that could affect the achievement of the goals and objectives suggested earlier by the agencies. Finally the agencies will have to describe how the performance goals included in annual performance plans will be related to the agencies goals and objectives [1, 53 - 54].

Once all the elements mentioned in the previous paragraph have been addressed, the agencies must receive feedback from the US Congress, the Board of Directors of the companies, the public and the stakeholders (as shown in Figure 5).

Congress will have to review the plan for every agency to achieve the corresponding goals and objectives and analyze the processes and resources required to meet such goals. This is necessary information for Congress to assign the appropriate budget for the agencies to fulfill their objectives. However, for this to be completed a performance

plan has to be analyzed and discussed between the agency and Congress. Some points that must be addressed in this plan are:

- Description of the processes and resources required to meet the performance goals;
- Determine which are the performance indicators to be used in measuring or assessing the relevant outputs and outcomes of each activity;
- Provide a comparison basis of the actual program results to the established performance goals [53].

Figure 5 Feedback path for the agencies

Furthermore, before this plan is given to Congress, several perspectives have to be considered. For instance, the expertise of the Board of Directors of the companies (experts), stakeholders and the public will strengthen the performance regulations by making them more achievable and realistic. Wholey *et al.* [53] proposed a six criteria methodology to grant the political, senior management and analytical support for the successful implantation of performance-based regulations. These criteria are:

- Agreement on goals and strategies by using the professional judgment of experts;

- Performance measurement systems of sufficient quality. In this respect, the national database system recommended and discussed earlier could be used to develop the performance measurement systems.

- Performance-based management systems to build the communication of the performance information to the relevant agency;

- Accountability, demonstrating effective or improved performance, and supporting policy decision making, establishing communication between the agencies with the stakeholders and the public.

Moreover, it is recommended that a proper inspection methodology for agencies to enforce regulations is established, as well as a uniform terminology across agencies and industries. Finally, a training program has to be implemented. This training should include the political and bureaucratic context for performance-based management and should focus mainly on the following issues [53]:

- Measuring, evaluating, and reporting on performance to analyze the implications of alternative policies and program approaches;

- Using performance information to support resource allocation and other policy decision making;

- Reinforcing performance-based management and building expertise in performance-based management.

6. Apply Risk Assessment in Performance-based Regulatory Regime

Risk assessment will definitely play an important role in performance-based regulatory regime if the performance objective is to control risk level within specified acceptance criteria. Additionally, it can be extended to support decision making, including design, construction and operation of Oil & Gas plants.

The objectives of a risk assessment study include [55]: (1) Evaluating risk; (2) Identifying the main contributors to the risk; (3) Defining accident scenarios; (4) Comparing design alternatives; (5) Evaluating risk reduction measures; (6) Demonstrating acceptability to regulators. For example, the risk assessment can be used to judge if the risk has been reduced to As Low As Reasonably Practicable (ALARP).

Risk assessment methodologies (qualitative and quantitative) can identify the hazard scenarios and estimate the frequency of occurrence and the severity of the consequence. In performance-based regulatory regime application, two regulatory agencies have been applying quantitative risk assessment (QRA) in the offshore

industry for decades: Norwegian Petroleum Directorate (NPD) of Norway and UK Health and Safety Executive (HSE).

The NDP issued "Guidelines for Safety Evaluation of Platform Conceptual Design," in 1981, which was the first formal regulatory requirement for offshore QRA [55]. The Concept Safety Evaluations required by this regulation intended to control the total probability of occurrence of safety functions impairment under 10^{-4}/year [55]. This performance-based regulation targeted a specific risk criterion and was considered to produce a major improvement in Norwegian platforms. However, to enhance the operator's management attitudes, the 1990 NPD regulations required the companies to manage safety in a systematic way, and documenting their own safety objectives and risk acceptance criteria [55]. In this way, the operators could take greater responsibility for their own operations.

Regulated by UK HSE in 1992, each operator is required to submit a Safety Case for its installations. In the Safety Case document, they should ensure that the risks of major accidents have been assessed and measures to reduce risks to the lowest level reasonably practicable (ALARP) have been taken. QRA is consequently considered as most important technique used to identify the major accident hazards and that the risks have been reduced to ALARP. HSE instructs that safety cases should demonstrate that risks in any given area are not higher than 1 in 1000 fatalities per year and that preventive measure do not result in expenditures more than £1 million (about $1.6 million). HSE also proposes applying QRA for certain situations, such as complicated plants, important stages, high inventory/pressure/temperature processes etc [56].

Several other countries have followed the Norwegian/UK approaches and recommended QRA applications, including Canada, Australia, Denmark and the Netherlands.

Some concerns that should be paid addressed to when applying risk assessment for performance-based regulatory regime [55-56]:

- The selection of risk assessment methodology should be considered cost-effectively and the rigor of assessment should be proportionate to the complexity of the problem and magnitude of risk. The risk assessment should be updated through the whole life cycle of the facility, using proper methodology. In extremely high risk situations, QRA is strongly recommended, and semi-quantitative and qualitative methodologies can be adopted for less hazardous situations.
- To ensure the good quality of the risk assessment, specific standards or guidelines should be stringently followed. The regulation should provide sufficient information about the methodology that should be applied in a specific situation

(*e.g.,* UK HSE proposes situations for QRA). The format needs to satisfy the judgment of the authorities. Sufficient confidence must be provided to support decision making.

- Risk assessment should address and/or quantify the impact of uncertainties. Uncertainty analysis is very important because the development of an accident scenario may depend on the numerous combinations of input variables. Monte Carlo simulation can simplify complex interactions of different parameters and has been considered as the most widely used technique for combining uncertainties.

- Risk presentation: expected number of fatalities per year, FAR, f-N curves. The risk presentation should be comparable with the acceptance criteria. The impact to humans can be expressed with “expected number of fatalities per year”, “Fatal Accident Rate” or “f-N curves”. Loss of safety functions can be expressed by the frequency of impairment accidents. A very important issue that needs to be addressed is that risk presentation and risk communication should be uniformly consistent across different agencies, industry and all other stakeholders.

- Risk goals/criteria: in a performance-based regulatory regime, risk acceptance criteria must be established to set performance goals. The criteria can be regulated by the authorities or the operators on their own. Especially in quantitative risk assessments, the risk estimates should be compared with quantitative risk acceptance criteria. The risk goal can be a numerical value or ALARP.

- Human factor consideration: people should also be considered as a key factor in a potential major accident, including evaluating the feasibility of various tasks, implementing control measures and training, etc. The complexity of this analysis can be based on the severity of the consequences. Human evaluation is also important to estimate the capability to implement evacuation.

7. Conclusions

For all the various combinations of agencies and regulatory programs, it is very difficult to judge which regulatory regime is more effective. To answer this question, performance data should be collected adequately and uniformly under consistent incident reporting system. Otherwise, biased data collection will always lead to incorrect conclusions.

Secondly, it has been discussed that a “one size fits all” regulatory approach is not appropriate due to the diversity of existing industries, processes and company sizes. It is therefore necessary to determine the most adequate regulatory approach to

implement according to the situation. Some situations in which prescriptive regulation is preferred are mentioned below:

- High risk situations, particularly, when there are technologies known to work well. For example, in the case of the airline industry where the consequences of an accident are severe, there are prescriptive methods to achieve the required level of safety, which have shown successful results.

- When companies have limited capabilities to develop their own approach to achieve performance targets, such as small companies. These companies would benefit from prescriptive regulations or prescriptive components given as optional guidance to complement performance-based regulations.

- Standard procedures that have little need for innovation.

- Situation where experience exists, or there is little room for innovation, a prescriptive regulation should be preferred. Instead, when the rate of change of technology or innovation is an important consideration, performance-based regulations might be desirable.

- Businesses could benefit from prescriptive components as a complement to performance standards to provide more concrete guidance.

Finally, to answer the question that if we should consider further changes in the regulatory framework, we should figure out how to improve our existing program instead of changing the whole system and allow time for existing regulations (*e.g.,* PSM) to be implemented properly. We could increase training and reinforce the regulation compliance, gradually add regulatory reform and efficiencies to the existing system, and implement overall quantitative risk assessments for plants. We should put in place a well-planned national database system to collect appropriate and statistically significant data on incidents to be able to evaluate the performance of regulatory agencies as well as the regulated entities.

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From:	Janet Gunter
To:	chevroncomments
Cc:	lisa.pinto@mail.house.gov; maurice_lyles@boxer.senate.gov; elise.swanson@mail.house.gov; michael_davies@feinstein.senate.gov; helmlinger.andrew@epa.gov; wesling.mary@epamail.epa.gov; kitf@rpv.com; rgb251@berkeley.edu; carl.southwell@gmail.com; lpryor@usc.edu
Subject:	PLEASE ADD REMARKS BELOW COMMISSIONER MOURE-ERASO LETTER to Chevron Report as official comments. Thank you.
Date:	Friday, January 03, 2014 5:43:16 PM

Dear Mr. Moure-Eraso,

Please accept my thanks to you and the CSB for intervention on the issues related to safety regarding hazardous facilities. As you may or may not know, our homeowners have long been fighting the presence of a massive butane and propane gas storage facility located a mere 1,000 feet from neighborhoods and schools in San Pedro (near the Port of LA). We were elated to find your comments regarding more proactive safety measures...but, find that the term "practicable level" (see below).....leaves a great deal of legal wiggle room for hazardous operations. In a heart beat, the LPG facility that we are dealing with was introduced in 1972 during the Arab-Israeli oil crisis by President Nixon's close friend and campaign supporter, RJ Munzer CEO of "Petrolane LPG". There was great emphasis placed on broad based future use of these gasses as a means to off set oil as an energy source. The facility was expedited through a deficient EIR and permitting process and awarded an "emergency exemption" from LA City Fire Regulations. The tank facility was built in the Earthquake Rupture Zone of the Palos Verdes Fault (mag. 7.3) in tanks built to a seismic sub-standard of 5.5 to 6.0. Obviously, the future expectation of butane and propane uses were never met. The Petrolane facility went bankrupt in the 1980's and was picked up by UGI/Amerigas and more recently was sold to its current operators, Rancho LPG LLC./ Plains All American Pipeline. The extremely hazardous transfer of these butane and propane gasses by rail and truck are a daily occurrence. There have been two rail accidents within 7 years. Miraculously, neither of them ruptured the rail car. The great predicted California earthquake has not occurred yet either. However, it is only a matter of time. The blasts and "cascading failure event" potential from this facility and its operations far exceed any recent disasters that we have witnessed. We drastically need the assistance of all agencies that have authority over these types of facilities. The "wiggle room" afforded by less restrictive language should be eliminated. The safety of our people should be the greater concern, not the well being of such hazardous operations. We look to you and the CSB to be the leaders in assuring a stronger, wiser and more protective policy of public safety.

Thank you again,
Janet Schaaf-Gunter
Member: San Pedro Peninsula Homeowners United, Inc.

PLEASE ADD THE FOLLOWING TO ABOVE COMMENTS REGARDING THE CHEVRON ACTION

To All Agencies and Officials Responsible For Public Safety:

In addition to this letter, I would like to express a strong sense of outrage at the lack of attention paid to so called "Grandfathered" facilities as they relate to common sense public safety policy. As with the Rancho LPG facility in San Pedro, CA, it has been acknowledged by multiple City, State and Federal officials that the huge LPG facility is of extreme concern. Yet, for over 40 years now the facility has been allowed to exist without ever engaging in any independent comprehensive risk analysis to establish that level of risk. The "hands off" attitude regarding this facility has been attributed to government's unwillingness to stand up to industry completely frozen in their fear of a lawsuit. To hell with the lives of those being threatened! The typical answer by government across the board has been that the facility is "grandfathered in" and is in "legal compliance". One has to wonder how any coherent mind can make that statement in light of the fact that the existing facility does NOT comply with existing distance requirements.... was exempted from LA City Fire regulations when built...and maintains a seismic sub-standard while being located in an earthquake rupture zone with a magnitude of potential that far exceeds tank durability! There are many, many questions about how rationale

minds can ignore the extreme risk presented by this facility. None of which could ever be answered in any reasonable or responsible way.

While we respectfully recognize that there are MANY hazardous and ultra hazardous facilities that exist now threatening members of the public, we underscore this one because of it's prime location for concern. As a facility so close to the economic hub of the State of California, the Ports of LA and Long Beach, this facility makes a choice target for terrorism. The Ports of LA and Long Beach rank #'s 3 and 5 on a known list of terrorism targets identified after 9/11. Abutting this facility is a major Conoco Phillips refinery, while across the street is the Naval Fuel Depot storing huge volumes of jet fuel and propellants. A "cascading failure event" at this Rancho LPG facility has the potential to cause an unimaginable inferno, decimate both ports and cause death and destruction to the densely populated Harbor communities representing many thousands. The potentials of disaster caused by earthquake, tsunami, antiquated infrastructure and human error are all very real for this facility as well.

It is incumbent upon all responsible agencies to identify the current deficiencies associated with all hazardous facilities, new and "grandfathered", and to begin the process of prioritizing public safety rather than bowing to the agenda of the powerful Oil and Energy Industry. As we have witnessed multiple times this year alone, there are major voids in their system of public protection that have simply been accepted. Any and all further losses must be prevented! It is time for government to grow a backbone and protect its people and its own assets... rather than the assets and profits of industry!

Janet Schaaf-Gunter

From: Secretary, ACS Division of Chemical Health and Safety <secretary@dchas.org>
Date: Tue, Dec 17, 2013 at 5:06 AM
Subject: [SAFETY2] CSB Draft Report Proposes Overhaul of Refinery Industry Regulatory System in California
To: SAFETY2@lists.asu.edu

In Wake of Chevron 2012 Pipe Rupture and Fire in Bay Area Q and Urges Adoption of the Safety Case Regime to Prevent
Major Chemical Accidents

Richmond, California, December 16, 2013 - In a draft report released to the public today, the U.S. Chemical Safety Board (CSB) proposes recommendations for substantial changes to the way refineries are regulated in California. Entitled "Regulatory Report: Chevron Richmond Refinery Pipe Rupture and Fire," the CSB draft calls on California to replace the current patchwork of largely reactive and activity-based regulations with a more rigorous, performance-based regulatory regime - similar to those successfully adopted overseas in regions such as the United Kingdom, Norway, and Australia - known as the "safety case" system.

LINK TO REPORT: http://www.idevmail.net/link.aspx?l=3&d=86&mid=414620&m=1280

The draft report is the second part of three in the CSB's investigation of the August 2012 process fire in the crude unit at the Chevron refinery in Richmond, California. That fire endangered 19 workers and sent more than 15,000 residents to the hospital for medical attention.

CSB Chairperson Dr. Rafael Moure-Eraso said, "After exhaustively analyzing the facts, the CSB investigation team found many ways that major refinery accidents like the Chevron fire could be made less likely by improving regulations. Refinery safety rules need to focus on driving down risk to the lowestpracticable level, rather than completing required paperwork. Companies, workers, and communities will all benefit from a rigorous system like the safety case. I believe California could serve as a model for the nation by adopting this system. We applaud the work of the Governor's Interagency Task Force for their proactive approach and highly positive recommendations to protect worker and public safety in California. I have great confidence that California will embrace the recommendations in our draft report and carry them forward to implement policy change."

The draft report is available at www.csb.gov for public comment until Friday, January 3, 2014. Comments should be sent to chevroncomments@csb.gov . All comments received will be reviewed and published on the CSB website.

As detailed in the CSB draft report, the safety case regime requires companies to demonstrate to refinery industry regulators - through a written "safety case report" - how major hazards are to be controlled and risks reduced to "as low as reasonably practicable," or ALARP. The CSB report notes that the safety case is more than a written document; rather, it represents a fundamental change by shifting the responsibility for continuous reductions in major accident risks from regulators to the company.

To ensure that a facility's safety goals and programs are accomplished, a safety case report generated by the company is rigorously reviewed, audited, and enforced by highly trained regulatory inspectors, whose technical training and experience are on par with the personnel employed by the companies they oversee, the draft report says.

The draft report - which is expected to be considered for formal adoption by the Board at a public meeting at 6:30 p.m. on January 15, 2014, at Richmond City Hall - follows the CSB's first, interim report on the accident, which was approved by the Board and released in April 2013. That report found that Chevron repeatedly failed over a ten-year period to apply inherently safer design principles and upgrade piping in its crude oil processing unit, which was extremely corroded and ultimately ruptured on August 6, 2012. The interim report identified missed opportunities on the part of Chevron to apply inherently safer piping design through the use of more corrosion-resistant metal alloys. The interim report also found a failure by Chevron to identify and evaluate damage mechanism hazards, which if acted upon, would likely have identified the possibility of a catastrophic sulfidation corrosion-related piping failure. There are currently no federal or state regulatory requirements to apply these important preventative measures. The investigation team concluded that enhanced regulatory oversight with greater worker involvement and public participation are needed to improve petroleum refinery safety.

The draft CSB Chevron Regulatory report released today states there is a considerable problem with significant and deadly incidents at petroleum refineries over the last decade. In 2012 alone, the CSB tracked 125 significant process safety incidents at U.S. petroleum refineries. Seventeen of these took place in California. The draft report also notes that the U.S. has experienced financial losses from refinery incidents that are at least three times that of industry counterparts in other countries, citing insurance industry statistics.

The existing California system of regulation can be significantly improved, the report concludes. Since 2010, the CSB has examined the extent to which a safety case regime would improve regulatory compliance and better prevent major accidents, both onshore and offshore. The safety case regime, which originated in Europe, requires high hazard facilities to demonstrate, to the satisfaction of a competent regulator, that they are able to operate safely, in conformance with the latest safety standards, and at the lowest practicable risk levels. The report illustrates that under a safety case approach, demonstrating control of major hazards is a pre-condition for a refinery to operate.

Dr. Rafael Moure-Eraso said, "In contrast to the safety case, the current regulatory system for process safety is largely reactive, at both the state and federal level; companies have a default right to operate, and are subject to penalties when accidents occur or their activities otherwise draw negative attention from regulators. In the case of the Chevron refinery fire, the reactive system of regulation simply did not work to prevent what was ultimately a preventable accident."

Don Holmstrom, Director of the CSB's Western Regional Office, which is conducting the Chevron investigation, said, "The Process Safety Management [PSM] standard, the EPA's Risk Management Program, and California's system do not work consistently to prevent industrial process accidents. What is lacking, and what the safety case regime requires, is an adaptable, rigorously inspected, goal-setting approach, aimed at continuously reducing risks to "as low as reasonably practicable - known in the

industry as ALARP."

The OSHA PSM standard is a set of requirements for facilities to identify, prevent or mitigate major chemical releases and catastrophic accidents. The current PSM standard requires companies to implement 14 elements to control the hazards from processing chemicals - such as hazard analysis, management of change, and worker training programs.

Only two of these 14 elements contain goal-based requirements - Process Hazard Analysis and Mechanical Integrity. Companies are able to comply with the other twelve elements by simply conducting highly specified activities, such as a "management of change" review. The current PSM standard does not require refineries to reduce their risks to a specific level, and companies are not required to submit their safety programs to regulators for review.

A 2007 CSB report on an explosion at a BP refinery in Texas found that only a handful of comprehensive process safety compliance inspections were occurring a thousands of refineries and chemical plants covered by the PSM standard across the U.S. Federal OSHA instituted an expanded refinery inspection National Emphasis Program following the explosion in Texas City, but that program was subsequently dropped due to lack of resources.

The CSB draft regulatory report contains an extensive analysis comparing actions required by Chevron under the OSHA PSM standard over the years and actions that would have been required had Chevron operated under a safety case regulatory regime. For example, Chevron employees recommended implementing the inherently safer approach of upgrading piping materials to prevent sulfidation corrosion through PSM activities. However, the CSB draft report found that the California process safety regulations do not require that these preventative measures be implemented. Prior to the fire, Chevron had repeatedly failed to implement the proposed recommendations; using inherently safer approaches, on the other hand, is required under the safety case. The CSB found that had Chevron implemented these recommendations, the incident could have been prevented.

Other examples in the report detail how a safety case would have required Chevron to conduct root-cause investigations, including an evaluation and incorporation of inherent safety and implementation of safety recommendations that more broadly address safety system performance. Effective implementation of the safety case requires strong workforce involvement, proactive inspections and enforcement by a well-resourced regulator, as well as incorporation of best practice performance standard requirements.

The draft report notes that promulgation of new standards by OSHA requires about seven years, and that process has made few - if any - changes to its process safety rules in more than two decades. The report contrasts this ineffectual system for updating federal safety regulations through rulemaking with the greater adaptability of the safety case regime. Under a safety case system, changing safety standards, new technologies, and findings from accident investigations are required to be incorporated by facilities.

"In the last decade," the draft report states, "the CSB has made a number of process-safety related recommendations to OSHA and the EPA in its investigation reports and studies (e.g. Motiva, BP Texas City, and Reactive Hazards). However, none of these important regulatory recommendations have been implemented, and there have been no substantive changes made to the PSM or RMP regulations to improve the prevention of major accidents."

In contrast, regulators in countries such as the UK and Norway are able to more quickly implement appropriate safety improvements. Available studies summarized in the report illustrate that the safety case continues to be effective. For example, data from Norway and the UK show a reduction in hydrocarbon releases offshore under the safety case regime. The draft report concludes that "Independent studies of the safety case in the UK have identified improvements to safety performance from the safety case regulatory regime and support of the safety case by major oil companies."

Chairperson Moure-Eraso said, "The safety case is being increasingly adopted around the world, and

the U.S. safety system has fallen behind. Workers, the public and the industry itself would benefit greatly from the enhanced advantages of this more adaptable and effective approach to regulation. Other regimes have long since recognized the need for increased participation by workers and their representatives, transparency of information and the use of key process safety indicators to ensure the system works to prevent major accidents."

Subject to a vote by the board, the draft report would recommend that California "Develop and implement a step-by-step plan to establish a more rigorous safety management regulatory framework for petroleum refineries in the state of California based on the principles of the "safety case" framework in use in regulatory regimes such as those in the UK, Australia, and Norway." The recommendation urges specific steps to accomplish this, including ensuring that workers are formally involved in the development of a safety case approach. The report also urges California to work with industry in gathering refinery safety indicator data to be shared with the public.

CSB Investigator Amanda Johnson said, "We believe our draft report provides a definitive examination of the advantages of the safety case system, one that would not only benefit California but the U.S. as well."

Ms. Johnson continued, "We have reviewed the literature, studied systems in place overseas, and held hearings to gather data and opinions. Some critics of the system fear it would lead to self regulation; by the industry; however, the safety case regime requires highly qualified regulators, whose technical abilities and experience match those of the technical staff at refineries. And it provides the regulator with the authority to accept or reject the safety case report to ensure that the employer has demonstrated that effective safeguards are in place."

The CSB is an independent federal agency charged with investigating serious chemical accidents. The agency's board members are appointed by the president and confirmed by the Senate. CSB investigations look into all aspects of chemical accidents, including physical causes such as equipment failure as well as inadequacies in regulations, industry standards, and safety management systems.

The Board does not issue citations or fines but does make safety recommendations to plants, industry organizations, labor groups, and regulatory agencies such as OSHA and EPA. Visit our website, www.csb.gov http://www.idevmail.net/link.aspx?l=4&d=86&mid=414620&m=1280

For more information, contact Communications Manager Hillary Cohen, cell 202-446-8094 or Sandy Gilmour, Public Affairs, cell 202-251-5496.

Katten
Katten Muchin Rosenman LLP

1301 McKinney Street,
Suite 3000
Houston, TX 77010-3033
713.270.3400 tel
713.270.3401 fax
www.kattenlaw.com

MARK L. FARLEY
mark.farley@kattenlaw.com
(713) 270-3434 direct
(713) 583-1953 fax

January 3, 2014

VIA ELECTRONIC MAIL
U.S. Chemical Safety and Hazard Investigation Board
2175 K Street, N.W., Suite 650
Washington, D.C. 20037

Re: Comments on Report No. 2012-03-I-CA Chevron Richmond Refinery Regulatory Report

To The U.S. Chemical Safety and Hazard Investigation Board:

On December 16, 2013, the U.S. Chemical Safety and Hazard Investigation Board ("CSB" or "Agency") issued for public comment its draft Regulatory Report, Report No. 2012-03-I-CA ("Report") relating to the August 6, 2012 incident ("incident") that occurred at the Chevron U.S.A. Inc. ("CUSA") Richmond Refinery. I write on behalf of CUSA in response to your request for public comments on the Report.

The Report to be issued for public comment continues to contain previously identified inaccuracies and mischaracterized statements relating to CUSA and the incident. CUSA has identified these inaccuracies and mischaracterizations in prior communications relating to both the Report and the CSB's Interim Investigation Report: Chevron Richmond Refinery Fire. We respectfully repeat that full consideration and response to the issues that CUSA has raised regarding the Report would be consistent with the mission and values of the CSB.

Moreover, while CUSA remains committed to working cooperatively with the CSB regarding its investigation into the incident, due to the issues noted above, CUSA cannot adopt the CSB's findings and conclusions in the Report for the reasons detailed in our previous correspondence. If you have any questions, please let me know.

Very truly yours,

Mark L. Farley

Comments on the CSB's Draft Report
Regulatory Report: Chevron Richmond Refinery Pipe Rupture
REPORT NO. 2012-03-I-CA, DECEMBER 2013

By

Najmedin Meshkati and Alvin Chin

Najmedin Meshkati, PhD. CPE
Professor
Department of Civil/Environmental Engineering
Department of Industrial and Systems Engineering
Viterbi School of Engineering
Kaprielian Hall (KAP), Rm 238B
University of Southern California
Los Angeles, California 90089-2531
Tel: (213) 740-8765 ; Fax: (213) 744-1426
Email: meshkati@usc.edu
http://www-bcf.usc.edu/~meshkati/

Alvin Chin
B.S. Industrial and Systems Engineering, 2014
Viterbi School of Engineering
University of Southern California
Tel: (213)595-8427
Email: alvinchi@usc.edu, alvincyw@gmail.com

January 3, 2014

Introduction

We would like to commend you for CSB's recommendation to implement "safety case" system to supplement the existing safety regulations such as OSHA, which indeed is a thoughtful and interesting idea. According to the released draft report, "safety case" system is inherently more effective, proved by the successful implementation in other countries such as United Kingdom, Norway, and Australia. We fully agree with your following assertion:

> "[T]he safety case regime requires companies to demonstrate to refinery industry regulators – through a written "safety case report" – how major hazards are to be controlled and risks reduced to "as low as reasonably practicable," or ALARP. The CSB report notes that the safety case *is more than a written document*; rather, it represents a *fundamental change* by shifting the responsibility for continuous reductions in major accident risks from regulators to the company." (Emphasis added)

We support your recommendations in principle, however, would like to point out the following equally important issue that, in our judgment and based on our research, represents the foundation and a necessary condition for the "fundamental change" that is needed. We believe that a strong safety culture is the bedrock and prerequisite for such fundamental change, which in turn is a prerequisite for success of any "safety case" approach. Furthermore, in this context, we mean not only the safety culture of the operating plant, e.g., a refinery, but also its holding company, industry sector as well as responsible federal regulatory and state/local designated oversight agencies.

The need for safety culture maturity (of the industry), as a prerequisite for adopting and implementing safety cases, precisely is a conclusion and a recommendation of a seminal recent research, entitled: *Using Safety Cases in Industry and Healthcare: A Pragmatic Review of the Use of Safety Cases in Safety-Critical Industries – Lessons and Prerequisites for Their Application in Healthcare*, which was commissioned and funded by the Health Foundation of the UK (December 2012):

> "Lessons and recommendations for healthcare….The safety culture in the industries reviewed in this report may be more mature than the current safety culture in healthcare, with patient safety still being a recent and emerging discipline. This may suggest that safety cases should only be adopted in those contexts where there is a good level of safety maturity, both on principles and methods." (p. 12)

Safety Culture

Safety culture is typically defined as the assembly of characteristics and attitudes in organizations and individuals, which establishes that as an overriding priority, safety issues receive the attention warranted by their significance. Creating and nurturing a positive safety culture basically means to instill thinking and attitudes in organizations and individual employees that ensure safety issues are treated as high priorities. An organization fostering a safety culture would encourage employees to cultivate a questioning attitude and a rigorous and prudent approach to all aspects of their job, and would set up necessary open communications between line workers and mid- and upper management. These safety culture characteristics are equally applicable both to the operating companies as well as to their cognizant/designated governmental regulatory safety agency.

We believe that safety culture can be characterized as the "fruit" or "overlay" or direct result of the sound Human-Systems Integration (HIS) considerations that should have been incorporated during the work system's design and operation stages. Alternatively, the HSI considerations constitute the blueprint for integrating the system's components as well as its subsystems and ensuring their smooth interactions, while safety culture can be considered, even possibly, as a "fruit", indirect "effect" of such (socio-technical) system design and integration. Of course the "forcing functions" of regulator's competence and oversight, plus economic pressures can seriously affect the integrity of the whole system.

Regulatory Oversight

The paradox of regulation in our technologically-advanced society is that we increasingly need and resist them. Regulation, to paraphrase Churchill ("Democracy is the worst form of government, except for all those other forms that have been tried from time to time"), is the worst form of control for ensuring industrial safety and protecting the public and environment from the adverse effects of failures in technological systems. In the US, most safety, health, and environmental regulations are after-the-fact phenomena promulgated only after a major accident or spill, etc., and are products of complex compromises among special interest groups, trade associations and their persuasive

lobbies, and the prevailing political atmosphere of the country. The regulations that result are the least common denominators of such entities' differential understandings and competing interests. As such, they can only provide the foundation and, in most cases, the bare minimum for ensuring and improving safety, health, and environmental quality.

Based on one the author's (Meshkati's) 25+ years of teaching, conducting research and consulting on accident causation and safety of complex technological systems, such as nuclear power, refining, oil drilling, petrochemical and transportation industries, he is convinced that regulations can be considered as resultants of least common denominator of such entities' sometimes differential understandings and competitive interests. As such they only provide the "floor" and in most cases, bare minimum for ensuring and improving safety, health and environmental considerations of our "regulated" industries. Those industries' safety culture and their senior management's safety consciousness and genuine commitment are the key to move above and beyond the bare minimum, which compliance with regulations will achieve for us.

Furthermore, by concentrating on improving safety culture we can also avoid another natural risk/peril of reliance on regulations and their enforcing agencies, which is called "regulatory capture", which is a not a rare disease infecting politically-susceptible weak agencies. It often happens when such agencies become dominated by the very industry that they were supposed to oversee; their enforcement function becomes toothless and practically surrender.

Another inherent problem with regulatory mechanism of control is that when an industry whose technological systems' advancement out-paces its regulator technical capabilities and know how (which happens most of times) to "certify" the safety of those systems. Exhibit A: the complexity of all the advanced and rapidly changing technologies and techniques which were used in deep-water drilling [(e.g., the Blowout Preventor (BOP)] and the incapable, feeble cognizant regulatory agency the Minerals Management Services MMS (now called BSEE) to test or certify it. Exhibit B: When the F.A.A. asked and granted Boeing the authority to develop new certification standards and self-certify its lithium-ion batteries for its new 787 Dreamliner.

One, though reactive, way to keep tabs on the effectiveness of government regulatory agencies is through independent safety and accident investigation boards. The National Transportation Safety Board (NTSB) and its younger sister, the U.S. Chemical Safety and Hazard Investigation Board (CSB), are two success stories which should be used as models for other industries. The NTSB was created by the Independent Safety Board Act of 1974 and the CSB was authorized by the Clean Air Act Amendments of 1990. It is no secret that all of us enjoy safer transportation systems and workplaces in this country as a direct result of the diligent efforts of these two rather low-profile independent safety boards. They enjoy subpoena power, conduct independent and unfettered accident investigations and write the most technically sound reports that are used around the world and referred to in university teaching. They ensure that lessons learned are understood and shared, and make strong and specific recommendations to cognizant regulatory

agencies and targeted or impacted industries. Moreover, for instance, the NTSB, through its frequently updated "Most Wanted List" of its unimplemented safety recommendations, holds the feet of the targeted transportation sectors and related regulatory agencies to fire, so to speak.

Safety Culture and Recent Accidents

We would like to commend you for the quintessential BP Refinery Texas City Refinery Explosion and Fire (2005) accident investigation report, wherein you identified human factors and safety culture as two out of four root-causes or "Key Issues" contributing to that accident.

We are also pleased to see that the above issues have addressed in your interim report about Chevron Refinery fire of August 2012, as you noticed in the ten years prior to incident, there were at least six specific recommendations by Chevron personnel to fix the problem which "were not implemented by Chevron management". This serious fire, lead Chevron management to acknowledge and declare a year later that, "we will also soon begin discussions with Contra CostaHealth Services in preparation for a proposed review of the Refinery's safety culture, process safety management systems, and human factors associated with our operations". The vital role of human factors and safety culture in refinery safety has been further emphasized in a recent report by the *Interagency Working Group on Refinery Safety* where two of its major recommendations include to "require refineries to perform periodic safety culture assessments" (p. 27) and to "require refineries to explicitly account for human factors" (p. 28).

As a thorough published report by a 15-member interdisciplinary experts Committee of the National Academy of Engineering and National Research Council (NAE/NRC), "*Macondo Well–Deepwater Horizon Blowout: Lessons for Improving Offshore Drilling Safety*" (Dec 2011), recommended, under the title of "Fostering Safety Culture":

> "Summary Recommendation 5.5: Industry should foster an effective safety culture through consistent training, adherence to principles of human factors, system safety and continued measurement through leading indicators." (p.82)
>
> "Summary Recommendation 6.25: BSEE (Bureau of Safety and Environmental Enforcement) and other regulators should foster an effective safety culture through consistent training, adherence to principles of human factors, systems safety, and continued measurement through leading indicators." (p. 96)

Moreover, we would like to suggest that might be helpful in making the system more effective by providing relevant specific add-ons to the factors mentioned in the report. The report mentions about the importance of process safety indicators, particularly leading indicators. It continues in stating that HSE has developed a step-by-step guidance in assisting industry in developing process safety indicators with clear definition of leading and lagging indicators for each of the controls in the risk control system. Going

from there, we would like to build up a framework that can be utilized by both the industry and the regulator to better evaluate the safety of the processes. This framework will act as a check list in which specific items/factors will be used as reference points to the safety condition of the facility.

From the perspective of the employer, this list can be used for self evaluation, before being evaluated by the regulator who holds a similar list containing more details that can better assist them in evaluating the condition of the facility. If the regulator can achieve the ideal condition of being independent, well-resourced, comparatively competent, and having the authority to reject the industry's safety report, then this list will act as a helpful tool in preventing unqualified safety standard of the industry.

Conclusion

The oil refining industry's safety culture (in this context) and its senior management's safety consciousness and genuine commitment are the keys to moving above and beyond the bare minimums achieved by regulatory compliance. The most effective form of safety assurance for refining industry in the US is achieved by ensuring these systems are operated by organizations with strong human factors considerations and proactive safety cultures with conscientious senior management genuinely committed to safety. It is incumbent to the regulatory agencies and industry associations to assume leadership, provide guidance concerning safety culture. These entities along with operating companies should ensure accountability, via periodic audits. [The Institute of Nuclear Power Operations (INPO) has developed a seminal guideline and code of practice for safety culture in nuclear power industry, *Traits of a Healthy Nuclear Safety Culture* (April, 2013), that could be adopted and utilized for this purpose by the oil and refining industry.]

In conclusion we would like to point out that human factors, human-systems integration, and safety culture, which are vital issues, constitute the foundation and prerequisite for adoption of safety cases; as such they should never be made a pawn of regulatory feuds. Any rush to implementation of safety cases without ascertaining the maturity level of an industry's safety culture is not prudent and could have disastrous consequences. As the aforementioned seminal report, *Using Safety Cases in Industry and Healthcare: A Pragmatic Review of the Use of Safety Cases in Safety-Critical Industries – Lessons and Prerequisites for Their Application in Healthcare*, recommends:

> "The adoption of safety cases needs to be accompanied by appropriate guidance and training as well as a continuing development of safety culture maturity." (p. vii)

Suggestion

We believe that our recourses and efforts should be spent on improving safety culture and then, possibly, move toward staggered and gradual implementation of safety cases approach, based on demonstrated and proven "maturity" of the targeted industry. To

paraphrase the French statesman Georges Clemenceau, safety (culture) is much too serious a matter to entrust solely to the “safety case” implementation.

Best Regards

Najmedin Meshkati and Alvin Chin

Ps please find attached, FYI, copies of our relevant research writings and analyses of the Venezuela Amuay Refinery Explosion and Fire on August 25, 2012, which killed more than 40, injured more than 80 people, and affected nearly 520 houses.

ISE 370 Research Paper

Root Causes of Oil Refinery Accidents

Based on BP Texas City's Explosion and Venezuela Amuay's Explosion

Alvin Yee Win Chin

Professor Najmedin Meshkati

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1.0 Introduction

Oil industry has been a high risk industry especially in the sector of oil processing where oil refinery processes and refines crude oil into finished products of higher grade such as naphtha, petroleum, gasoline and so on. Oil refineries are typically large industrial complexes with extensive complicated piping and huge chemical processing units. The safety measurements involved in maintaining the complexes are of critical importance to ensure the safety and well being of employees and community surrounding the complexes. Despite a good safety standard developed throughout ages of practices, oil refinery accidents still occur in this 21st century.

In this research, I will determine some important but neglected factors of safety culture of oil refinery by investigating the root causes of two major oil refinery accidents which took place in recent years. By looking through reports and commentaries by experts about the oil refinery accidents, I will be able to extract similarities in between the accidents and come to a conclusion of some important safety measurements that should be emphasized by all oil refineries.

The first oil refinery accident is the BP refinery explosion and fire which took place in Texas on March 23, 2005. This accident is chosen as one of the subjects due to its high exposure via mainstream media and its impact on the issue of oil refinery safety standard in United States.

The second accident chosen is Venezuela's Amuay refinery explosion which took place in Falcon, Venezuela on August 25, 2012. This is a recent incident in which safety culture of oil industry is once again challenged. With Amuay being the world second largest refinery, this tragedy reminds us that even prestigious or important refinery can have huge deficiency in maintaining its own safety.

2.0 Methodology

Sources from mainstream media websites and blogs are referred to in the process of producing this report. I have also referred to a complete full report conducted by credible board. Assumptions and educated speculations are used to predict the sources of the accidents whenever plausible and credible sources are not available.

Firstly, I analyze news articles from main stream media such as The New York Times, BBC, CNN, Fox news and so on for a general understanding of the gravity and details of the accidents involved. I have also analyzed local news sources to have better unbiased understanding of the accidents. Important factors mentioned in articles are then extracted. Such factors include witnesses' remarks, official statement and professionals' comments. Next, logical comments with sound proofs by bloggers are collected via the internet as potential causes of the accidents. Furthermore, official report such as "Chemical Safety and Hazard Investigation Board's Investigation Report on BP Refinery Explosion" is obtained and analyzed to determined key findings of the report.

These potential factors from those two accidents will then be compared and contrasted among each other to highlight the neglected safety culture factors. These factors will then be the factors that need to be emphasized by all oil refineries, from which valuable lessons are to be learnt and applied in order to prevent the happening of tragedies.

3.0 Analysis of BP Refinery Explosion and Fire in Texas

3.1 Incident Synopsis

Figure i. The aftermath of the 2005 BP refinery explosion in Texas City (Photo: CNN)

On 23rd of March 2005, an explosion followed with fire occurred at the BP Texas City Refinery which is considered the third largest oil refinery in the states. It is referred as one of the worst industrial disasters in recent United States' history. The accident killed 15 people and injured another 180. This happened during the start up of an isomerization (ISOM) unit when a raffinate splitter tower was overfilled. The pressure relief devices opened resulting in flammable geyser from a blowdown stack that was not properly equipped with a safety flare system. The quick release of flammable vapor results in accumulated volume which is believed to be lit by an idle truck engine. Subsequently, explosion and fire occurred. The fatalities occurred in or near office trailers located close to the blowdown drum. Immediately, a shelter-in-place order was issued requiring 43,000 people to remain indoors. Physical damage on houses as far as three quarters of a mile from the refinery is observed.

3.2 Key Findings

Below are key technical and organizational findings extracted from “Chemical Safety and Hazard Investigation Board’s investigation report on BP refinery explosion”:

3.2.1 Key Technical Findings

Raffinate spillter tower overfilled for over 3 hours without any liquid being removed, leading to flooding of tower and high pressure, which activated relief valves that discharged flammable liquid to blowdown system.

1. Failure in tower level indicator system

- It showed that the tower level was declining when it was actually overfilling. Redundant high level alarm did not activate and no extra indications or automatic safety devices are installed.

2. Failure in control board display

- It did not provide adequate information on the imbalance of flows in and out of the tower to alert the operators

3. Lack of supervisory oversight and technically trained personnel during the startup process

- An extra board operator was not assigned despite being recommended to.

4. Poor communication between supervisors and operators

- Did not have a shit turnover communication requirement for its operations staff.

5. Poor consideration of operator's condition

- Operators were likely fatigued from working 12-hour shifts for 29 or more consecutive days.

6. Inadequate in operator training program

- Central training department staff had been reduced from 28 to 8, and simulators were unavailable for operators to practice handling abnormal situations.

7. Outdated and ineffective procedures

- Recurring operational problems during startup were not addressed.

8. Lack of cautionary measurement

- Process unit was started despite previously reported malfunctions of the tower.

9. Lack of safety in relief valve system

- The size of blowdown drum was insufficient to contain the liquid sent to it by the pressure relief valves.

10. Neglection of safety standard

- The blowdown drum was not connected to a flare system which would detect overflowing problem despite being recommended to install it.

11. Faulty refinery design

- Occupied trailers were located too close to a process unit handling highly hazardous materials resulting in all fatalities.

12. Ignorance on previous accidents

- No investigations have been done on 8 serious releases of flammable material from the ISOM blowdown stack that occurred in previous years prior to the incident.

13. Ineffective implementation of pre-startup safety review policy

- Not all nonessential personnel were removed from areas in and around process units during startups, an especially hazardous time in operations.

3.2.2 Key Organizational Findings

1. Lack of investment

- Cost-cutting, failure to invest and production pressures from the BP Group executive managers impaired process safety performance.

2. Lack of supervision on safety culture

- BP Board of Directors did not provide effective oversight of BP's safety culture and major accident prevention programs. The board did not have a specific member responsible for assessing and verifying the performance of BP's major accident hazard prevention programs.

3. Deluded performance rating

- Reliance on low personal injury rate at the refinery as a safety indicator failed to provide true picture of process safety culture performance.

4. Deficiency of mechanical integrity program

- A “run to failure” of process equipment scheme is followed.

5. Improper work ethic

- There exists “check the box” mentality where personnel completed paperwork by checking on safety policy and procedural requirements even when those requirements were not met.

6. Lack of reporting and learning culture

- Personnel were not encouraged to report safety problems and lessons from previous incidents were not generally incorporated.

7. Flaws in safety campaign

- The campaigns focused on improving personal safety metrics and worker behaviors rather than on process safety and management safety systems.

8. Ignorant management leadership

- Numerous studies, surveys and audits identifying deep-seated safety problems at the refinery were ignored.

9. Lack of assessment

- The refinery did not administer effective assessments of personnel, policies or organization which might impact process safety.

4.0 Analysis of Venezuela Amuay Refinery Explosion

4.1 Incident Synopsis

Figure ii. The aftermath of Amuay refinery explosion (Photo: El Universal)

On 25th of August 2012, an explosion occurred at Venezuela's world second largest refinery- the Amuay refinery. This deadliest refinery disaster in the history of Venezuela killed more than 40 people and injured more than 80 people. It also affected nearly 520 houses near the refinery. The blast unleashed a huge fire that destroyed two fuel tanks and stopped the production at the plant. The fire later spread to another storage tank before being brought under control. At least 20 members of a national guard unit assigned to protect the facility were killed along with some members of their families. The causes for this incident have not been formally determined as investigations are announced by the government but the report has not yet been produced or announced to public.

Figure iii. Amuay refinery is situated at the northeast area of Venezuela (Photo: BBC)

4.2 Findings from International and US News Media

Due to lack of official investigation report on the incident, I have compiled the possible causes of the incident based on the reports from several media news article as followed:

1. British Broadcasting Corporation (BBC)

An article from BBC dated 25 August 2012 pointed out that the explosion unleashed a huge fire that destroyed two fuel tanks and stopped production at the plant. The gas cloud exploded, igniting at least two storage tanks and other facilities at the refinery. It pointed out that critics believe there exists a decline in production and safety standard recently due to under investment from the state-controlled oil company. Refineries including this one have been suffering problems including power failures and accidents.

Possible root cause:

- decline in production and safety standard

2. Cable News Network (CNN)

An article dated 25 August, 2012 reported that an evacuation of the area is immediately executed following the explosion. However, it reported that “we had a release of gas whose origin we are going to determine”, a direct quote from Rafael Ramirez, the president of the state-owned petroleum company PDVSA. Thus, possible factor of the incident would be a leak of gas which went unnoticed until the tragedy has occurred.

Possible cause:

- unnoticed leaked gas

3. New York Daily News

This article, dated 25 August 2012, reported that Hugo Chavez, the president of Venezuela, ordered an investigation on the cause of the explosion. Rafael Ramirez also said that a panel of investigators was being formed to probe the cause of the gas leak. However, Gustavo Coronel, an energy consultant and former executive of PDVSA, commented that there are frequent accidents happening during the past year which is a direct result of lack of maintenance and inept management. Furthermore, Ivan Freites, a labor leader and employee who has worked at the refinery for 29 years, said workers had repeatedly alerted PDVSA officials to problems that they feared could lead to an accident. Problems mentioned include fires, broken pipes and lack of spare parts. However, it seems that their voices are ignored.

Possible root causes:

-lack of maintenance

-inept management

-ignorant management leadership

4. The New York Times

An article dated 27 August 2012 reported that the safety record of the oil company is criticized. Eddie Ramirez, a former PDVSA executive who is part of a watchdog group that monitors the company, said the company reported an accident rate in 2011 that was several times greater than the rate of Colombia's state oil company, Ecopetrol. The company's response has also seemed uneven. Officials backed off promises to have the refinery back in operation within two days of the explosion. And despite assurances that the fire in two fuel tanks was under control, it spread to the third tank, which burst into a huge ball of flames, sending National Guard soldiers, journalists and bystanders running.

The article reported that critics said that there might be a lack of maintenance. The article also reported that PDVSA's income is used by the government to pay for increasing levels of governmental expenses, including military spending, infrastructure projects and social welfare programs. Roger Tissot, an energy consultant based in Canada, said the financial strain on PDVSA in recent years has caused cash flow problems. This might be a root cause to the lack of resources for maintenance. A PDVSA report said it had planned nine major maintenance operations last year at the Amuay refinery but postponed six of them. Planned maintenance projects at other refineries were also postponed. Iván Freites, a union leader who works at another refinery in the same complex, said his union had complained since last year about problems with damaged equipment, lack of spare parts and other unsafe conditions.

Possible root causes:

-lack of maintenance

-lack of investment

-loose safety standard

5. Euronews

This article dated 25 August 2012 reported that the perceived cause of the explosion was a gas leak.

Possible cause:

- gas leak

6. Fox News

The article dated 25 August 2012 reported the possibility of early warning systems failure at the country's main Amuay oil refinery as residents reported there had been a strong smell of gas before Saturday's deadly explosion but no action was taken. People living close to the refinery have spoken of a dense fog-like cloud descending in the days before the huge explosion. According to Mario Theis, an operations manager in the Amuay, "The smell of gas could be normal close to a refinery, especially on a windless day like Friday, but [this] wasn't. At the first hint of a gas leak sirens should go off and all access roads get closed. It didn't happen." According to Gente del Petroleo, an organization of retired oil executives, since 2003 there have been 79 accidents in the Paraguana refining complex, where 19 workers have died

and 67 have been gravely injured. The article also mentioned that the Amuay refinery was scheduled to undergo nine maintenance shutdowns but only two were conducted because of lack of parts.

Possible root causes:

- early warning system failure

- lack of maintenance

7. The Economist

The article dated 1st of September 2012 reported that many locals noticed an unusual smell that lasted for several days in late August. According to Ramon Salas, it is “like a gas or something, it hurt the nostrils and made us feel dizzy”. The article also reported that over 200 homes and a dozen businesses were severely damaged or destroyed. The barracks of the national guard troops charged with perimeter security was levelled, killing at least 20 soldiers.

It was the worst disaster in the history of PDVSA, the state oil monopoly, and one of the worst refinery explosions ever. Firefighters took more than three days to extinguish the blaze from storage tanks ignited by the blast. Ivan Freites, leader of the local oil workers’ union, said the disaster could have been avoided. He said the union had complained of damaged equipment, leaks and lack of repairs. Furthermore, it is reported that investment and maintenance of the refinery have taken second place to the government’s appetite for oil revenue. Even Ramírez, PDVSA’s president, admitted that much essential maintenance had been postponed “owing to lack of parts”.

Possible root causes:

- unusual and unnoticed gas leak days before the incident

- improper proximity of homes and communities to the refinery area

- damaged equipment, leaks and lack of repairs

- insufficient investment in maintenance

8. The Guardian

This article dated 26 August 2012 reported that More than 200 homes are reported damaged by the shockwave. Nearby residents claimed that strong smell of gas and fog-like haze hung in air days before the explosion. Mario Theis, an operations manager in the Amuay complex, commented that "At the first hint of a gas leak sirens should go off and all access roads get closed. It didn't happen." However, president Hugo Chavez denied the claim of leaked gas by saying, "there is no way that there could have been a gas leak during three or four days and that no one did anything."

Possible root causes:

- improper proximity of local community to the refinery

- early system warning failure

4.3 Findings from Venezuela Local Sources

To obtain more information about the incident, local sources are investigated:

1. El Universal (major Venezuelan Newspaper)

According to an article titled “Explosión en Amuay deja hasta ahora más dudas que certezas”(Amuay Explosion leaves far more questions than answers) written by Ernest J. Tovar on October 24,2012, there is still no official release of any form of formal investigation report of the incident. PDVSA initially reported that the gas cloud was formed from leakage in block 23 of olefin tank farm without details such as how long the oil was leaking or the volume of leaked oil. This information is vital to determine the cause of the tragedy and to further develop a safety protocol.

A probable cause of leakage is due to an under maintained of mechanical pump seals in the areas TK-208 and 209. A technical worker stated that a transfer of olefins and propane-proplylene from Amuay refinery to Alkylation Cardon refinery an hour and 40 minutes before the explosion revealed a flow pressure loss which would be an evidence of leakage of olefins. The lack of actions in response to this only concurred to the loose safety protocol.

According to another article titled “Amuay conduce al fraude” (Amuay leads to fraud) written by Fernando Ochoa Antich on September 9, 2012, the incident occurred due to a violation of security protocols in which the automated system to prevent and control accidents have failed due to lack of maintenance. The article then continues on with political reasoning of government reaction towards this incident which will not be discussed in this section.

Probable root causes:

- lack of maintenance

- lack of safety awareness

- loose safety protocol

2. El Tiempo (Venezuelan Newspaper)

According to this article titled “Petroleros dicen que investigación en Amuay llevará al menos un mes”(Petroleum research of Amuay will take at least one month” dated August 30,2012, the explosion was due to a gas leak that ignited in storage yard known as Block23, affecting nine of 608 tanks of the complex.

3. La Patilla

According to this article titled “MCM: 80 días después de Amuay aún el gobierno no tiene respuestas” (MCM: government still has no answers for Amuay after 80 days) dated November 13, 2012, government has not came out with an investigation report on the incident despite it has already been 80 days after the explosion. According to Congresswoman Maria Corina Machad, three official reports are well overdue. She also suggested that this incident has not generated lessons to be learnt and applied in changing maintenance policies of local the oil industry.

4.4 Findings from Independent Websites

1. The Global Barrel

I analyzed an article written on this website where its topics are based on global oil system's economics and geopolitics. This article discusses aspects of the incident such as its sequence, possible causes and so on. It condemns the design of the refinery for the death and injury of all victims outside the refinery's area. It suggests that people beyond the facility perimeter should not die or suffer significant injury when an accident happens. One worker died within the refinery area while the remaining 40 to 47 death should not have taken place as they are away from refinery area. The dead included about 20 members of a national guard engineering unit who were repairing the local airport plus several of their family members staying with them at a nearby barracks which is situated outside the compound's perimeter.

The article suggests that the fact that 40-47 people died outside the southeastern perimeter of the refinery complex, and beyond the road there, demonstrates that the buildings they died in were built within the potential blast radius of high-vapor-pressure, liquefied-gas tanks inside the facility. In other words, the community is too close to the tanks and it should not be so. The article also mentions that some observers feel that a national guard post is a "special" case where one might accept such risks. But, the fact is that the blast wave traveled far beyond the guard post before dissipating, well into a residential and commercial neighborhood where it caused injuries, building damage and fires. Besides the dead, over 80 people from this residential and commercial region, located to the southeast of the Amuay facility were injured. The author suggests that this is a fundamental facility design problem.

Figure iv. Amuay refinery (in highlighted red area) located next to local community (Photo: wikimapia)

The article also talks about the possibility of deferred maintenance and mismanagement which cause this disaster. There were constant postponement and cancellations of scheduled shutdowns for regular maintenance at Amuay over the past five or six years. The author has even asked PDVSA personnel about refinery "efficiency" and was given a typical sarcastic-retort response of "What efficiency?". The author also suggests that this accident at Amuay is but one in a series of all-too frequent accidents at Venezuelan refineries over the past five years or so. According to the author, this is due to managerial incompetence and deferred maintenance corresponding to industrial policy. The article then goes into specific: "this general failure is due to, first, the loss of skilled technical and managerial personnel; the unwillingness of the Bolivarian state, for sectarian political reasons, to trust the most capable universities to rapidly train new personnel after the 2002 strike and 2003 anti-Chavez coup-events; and due to the unsustainable over-diversion of PDVSA revenues to clientelist social programs".

Possible causes:

- improper proximity of local community and national guard barrack to the refinery

- deferred maintenance

- mismanagement

- inadequate in skilled technical and mangerial personnel

2. La Verdad

According to an article titled “Amuay: Investigación marcada” (Amuay: Researched marked) written by Rafael Perez Pina on September 6, 2012, only three out of nine scheduled plants shutdowns were carried out in 2012. There was also an increase in the rate of accidents gross measuring the number of work injuries in million man-hours from 0.5 in 2003 to 9.4 this year. Operational expertise and meritocracy in PDVSA is significantly decreasing. It has failed to meet the industrial security protocol set by international standards, resulting in compromise of the safety operation in the facility. Decreased investment has also caused insufficient maintenance.

Possible causes:

- lack of maintenance

- lack of investment

- loose safety protocol

4.5 Key Findings

Based on the analysis of the sources that I have gathered and few speculations of my own self, below are the root causes of the incident, divided into technical and organizational factors.

4.5.1 Key Technical Findings

1. Faulty refinery design

- The refinery is built too close to homes and businesses which make the local communities vulnerable to damages incurred by refinery accident. It should be a secluded area in which explosion occurred should be contained in the refinery.

- The national guard barrack is built too near to the refinery resulting in deaths following the explosion. It should not be built within the blast range of any possible explosion that might occur in the refinery.

2. Faulty detector system

- Failed warning system. Leaked gas for few days remained undetected by the authority in which no measurements were taken.

- Failed detection of leaked gas which caused the explosion. Safety measurements to detect gas leak and prevent accidents did not activated on time or perhaps not even implemented.

3. Lack of supervision on storage tanks area

- More supervision and investment are provided to higher risk distillation processes area, neglecting the importance of such factors at lower risk storage tanks where the explosion occurred.

4. Lack of safety and maintenance standard

- Obvious maintenance flaws noticed by workers and the public. Only two out of nine scheduled operation maintenance are carried out due to lack of parts.

- Damaged equipment, leaks and lack of repairs.

- Lack of safety awareness. Workers and management have low safety awareness resulting in careless maintenance of the refinery.

5. Inadequate in skilled technical and managerial personnel

- Loss of skilled personnel by distrusting universities to train its personnel.

- Lack of skilled and experienced worker to suspect the possibility of leaked gas when loss in flow pressure was noticed.

4.5.2 Key Organizational Findings

1. Lack of investment

- Investment that should be put into maintenance is diverted into governmental activities, resulting in insufficient funds to ensure the safety and optimality of the refinery. For example, lack of monetary resources is reflected in lack of parts.

2. Ignorant management leadership

- Complaints of nearby residents about leaked gas days before the explosion were neglected by the authority.

- Complaints of workers about lack of parts and damaged parts were neglected.

3. Lack of learning culture

- Refinery authority did not learn from previous accidents by neglecting lessons that could have been learnt.

4. Lack of assessment

- The refinery did not administer effective assessments of policies and organizational management which impacted process safety.

4.5.3 Non-Technical Findings

Based on few sources that I have obtained, it is suggested that the incident may be politically related. These factors are grouped under this segment because they are sensitive issues which relate directly to Venezuela's political conditions and thus may not contribute to risk management of the oil industry especially oil refinery operations in other countries.

The complete articles are attached in appendices A and B. Below are the extracted points of argument from the articles:

1. Venezuela-Syria fuel exchange

Figure v. Oil tanker Negra Hipolita (Photo: convenientflags.blogspot.com)

This is discussed in the article of "Amuay refinery disaster: Syrian naphtha & Chavez' "petroleum revolution" in flame" posted on August 30, 2012 on the website of The Global Barrel.

Under economy sanctions from western countries, Syria's economy is badly hit. In order to support Syria's armed forces of President Assad against the people's uprising for democracy, Venezuela President, Hugo Chavez, sent three shipments of diesel fuel to Syria in exchange of

naptha which is contained in tanker “Negra Hipolita”(naptha is the feedstock in production of olefin). Considering the full capacity of the ship, it could have delivered 340,000 barrels of Syrian naptha in which the fraction of the fuel ended in Amuay’s storage tanks remain unknown. It is also unknown whether the imported naptha is of any faulty quality which leads to the explosion. However, one thing is certain- the naptha has been burnt off completely in flames.

2. Suspected U.S. Sabotage

Figure vi. Colombian President Manuel Santos (L) shakes hands with a US special forces during their training of Latin American soldiers at the U.S. military base in Tolemaida, Colombia on June 10, 2012(Photo: Getty Images)

According to “Venezuela’s Oil Refinery Blaze: Seven Good Reasons to Suspect Sabotage” written by James Petras on the website of Axis of Logic on August 31, 2012, the explosion may be another sabotage carried out by US operative for political purpose. The article proceeds by providing seven arguments for such claim.

Firstly, it suggests that US benefits from the destruction of lives and oil production of Venezuela. The economy loss put a dent on social spending and delay productive investments to increase

Hugo Chavez's reelection as president on October. At the mean time, Chavez's rival, Henrique Capriles Radonski who is supported by US, launched a propaganda blitz to discredit the role of government in providing security and safety to the citizens. The explosion also creates insecurity and fear among sectors of electorate and thus might influence their voting. US's effectiveness of a wider destabilization campaign can also be tested out through this incident. The government's capacity to respond to further threats would also be tested.

Next, U.S. has special forces operations in over seventy-five countries including Venezuela. The capture of a US marine for illegal entry in Venezuela with prior experience in warzones of Iraq and Afghanistan is suggestive.

Thirdly, U.S. has been involving in the violent destabilization of Venezuela by backing the military coup in 2002 and the bosses' lockout in the petroleum industry in 2003.

Fourthly, U.S. has a well known history of sabotage and violence against incumbent adversarial regimes.

Furthermore, sabotaging Venezuela's oil refineries is within the logic and practice of current global U.S. foreign policy which uses force, violence and destabilization campaigns against incumbent regimes.

The changing domestic politics in which Obama regime escalated military policies is also another factor affecting this incident. Washington has been channeling millions of dollars via NGO's to the Venezuelan opposition for electoral and destabilization purposes. This is an act of Obama regime to demonstrate that he can be as militarist as the Republicans to win votes.

Lastly, this incident would impose negative impact on President Chavez's 20 percentage point advantage over his rival. A blow to Venezuela's recovering economy can be impactful. Without the chance of defeating Chavez electorally nor the chance of imposing economic boycott, this sabotage may be a necessary step for US supported rival of Chavez to gain the authority of a president electoral voting on October. Nonetheless, if this was really a mean to pull down Chavez from his presidency, it has failed as Chavez has won the voting and was reelected to a third six-year term as president of Venezuela.

5.0 Root Causes Derived From Both Analyses

Table 1(on page 32) shows the comparisons of the root causes from the two incidents. Root causes are grouped based on the respective incidents. The numbering of the root causes is based on the exact numbering of technical finding and organizational finding discussed in previous sections. Non-technical findings are omitted as they do not contribute much to refinery safety as political conditions differ according to region or country.

The highlighted cells in blue color represent similar root causes derived from analyses. These common root causes of two different incidents happening at different countries need to be emphasized as important factors to be considered in risk management and safety standard of oil refinery. They comprises of factors that are often neglected in safety culture and therefore are always the underestimated factors which contribute to the possibility of an oil refinery accident.

From the figure, it is obvious that faulty refinery design, lack of safety and maintenance standard and inadequate in skilled technical and managerial personnel comprises of the top prioritized

technical findings. Faulty refinery design refers to the physical location of refinery in which safety should be prioritized by considering its proximity to local community and its placement of buildings (temporary/ permanent). Lack of safety and maintenance standard conforms to the violation of internationally set standard, resulting in inadequate safety measurements, lack of contingency response and faulty equipments. Next, inadequate in skilled technical and managerial personnel result in less comprehensive supervision and execution of the operations, eventually compromising the safety parameters involved.

On the other hand, most important organizational findings include lack of investment, ignorant management leadership, lack of learning culture and lack of assessment. Insufficient fund invested in the refinery results in under maintained equipments due to lack of parts and lack of resources to repair damaged parts. This is fatal to the safety of the production and storage operations. Ignorant management leadership is also another organizational failure: lack of response and considerations of consequences from the refinery leadership expose the refinery to vulnerable threats such as accidents and workers' dissatisfaction. Lack of learning culture refers to the ignorant inability to analyze and learn from previous accidents so that valuable lessons can be applied towards improving well-being of the refinery. Lack of assessment on the company's policies, organizational management and safety protocol results in the failure to form effective management leadership to keep up with the latest safety applications.

Root Causes	Incidents	
	BP Texas City Explosion	**Venezuela's Amuay Refinery Explosion**
Technical Causes	1. Failure in tower level indicator system	1. Faulty refinery design
	2. Failure in control board display	2. Faulty detector system
	3. Lack of supervisory oversight and technically trained personnel during the startup process	3. Lack of supervision on storage tanks area
	4. Poor communication between supervisors and operators	4. Lack of safety and maintenance standard
	5. Poor consideration of operator's condition	5. Inadequate in skilled technical and managerial personnel
	6. Inadequate in operator training program	
	7. Outdated and ineffective procedures	
	8. Lack of cautionary measurement	
	9. Lack of safety in relief valve system	
	10. Neglection of safety standard	
	11. Faulty refinery design	
	12. Ignorance on previous accidents	
	13. Ineffective implementation of pre-start up safety review policy	
Organizational Causes	1. Lack of investment	1. Lack of investment
	2. Lack of supervision on safety culture	2. Ignorant management leadership
	3. Deluded performance rating	3. Lack of learning culture
	4. Deficiency of mechanical integrity program	4. Lack of assessment
	5. Improper work ethic	
	6. Lack of reporting and learning culture	
	7. Flaws in safety campaign	
	8. Ignorant management leadership	
	9. Lack of assessment	

Table 1.Root causes derived from both analyses.

6.0 Recommendations

Based on the derived root causes of the accidents, I came upon the conclusion of some recommendations that might aid in preventing accidents and increase the standard of safety culture in oil refinery. Below are the mentioned recommendations with their reasoning:

1. Assessing refinery design in terms of safety of workers and nearby community.

A good refinery design should include an area, best secluded from local community, in which any occurring accidents would not affect the local community. If this is not possible, as many refineries are built nearby local community to provide ease of commutation to their worker, then a contingency plan in which any occurring accidents would be contained in refinery area should be researched and applied. Furthermore, buildings or processing units or storage tanks in the refinery area should have defined distances between them so that an occurring accident such as fire would not affect the surrounding units and worsen the conditions.

2. Invest in safety training programs

Other than training workers to learn proper safety procedures, it is very important to raise the safety awareness in refinery. Safety training programs and safety drills should be held regularly and sometimes on unexpected days to ensure every personnel in the refinery is well aware of the risk of their work and the surrounding.

3. Reward workers based on performance

Performance mentioned should include safety awareness, work ethics and the performance of assigned tasks. Clear rewarding system should be created to provide positive reinforcements to

any worker who is performing excellently and seriously in upholding safety and maintenance standard of the refinery.

4. Invest in technical training programs

Other than safety training, every worker needs to be trained rigorously to perform a specific task assigned. The operation and maintenance standard of each process in the refinery must be scrutinized and supervised carefully so that all workers are well qualified to perform their jobs. Advanced technical program should be held to improve workers' applicable knowledge so that they understand their jobs clearly and are able to response to any suspicious factors that might occur in their daily routines.

5. Streamline organizational and operational management

Eliminate unnecessary positions especially in operational management. The communication between supervisors and operators should be kept simple and clear. Clear job aspects and authority should be given to any particular worker so that he/she understands her power and responsible clearly, resulting in efficient and effective communication in the refinery.

6. Assessing and updating safety measurements and operation procedures

Equipments should be assessed at a timely manner in which repair should be done immediately to any damaged equipments. Any newly recommended safety procedures and applications should be considered to be applied to refinery to eliminate any outdated and ineffective safety measurements. Any improved operation procedures should also be analyses and considered to replace outdated ones to increase efficiency and effectiveness.

7. Implementing risk-management mindset

All managerial and operational personnel should be trained to have high cautious awareness about risk management. Management should be constantly reminded to consider risk management in any decisions to be made. Operational personnel should also be trained to have such awareness. Any complaints should not be taken lightly and should be investigated thoroughly to avoid any possible threat or damage.

8. Analyze previous accidents and apply lessons learnt

Form a new task group or let the risk management team analyze previous accidents including major and minor ones to avoid repeating the same mistakes and to apply lessons learnt so that safety of the refinery is strengthen.

9. Allocate more investment in safety and maintenance aspects of the refinery

Allocating enough resources to safety and maintenance of the refinery assures that the refinery operates optimally at a safe level. Investment in these aspects should include enough money to buy spare parts or for contingency plans.

10. Hiring unassociated well known firm for performance rating

A performance rating from an unbiased firm would provide a clear and valid picture of the working environment and systems of the refinery. This is important to eliminate any deluded performance rating so that improvements can be done according to well defined and proved facts.

7.0 Conclusion

This research pointed out that there remains flaws in safety standard even in well know refineries. Although many refineries have established high standard of safety culture, it is critical to constantly evaluate and improve procedural and operational safety measurements to ensure safety of workers and the surrounding of the refinery are protected at all time. Safety and maintenance factors should be given more emphasize and weightage in the operation of an oil refinery. As discussed in this research, neglecting these factors resulted in tragedies involving loss of lives and huge economical loss. Nonetheless, a high standard does not equate to a foolproof standard. Thus, all workers should be constantly reminded of the risks of their works and the consequences of mistakes no matter intentional or non-intentional ones. Prevention and response plans must be researched and applied to minimize the possibility of accidents.

More importantly, the correct risk management mindset must be instilled in each of the worker so that each decision or evaluation is made critically without any deluded perceptions or biased method. Oil refinery should operate with the notion of transparent management in which all systems (especially safety management system) of the refinery are susceptible to strict inspection from many different parties. This is vital to ensure improvements on safety culture which based on well proved facts by all parties.

8.0 Appendix A

This article is posted on The Global Barrel.com dated August 30, 2012. Below is a part extracted from the original article:

"Amuay refinery disaster: Syrian naphtha & Chavez' "petroleum revolution" in flames"

E. The Unseemly Syrian Connection

One further note: It is well known that President Chavez and Minister Ramirez sent three shipments of diesel fuel to Syria to support the armed forces of President Assad against the people's uprising for democracy. However, it turns out that the Negra Hippolita, the PDVSA ship delivering this diesel, did not return empty. Reuters reported, 24May12:

A Venezuelan oil tanker is returning to Venezuela from Syria with a cargo of naphtha, shipping records showed on Thursday, after delivering badly needed diesel early this week as Western sanctions, causing severe shortages, hurt Syria's economy. ***The tanker loaded a cargo of naphtha,*** *a refined petroleum product that can be used to make petrol,* ***from the Syrian port of Banias.*** *Satellite tracking data shows the vessel is* ***due to reach Amuay in Venezuela on June 12.***

The Negra Hipolita is the third vessel to deliver diesel to Syria from Venezuela, …. Despite its chronic shortage of diesel, Syria has long had the appropriate refining capacity to be an exporter of naphtha. [emphasis added. T.O'D.]

So, a swap was taking place. The Negra Hippolita was returned to the Amuay refinery with naphtha from counter-revolutionary Syria. That is the great scheme H. Chavez had for the Amuay refinery these past several months. And now, for his efforts, he has been invited by Iran to help it bring about an end to that civil war in the mutual interests of this three-way cabal of

politically bankrupt regimes. It is, of course, not possible to know what fraction of the naphtha in the three tanks that burned at Amuay after the explosion were imported as part of this latest petroleum diplomacy scheme of President Chavez, Looking back at my posting of 20Feb12 on PDVSA's shipments to Syria, I see the Negra Hipolita can carry 47,000 tonnes of diesel. There are roughly 7.33 barrels of diesel per tonne of weight, so that's about 340,000 barrels. Hence, the ship could have delivered up to 340,000 barrels of Syrian naphtha.

In any case, one thing is clear: the whole unseemly diesel-for-naphtha affair has ended in flames, as part of a great tragedy.

9.0 Appendix B

This is an article written by James Petras dated August 31, 2012 on Axis of Logic.com:

"Venezuela's Oil Refinery Blaze: Seven Good Reasons to Suspect Sabotage"

Introduction

Only 43 days before the Venezuelan presidential election and with President Chávez leading by a persistent margin of 20 percentage points, an explosion and fire at the Amuay refinery killed at least 48 people - half of those were members of the National Guard – and destroyed oil facilities producing 645,000 barrels of oil per day.

Immediately following the explosion and fire, on script, all the mass media in the US and Great Britain, and the right wing Venezuelan opposition launched a blanket condemnation of the

government as the perpetrator of the disaster accusing it of “gross negligence” and “under-investment” in safety standards.

Yet there are strong reasons to reject these self-serving accusations and to formulate a more plausible hypothesis, namely that the explosion was an act of sabotage, planned and executed by a clandestine group of terrorist specialists acting on behalf of the US government. There are powerful arguments to sustain and pursue this line of inquiry.

The Argument for Sabotage:

1. **The first question in any serious investigation is who benefits and who loses from the destruction of lives and oil production?**

   The US is a clear winner on several crucial fronts.

   First, via the economic losses to the Venezuelan economy – 2.5 million barrels in the first 5 days and counting - the loss will put a dent on social spending and delay productive investments which in turn are key electoral appeals of the Chávez presidency.

   Second. On cue the US joined by its client candidate, Henrique Capriles Radonski, immediately launched a propaganda blitz aimed at discrediting the government and calling into question its capacity to ensure the security and safety of its citizens and the principle source of the country’s wealth.

Third. The explosion creates insecurity and fear among sectors of the electorate and could influence their voting in the October presidential election.

Fourth. The US can test the effectiveness of a wider destabilization campaign and the government's capacity to respond to any further security threats.

2. **US Special Forces*:** According to official government documents the US has Special Forces operations in over seventy-five countries, including Venezuela, which is targeted because of an adversarial relation.

   This means that the US has operative clandestine highly trained operatives on the ground in Venezuela. The capture of a US Marine for illegal entry in Venezuela with prior experience in war zones in Iraq and Afghanistan is indicative.

3. **History of Destabilization Activity:** The US has a history of involvement in violent destabilization activity in Venezuela – backing the military coup of 2002 and the bosses' lockout in the petroleum industry in 2003. The US targeting of the oil industry involvedsabotage of the computerized system and efforts to degrade the refineries.

4. **History of Sabotage & Violence:** The US has a history of sabotage and violence against incumbent adversarial regimes. In Cuba during 1960, the CIA torched a department store and sugar plantations, and planted bombs in the downtown tourist centers – aiming to undermine strategic sectors of the economy. In Chile following the election of Socialist Salvador Allende, a CIA backed right-wing group kidnapped and assassinated the military

attache of Socialist President, in an effort to provoke a military coup. Similarly in Jamaica in the late 1970's under democratic socialist President Manley, the CIA facilitated a violent destabilization campaign in the run-up to the elections.

Sabotage and destabilization is a common weapon in the face of impending electoral defeats (as is the case in Venezuela) or where a popular government is firmly entrenched.

5. **Campaigns of Incumbent Governments:** Force, violence and destabilization campaigns against incumbent regimes have become common operation procedure in current US policy. The US has financed and armed terrorist groups in Libya, Syria, Lebanon, Iran and Chechnya; it is bombing Pakistan, Yemen, Somalia and Afghanistan. In other words US foreign policy is highly militarized and opposed to any negotiated diplomatic resolution of conflicts with adversarial regimes. Sabotaging Venezuela's oil refineries is within the logic and practice of current global US foreign policy.

6. **US Domestic Politics:** Domestic politics in the US has taken a further turn to the far right in both domestic and foreign policy. The Republican Party has accused the Democrats of pandering to Iran, Venezuela, Cuba and Syria – of not going to war.

The Obama regime has responded by escalating its military policies – battleships, missiles are aimed at Iran. He has supported Miami's demand for "regime change" in Cuba as a prelude to negotiations. Washington is channeling millions of dollars via NGO's to the Venezuelan opposition – for electoral and destabilization purposes. No doubt the

opposition includes employees, engineers and others with security clearance and access to the petroleum industry. Obama has consistently taken violent actions to demonstrate that he is as militarist as the Republicans. In the midst of a close election campaign, especially with a tight race in Florida, the sabotage of the Venezuelan refineries plays well for Obama.

7. **Venezuela's 2012 Presidential Elections:** With a little more than a month left before the elections, and President Chávez is showing a 20 percentage point advantage; the economy is on track for a steady recovery; social housing and welfare programs are consolidating massive low income support or over 80%; Venezuela has been admitted into MERCOSUR the powerful Latin American integration program; Colombia signed off on a mutual defense agreement with Venezuela; Venezuela is diversifying its overseas markets and suppliers.

What these facts indicate is that Washington has **no chance** of defeatingChávez electorally; it has no possibility of using its Latin neighbors as a springboard for territorial incursions or precipitating a war for regime change; and it has no chance of imposing an economic boycott.

Given Washington's declared enmity and designation of Chávez as "athreat to hemispheric security" and faced with the utter failure of its other policy tools, the resort to violence and, in this specific case, sabotage of the strategic petrol sector emerges as the policy of choice. Washington, by revealing its resort to clandestine terror, represents a clear and present danger to Venezuela's constitutional order, an immediate threat to the life blood of its economy and of the democratic electoral process.

Hopefully, the Chávez government, backed by the vast majority of its citizens and constitutionalist armed forces will take the necessary comprehensive security measures to ensure that there is no repeat of the petrol sabotage in other sectors, like the electrical grid. Public weakness in the face of imperial belligerence only encourages further aggression. No doubt heightened public security in defense of the constitutional order will be denounced by the US government, media and their local clients as “authoritarian” and claim that protection of the national patrimony infringes on ‘democratic freedoms’. No doubt they prefer a weak security system to ply their violent provocations. Subsequent to their decisive electoral defeat they will claim fraud or interference.

All this is predictable, but the vast majority of voters who assemble, debate and cast their ballots will feel secure and look forward to another four years of peace and prosperity, free from terror and sabotage.

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Case Study:

A Look into Venezuela Amuay Refinery Explosion and Fire

On August 25, 2012

Source: El universal

Prepared by:

Alvin Chin

Industrial and Systems Engineering (B.S.) 2014
Viterbi School of Engineering
University of Southern California

November 9, 2013

Under the guidance of Professor Najmedin Meshkati

First Draft

(Anticipated improvements: more supporting details, deeper level root cause analysis, and adding recommendations)

Contents

Tables of figures and table

Figures

Tables

1.0 Introduction

On 25th of August 2012, an explosion occurred at Venezuela's world second largest refinery- the Amuay refinery. This deadliest refinery disaster in the history of Venezuela killed more than 40 people and injured more than 80 people. It also affected nearly 520 houses near the refinery. The blast unleashed a huge fire that destroyed two fuel tanks and stopped the production at the plant. The fire later spread to another storage tank before being brought under control. At least 20 members of a national guard unit assigned to protect the facility were killed along with some members of their families. After one year of investigation, a formal investigation report commissioned by Venezuela government was published.

1.1 Details of the Incident

Date : Saturday August 25, 2012

Time : 1:10 A.M.

Location : Amuay Refinery at Centro de Refinacion Paraguana (CRP) or Paraguana Refining Center, Falcon, Venezuela.

Event occurred : Explosion and Fire in the vicinity of the Spheres of Liquefied Gases Petroleum Gas (LPG) located in the Fuel Storage Patio Block 23 of

1.2 Losses of the Incident

1. 42 death, 5 missing, 135 injuries (PDVSA, 2013)

2. Estimated U.S. $1.835 billion, with components shown below (Manufacturing Committee, 2013):

Components	Dollars in millions	%
Assets Corporation	173.750	9.47%
Inventory losses at Amuay	170.933	9.32%
Loss of earnings in Amuay (for production losses)	1,200.000	65.40%
Fire Extinguishing Control	10.272	0.56%
Third Party	234.714	12.79%
Compensation to Victims	35.237	1.92%
Environmental Damage	10.002	0.55%
Total	**1834.908**	**100%**

Table 1.Breakdowns of estimated cost (Table modified and translated from page 44 of Center for Energy Orientation's report).

2.0 Methodology

This case study focuses on exploring the possible root causes leading to the incident, focusing in terms of technical and non-technical factors of the refinery. The steps of the method are shown below:

1. Gathering and analyzing findings from different sources of information.

2. Comparing and contrasting technical and non-technical findings to discover possible commonly-agreed root causes.

3. Analyzing the findings and common root causes to explore the possible contribution factors to the occurrence of the incident.

This method is based upon the sources shown below (with heavy emphasis on the first four sources):

1. Official investigation report by Venezuela Bolivarian government
- This report, written in Spanish, is released on September 9, 2013. This is attached externally as Appendix A.

2. Technical report by the Center for Energy Orientation in Venezuela (COENER)
- This report, written in Spanish, was commissioned by opposition lawmakers and published on August 25, 2013. This is attached externally as Appendix B.

3. Research Paper of "Root Causes of Oil Refinery Accidents based on BP Texas City's Explosion and Venezuela Amuay's Explosion"

- This research paper was written by me under the guidance of Professor Najmedin Meshkati during the academic year of fall 2012. It analyzes information gathered from news media, investigation report released by U.S. Chemical Safety Board (CSB), and websites to determine common root causes that can lead to potential hazards. This is attached externally as Appendix C.

4. Risk Improvement Recommendations Update Report on Centro de Refinacion Paraguana Estada Falcon

- This update report was prepared on behalf of QBE insurance by Roger Gregory from RJG Risk Engineering based on a site visit made on March 5th to 8th, 2012 (note: this was made before the incident occurred). It is an external risk improvement update to assess the progress of recommendations made in risk engineering surveys in 1993, 2002, 2005, 2007 and 2010. This is attached externally as Appendix D.

5. PetroleumWorld.com
- Non subscription free service web site focusing on Latin America Energy, Oil and Gas industry

6. VenezuelaAnalysis.com
- Independent website dedicated to disseminate news and analysis about the current political situation in Venezuela

7. HydrocarbonProcessing.com
- Website covering technological advances, processes and optimization developments from throughout the global Hydrocarbon Processing Industry (HPI)

8. Chicago Tribune
- United States Chicago news media website

9. PanAmericanPost
- Online media outlet for news and analysis throughout the American continent

3.0 Analysis of Information Gathered

3.1 Looking at the Venezuela Bolivarian Government Official Investigation Report

3.1.1 Parties Involved

1. State energy monopoly Petroleos de Venezuela (PDVSA)

2. Attorney General's office

3. State intelligence agency Sebin

Only governmental agencies are involved in the investigation, with 17 petroleum specialists. There was no independent, or NGOs technical experts involved in the process. However, makers of David Brown bomb and Westinghouse motor were consulted.

Concern: The lack of independent investigators contributes to the possible build up of suspicions that the investigation process is biased. The possibility that the report is biased would then damage the credibility of the report in discovering real root causes.

3.1.2 Technical Findings

1. Loosened bolts – The report concludes that the root cause of the accident is the loosened bolts at pump 2601. At pump 2601, where olefin is transported to neighboring Cardon refinery, it was analyzed that there were 7 studs (screws without heads) insufficiently screwed down and 1 stud completely absent. Thus, motor vibration of the pump would cause the studs to gradually fail. The failing studs then led to an opening of at least 0.589 inch at the pump's flange which allowed for gas leakage.

The leaked gas built up and moved in south east direction towards Detachment 44 of the National Guard. It was lit by the engine of a vehicle which started up as national guards began vacating the area after being informed of the leak.

3.1.3 Non-Technical Findings

1. Appropriate Emergency Plan – The report concludes that the refinery workers, supervisors and managers took the necessary actions in reporting the emergency of gas leak and closing off of roads. They also took adequate measures to extinguish and control the eventual fire.

2. Possible Sabotage – The report concludes that the studs were intentionally made loose, leading to suspicion of sabotage. According to Rafael Ramirez, Minister of Energy and Petroleum, "the bolts were intentionally loosened… and it was a person who knew what they were doing… and they knew the specific place to intervene and produce a gas leak that would be big enough to cause major losses". (Pearson, 2013) Moreover, Ramirez claimed that "whoever did this was not suicidal" and that the bolts were left "loosened so that they would work for a while… it was not just some defective device that leaked gas" (Sosa, 2013). It was suspected that the sabotage was orchestrated by conservative opposition to dampen the popularity of late president Hugo Chavez in the lead up to October 2012 presidential election.

3.1.4 Analysis of the report

Although the report claims that the loosened bolts due to sabotage act is the main cause of the incident, it is noteworthy to point out that the occurrence of sabotage is not possible without any detrimental flaws in the organizational structure especially the security system of the refinery (figure i shows the mapping process of the analysis).

To completely secure the world second largest refining complex requires extensive and rather complex layering of security structures. Assuming that the threat comes externally and thus neglecting possible deficiency or breach of security in internal worker-organization system, it is assumed that there might be a breach in the perimeter of the refinery. Such physical breach may be caused by imperfect perimeter security. In turn, imperfection in securing the refinery perimeter can be a direct indication that the security coverage is simply insufficient or that the existing security coverage is inefficient. This leads to the following question: Is the security system structure or protocol is as good as it should be?

If it's not, would it be a good assumption to say that this might be a result of weak security management mindset and or lack of resources invested?

The questions mentioned above are very suggestive and currently remain as such. This is because the report does not provide strong supporting details of the claim of sabotage nor does it analyze and explore its security system.

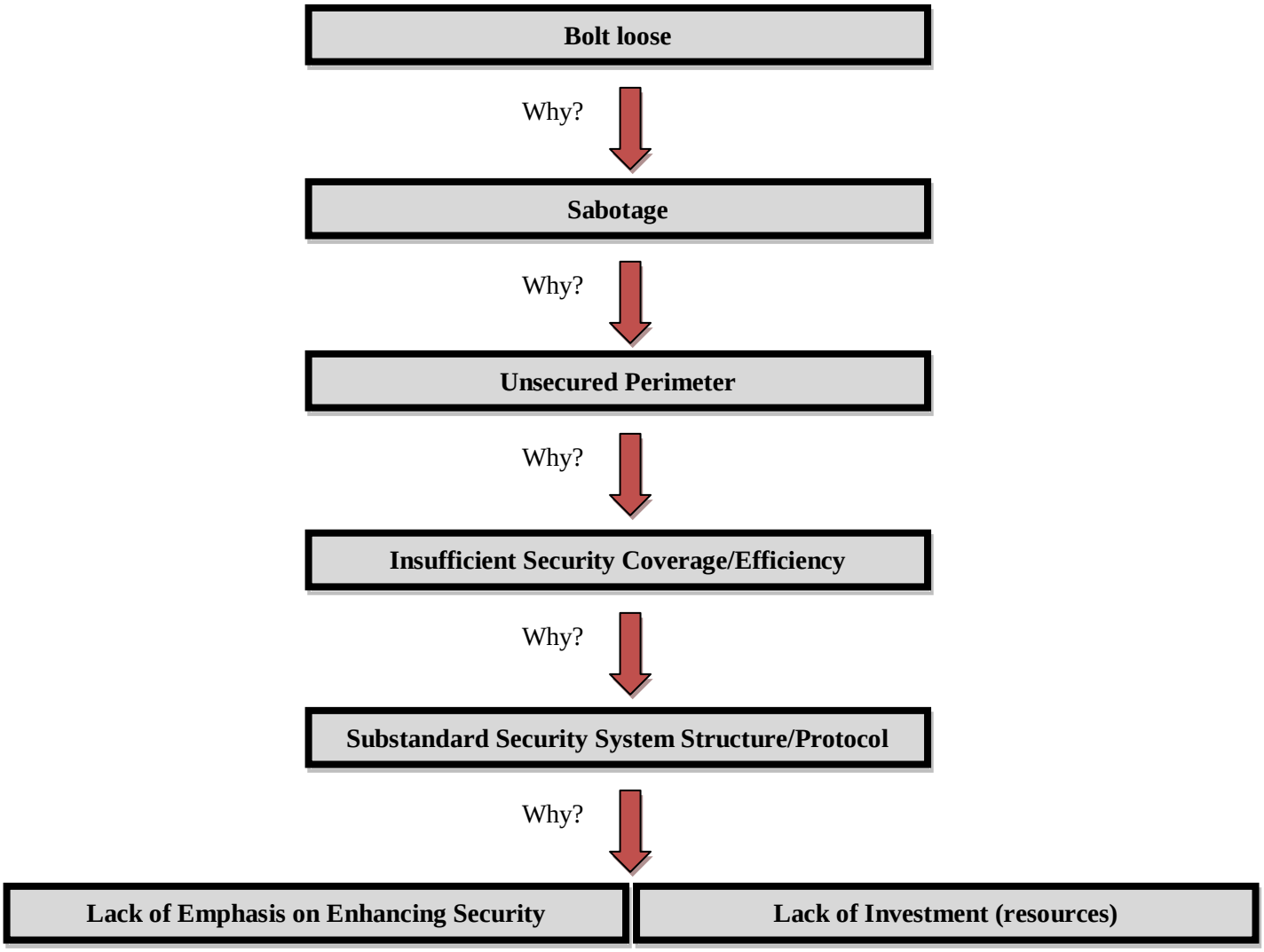

Figure i.Root cause analysis on the claim of sabotage.

3.2 Looking at the Independent Energy Orientation Center report

3.2.1 Parties Involved

1. Venezuelan oil industry professionals

2. Former PDVSA workers

This report is commissioned by opposition lawmakers and released a year after the incident, 16 days earlier than the release of official investigation report by Venezuela government. This report interviewed and consulted former PDVSA workers and independent oil industry professionals. However, this report is not recognized by the Venezuela government.

Concern: It is commissioned by opposition party and as such might be subjected to political biases.

3.2.2 Technical Findings

1. Failure of seals of mechanical pumps- The explosion was caused by the ignition of a gas cloud created by ignition of a gas cloud created by uncontrolled release of Olefins. The leak was most likely caused by the collapse of the seal of one or more of the mechanical pumps P-200 A or B or C, which is located at the foot of the TK areas 208 and 209 in block storage B23. The aforementioned gas cloud spread over a large area, causing the phenomenon known as "exploding gas cloud on unconfined space ".

2. Lack of cooling tanks- The fire was spread to several other oil tanks in Block 23 and 24. This is probably caused by gas leakage produced by the vaporization of part of the oil content in the tanks. The gas was leaked through defective mechanical seals on the roofs. The lack of timely cooling tanks in the vicinity of the affected area prevented effective cooling of the gas.

3.2.3 Non-Technical Findings

1. Alarms were not activated – According to testimony from local residents and statements of workers and managers of the companies, the gas was present in the atmosphere for several hours before the explosion. In addition, according to the statements and records of refinery performance, it is confirmed that there was uncontrolled release of gas in Block 23, at approximately 12 pm on Friday, August 24, 2012 (approximately 1 hour before explosion). However, alarms were not activated and eviction of the adjacent areas was not carries out. The only action taken was to block the valves manually at the leak site, which was fruitless given the magnitude of the leak and the high concentrations of gas in the environment.

2. Failure to learn from previous accidents– There were precedents for gas leaks and fires in the refinery. One of the reports of the insurance company documents the occurrence of approximately 100 fires during 2011, in which the majority of these are outstanding for research. In general, PDVSA accident indicators in recent years show an increasing trend, with figures significantly high and well above international averages. This highlights the possibility of the refinery's inability to comply with appropriate standard of the Culture of Safety, Health and Environment.

3. Inadequate contingency management – The report states that the actions and measures taken by PDVSA in the area during the detection of leaked gas and further control and extinguish of fire and care for affected people are ineffective.

4. Flawed evacuation plan – There are failures detected in the evacuation plan which might have resulted in increased number of victims.

5. Incompliance of standards during firefighting process – Flaws in compliance of LOPCYMAT (law of prevention, condition and working environment) and PDVSA standards and practices of contingency management during the fire fighting process involving tanks of liquid hydrocarbons.

6. Lack of effective measures to reduce operational risks – PDVSA's records of accidents subsequent to 25th of August 2012 5, 2012 show that the company had not taken effective measures to reduce the levels of risk in their operations.

3.3 Looking at the research paper of "Root Causes of Oil Refinery Accidents based on BP Texas City's Explosion and Venezuela Amuay's Explosion"

This report was written based on outdated sources gathered a year ago. However, much useful information based upon witnesses' remarks, official statements and professionals' comments can be constructive to explore the root causes of this incident. However, it is noteworthy to mention that the report's analysis of Amuay explosion incident was built solely on the gathering of data from news media, websites and my own speculative reasoning. As such, it might not be entirely conclusive or accurate.

3.3.1 Technical Findings

1. Faulty refinery design – The refinery was built too close to homes and businesses which make the local communities vulnerable to damages incurred by refinery accident. It should be a secluded area in which explosion occurred should be contained in the refinery. In addition, the National Guard barrack was built too near to the refinery resulting in deaths following the explosion. It should not be built within the blast range of any possible explosion that might occur in the refinery.

2. Faulty detector system – Leaked gas for few days remained undetected by the authority in which no measurements, or at least no effective/ noticeable measurements, were taken. Safety measurements to detect gas leak and prevent accidents did not activated on time or perhaps not even implemented.

3. Lack of supervision on storage tanks area – More supervision and investment were provided to higher risk distillation processes area, neglecting the importance of such factors at lower risk storage tanks where the explosion occurred.

4. Lack of safety and maintenance standard – Obvious maintenance flaws were noticed by workers and the public. For example, only two out of nine scheduled operation maintenance were carried out due to lack of parts. It was also reported that there were damaged equipment, leaks and lack of repairs.

5. Inadequate in skilled technical and managerial personnel – There was loss of skilled personnel in which universities were distrusted to train the refinery's personnel. The lack of skilled and experienced worker was apparent when nobody was reported to suspect the possibility of leaked gas when loss in flow pressure was noticed.

3.3.2 Non Technical Findings

1. Lack of investment – Investment that should be put into maintenance was diverted into governmental activities, resulting in insufficient funds to ensure the safety and optimality of the refinery. For example, lack of monetary resources was reflected in lack of parts.

2. Ignorant management leadership – Complaints of nearby residents about leaked gas days before the explosion were neglected by the authority. Complaints of workers about lack of parts and damaged parts were neglected.

3. Lack of learning culture – Refinery authority did not learn from previous accidents by neglecting lessons that could have been learnt.

4. Lack of assessment – The refinery did not administer effective assessments of policies and organizational management which impacted process safety.

3.4 Looking at QBE's Risk Improvement Recommendations Update Report

The result of this report is significant because it highlights few possible factors that might result in the happening of the incident 5 months after it was prepared.

1. Failure to follow up on recommendations – The report concluded that there "were 22 outstanding recommendations comprised of a total of 46 uncompleted action items" (Gregory, 2012). Although the report does mention that positive progress was observed, it still rates the "large refinery complex as 'in need of improvement' as in 2010" (Gregory, 2012). In other words, after 2 years from last survey made, the refinery's progress remains somewhat slow and requires a "stronger 'proactive' approach" (Gregory, 2012).

2. Delayed major maintenance – The report points out that major maintenance "has been seen to be suffering from delays, typically of one or two years" (Gregory, 2012).

3. Shift of preventive to corrective mindset – The report points that there was a "marked increase in the ratio of corrective to preventive maintenance" as a consequence of a significant "low" routine maintenance since 2009 (Gregory, 2012). The tendency towards corrective rather than preventive, according to the report, is also "evident in the maintenance backlog particularly for pumps and motors, and in a higher than target proportion of 'Emergency' and 'Urgent' work orders (Gregory, 2012).

4. Incomplete inspection – In term of inspection, it is reported that there was additional own-hire staff. Local contractor was responsible for on stream inspection while PDVSA own staffs were responsible for analysis works. The only concern about inspection that the report mentions is that there was no baseline inspection done for a "significant replacement and change of steel alloy" and that "the maximum 2 year cycle had not always been kept to" (Gregory, 2012).

5. Substandard firefighting equipments – In term of fire protection, the report applauses the refinery effort in refurbishing old fire trucks and getting new ones. However, it mentions that the fire pumps were "still do not comply with annual curve testing" (Gregory, 2012).

6. Improved security enhancement – For security, the department has been moved from "Operations" to the "Safety and Protection group" and the report mentions that "there are (were) investments in progress to automate the access control system, the inter-site communications, to improve perimeter lighting and to build the National guard a new 'Reaction Centre'" (Gregory, 2012).

7. Lack of commitment in learning culture – Lastly, the report uncovers the fact that incident investigations, despite having "good procedure", were not through enough in the sense that only "few had progressed past the stage of setting up a study committee" (Gregory, 2012). For example, there were 222 incidents, inclusive of some 100 fires, reported in 2011but "only 9 were 'closed', with recommendations carried out" (Gregory, 2012).

4.0 Compilation of Possible Root Causes

4.1 Compilation from Official Investigation Reports

Neglecting political biases and the actual accuracy of the reports, table 2 categorizing all findings from the PDVSA official report and COENER is constructed. These two reports were chosen as official investigation reports which are credible due to their more recent date of release and the parties involved in the making of the reports. However, in order to pinpoint flaws which contribute to the happening of the incident, positive remarks such as appropriate emergency plan is neglected.

Findings	**Technical Causes**	**Broken/Non-working Equipment**	1. Loosened bolts on pump* 2. Failure of seals of mechanical pump*
		Process Safety Regulations	3. Lack of cooling tanks* 4. Alarms were not activated* 5. Lack of effective measure to reduce operational risks
	Organizational Causes	**Reporting and Learning Culture**	6. Failure to learn from previous accidents
		Human Factors	7. Incompliance of standards during fire fighting process
		Hazard Management	8. Inadequate contingency management 9. Flawed evacuation plan

Table 2.Compiled findings from official investigation reports. (The table uses categorization criteria modified, edited and enhanced from U.S. Chemical Safety Board (CSB) safety video titled "Anatomy of Disaster")

The findings mentioned in the table do not necessary represent the root causes of the incident (especially those noted with *) because these factors are findings which have yet to be explored and related back to specific element(s) leading to their occurrence. The reason the deeper level exploration, at this point of time, is unable to be done is due to lack of clear evidences. Therefore, unless a transparent evaluation exploring the slightest details and the deepest level of factors leading to the incident is done, it is not safe to assume that the root causes of the incident are of those listed in the table.

4.2 Compilation from All Reports

By taking into account PDVSA official report, COENER's report, my research paper, and QBE's update report, table 3 that suggests possible root causes of the incident is constructed (note that * is still accounted in the table).

From all the information gathered, it is especially alarming that some of the equipments of the refinery are not maintained regularly and broken ones are not replaced with newer ones. In addition, continuous irregular and delaying of the maintenance operations only deteriorate the safety environment of the refinery.

In term of refinery geographical design, there is insufficient "buffering" area in which accidents of any sort can be contained in the refinery area. The fact that many of the national guards and their families die is a direct result of the overly proximity of National Guard barrack to the refinery. Furthermore, the devastating damages done to local homes and businesses stand as another proof that the breached safety of the refinery will translate as a direct damages to the local community.

What's more alarming is the ignorance of the management leadership towards the importance of lesson-learning from previous accidents. The management fails to analyze previous accidents, which include at least 100 fires, and come up with improvements on the safety of the refinery. More importantly, the management fails to initiate the actions to implement recommended plans. Moreover, the management's ignorance towards external responses such as resident's complaints of leaked gas stands as another factor that leads to extremely dangerous accidents.

Next, incompliance of protocols such as fire fighting standard procedures decreases the effectiveness in managing hazards such as fire and may also be another factor indicating the deficient training of involved personnel. Inadequately trained technical and managerial management may lead to ineffective safety maintenance which may also result in substandard procedures in managing accidents. In fact, the shift of preventive mindset to a corrective one is an indicator that the management does not put heavy emphasis on improving safety culture for averting risks. Instead, the management focuses on recovery actions, which is effective only for short term.

The hazard management of the accident also highlights the drawback of a recovery mindset – having less prepared to manage a sudden accident. The refinery is not prepared enough to have an effective combative plan to manage and control the fire and the evacuation of nearby residents. In fact, no alarm is sounded when the gas is leaked.

The organizational management seems to underestimate the gravity of having strong and sturdy safety culture, at least in the refinery complex. They lack the effective measure to reduce operational risks and to

have regular safety assessments. They also have dead corners in which there is a lack of supervision at the storage tanks area.

Root Causes	**Technical Causes**	**Broken/ Non-working Equipment**	1. Loosened bolts* 2. Failure of seals of mechanical pump*
		Process Safety Regulations	3. Lack of cooling tanks* 4. Alarms were not activated* 5. Irregular and delayed operation maintenance
		Refinery Geographical Design	6. Overly close proximity to local homes and business
	Organizational Causes	**Reporting and Learning Culture**	7. Ignorance on previous accidents 8. Ignorance on previous recommendations 9. Ignorant management towards local residents' complaints
		Human Factors	10. Incompliance of standards during fire fighting process 11. Inadequately trained technical and managerial personnel 12. Shift of preventive mindset to corrective mindset
		Hazard Management	13. Inadequate contingency management 14. Flawed evacuation plan
		Risk Management	15. Lack of effective measure to reduce operational risks 16. Lack of regular operational assessment 17. Lack of supervision on storage tanks area

Table 3.Compiled root causes from all reports

5.0 Conclusion

This incident acts as an alarming indicator that point out many organizational and technical flaws of the refinery. The publication of the report by the refinery itself which does not explore the possible root causes from organizational perspective translates to the lack of transparent self-evaluating mindset. This may result in deluded safety performances, which will act as a barrier to hinder the progress of safety culture in the refinery. Such barrier, if not eliminated, creates inaccurate perceptions of the working environment safety to workers, supervisors, managers and senior executives of the refinery. Such perceptions may then result in the involvement of biases in each decisions made. The end result, unfortunately, in this case study is the direct loss of 42 precious lives and immense physical and physiological damages to both the refinery and the local community.

Therefore, it is of top priority to maintain a clear risk management mindset in each of the workers of the refinery especially the management. The management leadership should carry out a total analysis of the refinery by concentrating on its human, organizational and technological factors to pinpoint any potentially lethal flaws. More importantly, the management should instill strong feedback system by encouraging all employees "to cultivate a questioning attitude and a rigorous and prudent approach to all aspects of their jobs" and set up effective communication system by "set(ting) up necessary open communication between line workers and mid- and upper management" (Meshkati, 2007).

Lastly, the installment of preventive mindset, persistence on budget allocation for safety related factors and perseverance on continual improvements are as important as having robust risk management mindset. Though improvements require time, efforts and resources to be implemented and tested, the end result of having a strong safety culture means that there will be fewer accidents with higher workers satisfactions.

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MARY KAY O'CONNOR PROCESS SAFETY CENTER
TEXAS A&M ENGINEERING EXPERIMENT STATION

Comments on CSB's Draft Report entitled, "Regulatory Report - Chevron Richmond Refinery Pipe Rupture and Failure"

Mary Kay O'Connor Process Safety Center

Artie McFerrin Department of Chemical Engineering
Texas Engineering Experiment Station
Texas A&M University System
College Station, Texas 77843-3122

Contact: Dr. M. Sam Mannan, PE, CSP
Phone: (979) 862-3985
e-mail: mannan@tamu.edu
http://process-safety.tamu.edu

January 3, 2014

Comments on CSB's Draft Report entitled, "Regulatory Report - Chevron Richmond Refinery Pipe Rupture and Failure"

This statement was prepared by the Mary Kay O'Connor Process Safety Center (MKOPSC) at Texas A&M University. Founded in 1995, the Center conducts programs and research activities that enhance safety in the chemical process industries. Educational activities of the Center promote safety as second nature to everyone in the industry. In addition, the Center develops safer processes, equipment, procedures, and management strategies to minimize losses within the processing industry. The Center supports the U.S. Chemical Safety and Hazard Investigation Board (CSB) and welcomes opportunities to assist the CSB in its mission to improve safety in the process industry.

These comments were prepared in response to the draft report released to the public on December 16, 2103 by the U.S. Chemical Safety Board (CSB) proposing recommendations for substantial changes to the way refineries are regulated in California. Entitled "Regulatory Report: Chevron Richmond Refinery Pipe Rupture and Fire," the CSB draft calls on California to replace the current patchwork of largely reactive and activity-based regulations with a more rigorous, performance-based regulatory regime – similar to those successfully adopted overseas in regions such as the United Kingdom, Norway, and Australia – known as the "safety case" system.

Having the knowledge of past chemical release incidents is widely accepted as necessary for preventing and mitigating future incidents. The CSB plays a vital role in providing detailed investigations of such incidents. These investigations are resource intensive and given the limited budget available to the CSB, only about 7-10 investigations can be performed per year. These incidents are typically at the top of the *incident pyramid* (Figure 1), that is, a small number of incidents with severe consequences. It is equally important that incidents with lesser consequences, but those that are more numerous, also be understood. The difference between an incident with severe consequences and one without any consequences is often just chance. For example, the direction of the wind may cause one incident to affect many people and another to affect no one.

Without sufficient detail of the less significant incidents, it is impossible to put investigated incidents in context. The types of incidents, the chemicals involved, the causes and other factors are necessary pieces of information to understand what is typical of the more numerous incidents with less severe consequences. Investigations may, for example, focus on dust explosions or reactive chemicals but not provide information as to how commonly such incidents occur because the investigation lacks reference to systems of more comprehensive data collection. Knowledge of the statistical nature of the 'more numerous and less severe incidents' category also could assist the CSB in selecting the most relevant incidents to investigate in the future. Understanding what is important statistically can help government, industry, academia, labor, emergency responders and planners, health professionals, and the general public focus resources to prevent, mitigate and respond to future incidents.

The MKOPSC has long advocated a more comprehensive and better coordinated set of chemical incident reporting systems. In 1999 and 2000, the MKOPSC held several forums with a wide variety of stakeholders interested in chemical incident data. In 2007 and 2008, the MKOPSC

participated in additional forums with the goal of improving reporting. The MKOPSC has published a white paper summarizing the results of the latter entitled, "Developing a Roadmap for the Future of National Hazardous Substances Incident Surveillance"[3]. These activities have given the MKOPSC a broad perspective on the features and shortcomings of the existing data collection systems, the needs of a variety of stakeholders and various approaches to overcoming the shortcomings.

The MKOPSC also has performed research in areas such as data and text mining of existing databases. In addition, the MKOPSC has completed a number of theses/dissertations[4,5,6,7,8,9,10] in this area and with others still in progress. This research has involved developing systems for classifying equipment and their components. In some cases, these were used to code text-based data[11,12].

The MKOPSC provides the following recommendations and comments in response to the December 16, 2013 CSB report.

1. PSM is not a Prescriptive Program

The Process Safety Management (PSM) Program is not a prescriptive program. We believe that each element of the PSM program is indeed performance-based. For example, the detail in the operating procedures will depend on the risk and the extent of information needed to safely operate the plant. Similarly, each one of the other elements of the PSM program is performance-based in nature and should be implemented as such. During the rule making process for the OSHA PSM program, various comments and OSHA documents refer to the PSM standard as a performance-based standard.

Recommendation of safety case regimes for California refineries on this basis is incorrect. Instead of trying to fix / improve what we have versus adopting a whole new approach is a highly cost-intensive proposition without the guarantee of better performance. Before such a change is envisioned, much more studies and analysis needs to completed. Safety case studies are extremely detailed and time consuming, requiring a high level of process safety expertise for both the regulators and the regulatory authority. The regulators they deal with are extremely engaged and highly competent. A question we must ponder, "if we have not been able to develop sufficient and competent experts to deal with PSM, one might wonder how we will fare if we have to deal with the safety case regime."

To some extent the CSB draft report is comparing issues with OSHA PSM (and many correct) with safety cases for 'just' refineries, in a different setting (more inspectors, perhaps more competent / trained / compensated inspectors) in much less litigious societies.

2. Lack of Statistically Valid Data

In order to advance the use of any regulatory approach in the US Oil and Gas Industry, several criteria must be met. The main factors in whether or not the programs are accepted and successful include the following:

- There must be convincing statistical evidence that the proposed measures will outperform the measures they are replacing.
- There must be a fair way to implement the proposed measures in relation to the existing measures (not overregulated, not too much burden on companies to comply too quickly) as well as in relation to the differences in situations that the companies currently have (large vs. small, no one taking advantage of rules).
- There must be an economic benefit to the switch where the financial sunk costs and operating cost increase is counterbalanced by a tangible economic benefit, whether that benefit is decrease in incidents/fatalities or a decrease in cost through more efficient use of resources and innovation.

We do not believe that there is a statistically valid data set that proves the case for a change in the regulatory system based on the three considerations listed above. As additional source of information, we attach the paper (Appendix A) prepared and presented by the MKOPSC at the, "Expert Forum on the Use of Performance-Based Regulatory Models in the U.S. Oil and Gas Industry, Offshore and Onshore," sponsored by OSHA at the College of the Mainland in Texas City, September 20-21, 2012.

3. Lack of Sufficient and Competent Experts

The CSB draft report infers that a safety case regime would be better suited to implement inherently safer technology, adoption of new technology, and reducing risk through ALARP. We beg to disagree with all three assertions. It is not the safety management program (PSM or safety case study) that ultimately improves safety performance. It is actually a combination of several factors including the following:

a) Framework for creating a Best-in-Class safety culture (in this respect, we refer you to a recent paper published by the Center[13])
b) Availability of sufficient and competent experts for both the regulated entity and the regulatory authority.
c) Sufficient and competent monitoring of compliance with existing regulations. There is a wealth of learning in this regard from the ammonium nitrate incident in West, Texas.

A case in point is the use of proper metallurgy for the situation to mitigate corrosion/erosion. No one can argue that the appropriate material should be used, but we disagree that a safety case regime is more likely to identify the issue and address it properly. While we believe in evaluating inherent safety approaches, we do not believe that the science is advanced enough to "mandate" its application. In addition, how to quantitatively compare IST options is not well understood.

4. Implementation of Appropriate Metrics and Indicators

As a nation, our regulatory approach should not be based on reacting to the latest incident. Of course, incidents like the Chevron incident should be investigated thoroughly and learnings from the investigation should be factored into the regulatory programs. However, our long-term approach should be much more proactive based on a national chemical incident surveillance

system for process safety incidents. There is presently no reliable means for evaluating the performance of industry in limiting the number and severity of accidental chemical releases. There is also limited data with which to prioritize efforts to reduce the risks associated with such releases. Without this information, there are no means to measure the effectiveness of present programs or to guide future efforts.

5. Existing Detailed Data Collection Systems

The ATSDR in its Hazardous Substance Emergency Events Surveillance (HSEES) system collects by far the largest number of chemical incidents of any system for fixed facilities. They collect approximately 6,400 fixed facility incidents per year in 15 states. The ATSDR does not, however, collect incidents which consist of releases of petroleum products unless other substances also are released. Studies have shown that ATSDR collects about 40% of the incidents in the US (excluding petroleum-only incidents)[3]. Current budgetary constraints appear likely to reduce this coverage significantly. The ATSDR data collection is not limited to a particular list of chemicals and employs relatively low threshold quantities for release amounts, typically 10 pounds or 1 gallon with no lower limit for certain designated substances.

The HSEES system focuses on the health consequences and emergency response to chemical releases with limited information concerning the causes, processes, equipment and components, causes and circumstances of the event. Information collected includes type and extent of injury, medical treatment, victim demographics, population potentially affected, emergency response, decontamination, and personal protective equipment utilized.

OSHA normally investigates any incident with one fatality or three or more injuries. This typically includes an estimated 400 incidents (300 chemical and 100 petroleum) per year. These investigations typically provide the basis for the issuance of citations and are not necessarily designed to determine root causes or provide lessons learned to prevent future incidents. Nor are the results presented in any organized fashion which would facilitate systematic analysis of the chemical incidents. The time lag for making the data publicly available is about 5 years, diminishing its effectiveness. A cooperative agreement with OSHA in which they would provide detailed data about incidents they investigate would seem to impose little additional work on OSHA while providing valuable information regarding significant chemical incidents.

The EPA under the Risk Management Program requires reporting of an accident history by covered facilities. The reporting is limited however to incidents with listed chemicals, stored in amounts above a certain threshold and resulting in significant consequences. The 12,000 facilities under the program (1999 – 2004 reporting period) reported only about 300 incidents per year. The combination of restrictions imposed can result in very serious incidents, such as the 2005 BP Texas City incident which resulted in 15 fatalities, not being required to be reported because liquid hydrocarbons are not on the list.

6. Statistical Relationships of Existing Systems

While each of these data collection systems provides valuable information, collectively an overview of incidents in general or even of the most significant incidents is not provided. A well-

designed system that could capture perhaps 2,000 to 3,000 of the most significant incidents would provide a basis, in conjunction with the ATSDR system, to estimate the total number and the characteristics of chemical releases in the US. With properly designed data taxonomy, these 2,000-3,000 incidents could be well understood without the expense of full-fledged incident investigations.

The ATSDR's HSEES data can be visualized (as shown in the following figure) as a slice of the *incident pyramid* encompassing incidents ranging from small releases with no consequences to severe incidents but of course limited to the states they cover. The new CSB data would occupy the top of the pyramid. Based on the overlapping portion of these two systems it should be possible to extrapolate to understand the missing portion of the pyramid and make estimates of the number and overall impact of chemical incidents.

The EPA's RMP data is also represented in a small slice of the *pyramid* since it excludes many chemicals, requires a threshold quantity to be stored and only reports incidents with consequences.

The OSHA data occupies the upper portion of the pyramid with the requirement for reporting of one fatality or three or more injuries.

The *incident pyramid* shown in Figure 1 also illustrates the extent of overlap between the existing and the proposed data collection system. This *pyramid* is based on earlier studies conducted by the MKOPSC[14] and our quantitative estimates of incidents covered by existing databases.

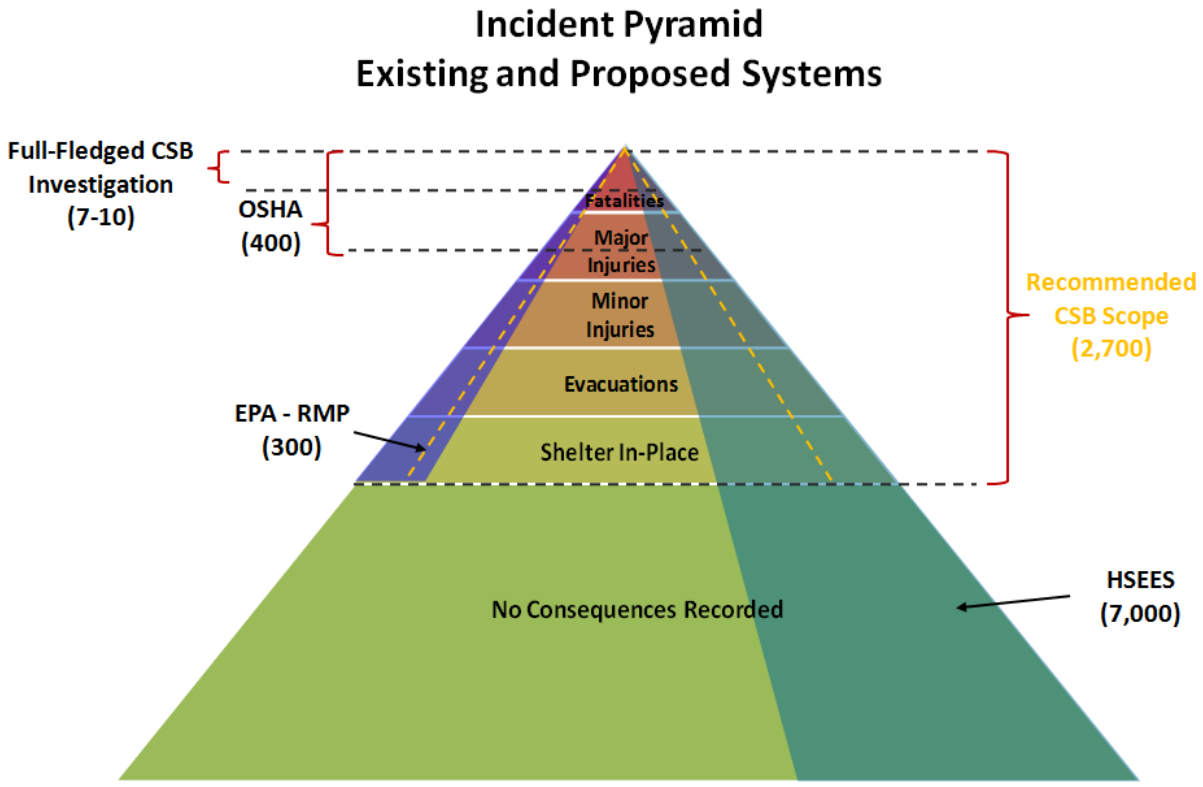

Figure 1: Estimated Total Number of Annual Incidents (30,000 or more)

The National Fire Protection Association (NFPA) is the agency primarily responsible for monitoring fires in the US. They rely on two sources of information to make national estimates of the number of fires. One source is the National Fire Incident Reporting System (NFIRS) which is a reporting system used by many fire departments to record the details of fires into a national database. Fire department participation is generally voluntary. Therefore, while this system contains millions of fires, it is not a complete or representative sample of the US. Large metropolitan fire departments are much more likely to report than are small fire departments, especially volunteer fire departments. To overcome this limitation, NFPA conducts a national stratified survey that provides information about the number of fires occurring in the jurisdiction of different sizes and types of departments. These two types of information are combined statistically to provide national estimates[15].

The HSEES system is analogous to the NFIRS system in that it has detailed reporting but is not necessarily a representative sample. However, rather than conducting a survey like NFPA the proposed CSB data collection system would provide sufficient national data to combine with the HSEES state samples to allow calculated estimates of the number of incidents with varying levels of consequences.

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APPENDIX A

The Pros and Cons of Performance-Based Regulatory Models

Dr. M. Sam Mannan, PE, CSP, DHC

Regents Professor and Director
Holder of T. Michael O'Connor Chair I
Mary Kay O'Connor Process Safety Center
Artie McFerrin Department of Chemical Engineering
Texas A&M University System
(979) 862-3985
e-mail: mannan@tamu.edu
URL: http://process-safety.tamu.edu

Expert Forum on the Use of Performance-Based Regulatory Models in the U.S. Oil and Gas Industry, Offshore and Onshore

September 20-21, 2012, College of the Mainland in Texas City

1. Introduction

As presented by May [1] a regulatory regime must provide a framework with a perfect equilibrium between control, accountability for results, and flexibility to achieve this results. Prescriptive regulatory system [2] "sets specific technical or procedural requirements that must be complied with by regulated entities". Performance-based regulatory (PBR) system [2] which is also referred to as goal-based, "identifies functions or outcomes for regulated entities but allows them considerable flexibility to determine how they will undertake the functions and achieve the outcomes".

After a series of accidents that occurred in the US, such as the 2005 Texas City Explosion and the 2010 Deepwater Horizon incident, recommendations have been made to adopt thorough performance-based regulatory regimes and develop a proactive and risk-based performance approach, taking the example of UK HSE Safety Case. However, considering the big difference between OSHA PSM and HSE Safety Case, we should be very cautious to make any immediate change and analyze this issue deeply in multiple aspects. This paper provides perspectives in the following fields: comparison of advantages and limits of performance-based regulatory approaches, how to advance of the use of performance-based regulations in the US, the status of effectiveness of current US agencies oversight and how to improve it, multiple agency jurisdiction issues and risk assessment application suggestions.

2. Advantages and Limits of Performance-Based Regulatory Approaches

Prescriptive regulatory approaches emphasize control and accountability, and performance-based regulatory approaches promote flexibility with accountability for results. These features must be acknowledged as integral parts of the discussion regarding the advantages and limits for adapting performance based regulations. The debate must consider two main points: the possibility for a long-term hazard reduction (Health, Safety and Environmental) and the utilization of resources. Based on this, Section 2.1 provides a summary of the advantages of performance-based regulatory regimes while Section 2.2 presents a review of the limits that their application implies.

2.1 Advantages of Performance-Based Regulatory Approaches

Numerous authors have provided discussions concerning the advantages of the use of performance-based regulatory regimes. The key points raised can be summarized as follows:

- Innovation and adoption of new technologies [3-7]

  The flexibility that accompanies performance-based regulations allows for a continuous improvement by means of the implementation of new technologies as they become available. This is a desired feature in order to keep up with a complex and continuously changing industry and market, where unique situations often occur. Moreover, contrary to what is a common belief, opportunities for innovation arise not only for the regulated entities, but also for the regulatory agencies. According to EPA [8], regulatory agencies are granted discretion to set performance targets within broad policy areas and to experiment with means to achieve them.

- Goal-oriented risk management system[7-8]

  The implementation of a performance-based regulatory system is accompanied by a goal-oriented risk management system. There is a more clear quantification of the performance, and any decision must then be based on the assessment of the hazards implied. Moreover, this management system will be common to all participating companies, thus allowing for unification in the objectives, communication, planning, and response to HSE-related issues.

- Safety ownership, responsibility and pro-activity [7-12]

  By means of the joint responsibility generated, traditional distinctions between regulated entities, regulatory agencies and regulation beneficiaries become fuzzier [12]. It results in a further understanding of the involvement and support necessary, and a wider use of the industry knowledge [11, 13-14]. The ownership of risk and the generated responsibility switch the focus to company's HSE objectives, abolishing dedication limitations. This provides plenty of opportunities for independent assessment and actions that go beyond minimum performance objectives.

- Potential for more efficient utilization of resources [1, 7-8, 11, 14-15]

  As a consequence of the flexibility to achieve results, the cost-effectiveness of the compliance strategies is stimulated. Companies are encouraged to innovate with cost-effective solutions [15] and proven successful alternatives applied in different locations of the world [7]. In the long-term, this will not only benefit the companies, but also their workers and the public in general.

2.2 Limits of Performance-Based Regulatory Approaches

The Regulatory Policy Program of the Center for Business and Government at Harvard University organized a workshop on May 2002, to discuss performance-based

regulations. Several government agencies and researchers from a variety of areas participated in the workshop. From the workshop, it was concluded that some of the most important criteria to consider when determining or selecting the regulatory approach include the effectiveness, efficiency, equity, clarity, and the ease and accuracy of enforcement [18]. The discussion provided in this section goes along the lines of the aforementioned report, but it also incorporates other literature sources.

- Cost increase pitfalls for companies and regulatory agencies [11, 13,14,16, 17]

  Apart from the obvious overwhelming task that the application of performance-based regulations implies, and the associated economic burden, several possible pitfalls can be identified for both the regulators and the industry. Several authors assure that an increased cost to regulators is unavoidable due to number of trained personnel that a more active regulator will demand. Some authors even point out monitoring compliance being too costly as a factor for failure [11].

- Lack of suitable metrics to ensure compliance

  One of the most widely debated issues about performance-based regulations is the lack of performance indicators for both regulators and regulated entities to measure the outcomes. Dave Drummond from the University of Wisconsin-Madison states that as long as the outcome cannot be measured, performance-based regulation should not be used [19]. He provides the diagram shown in Figure 1 to determine if performance-based regulation should be used, based on the ability to measure the outcome. However, even if the outcome can be measured, the measurements or indicators must be adequately reliable in order to provide appropriate feedback. For this purpose, performance-based regulation may be accompanied by appropriate prescriptive requirements for measuring, reporting, recordkeeping and data management [20].

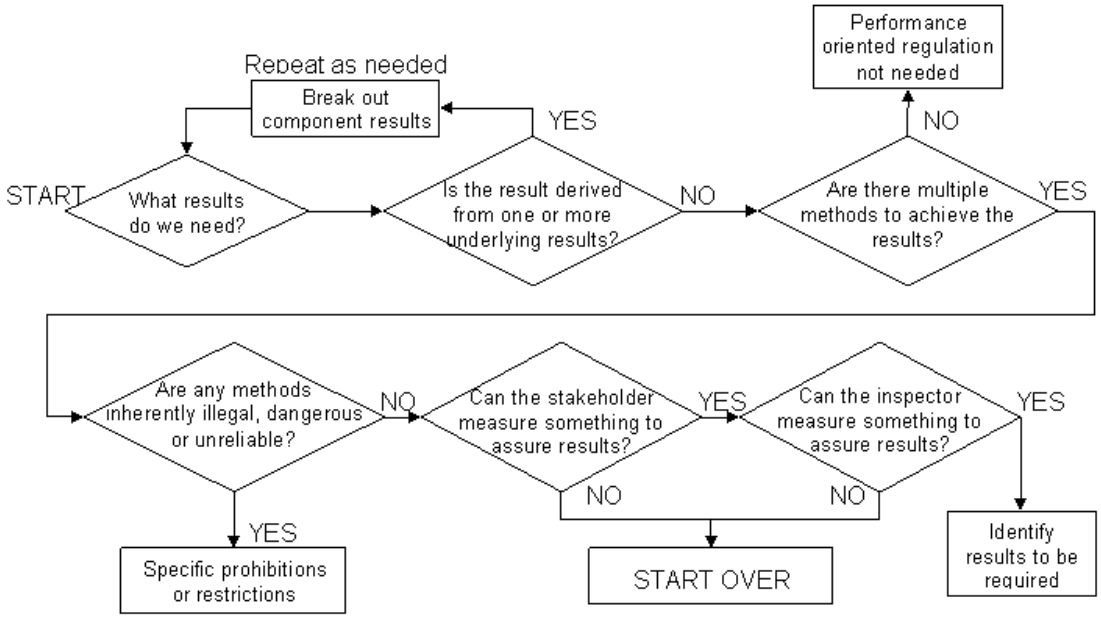

Figure 1 Process to establish performance-based regulations [19]

- Performance may be difficult to measure directly for rare and catastrophic events

  Performance-based regulations might be difficult to implement when the consequences of poor performance are very serious. In that case, the regulation must be formulated very carefully. Youngblood and Kim [20] recommend the use of objectives hierarchy for the selection of performance measurements and establishment of performance criteria. These measurements and criteria should focus on levels of performance in which the failure to meet a criterion or a given target will not lead to severe consequences or immediate safety concerns [20].

  Performance-based regulations are less desirable when used to address rare catastrophic events, such as big fires, explosions or toxic releases, as it is almost impossible to measure performance for this type of events. Instead, performance must be predicted, which causes uncertainty and difficulties in the implementation [18].

- Small companies having limited expertise or capacity for innovation

  With regard to the size of the company, performance-based regulation is usually more difficult to implement in small companies. Medium and large companies have a larger availability of resources to create customized programs to achieve the desired outcomes. They also have the capacity of developing innovative, efficient and cost-effective solutions to meet performance goals [21]. Instead, smaller companies may not have the resources to develop new programs or

processes or invest in innovation [21]. Some small companies would rather be told the process they have to follow to achieve the desired outcome instead of creating one on their own [18].

- There is no detailed understanding of the problem

  Performance-based regulations can be either tightly or loosely specified, depending on the level of discretion provided to the regulator and the regulated entity [18]. For tightly specified performance-based standards or those where a quantitative threshold is provided, it is necessary to understand in detail the cause-effect or dose-response relationships between the sources and the final objective in order to establish optimal thresholds [18]. Lack of understanding of the problem or loosely specified requirements including words such as “adequate” or “effective” [22], cause difficulty in the implementation and enforcement of the regulation.

  It is worth pointing out, that the workshop at Harvard University [18] was conducted 10 years ago. However, the challenges, and difficulties to implement performance-based regulation remain more or less the same. More research is needed to obtain data on the effectiveness of performance-based regulation as compared to prescriptive regulation in order to determine the best approach for each industry / situation.

  Overall, it is desirable to use a combination of performance-based and prescriptive regulations, in order to address a specific issue or problem [21].

3. Advancement of the Use of Performance-Based Regulation in U.S.

In order to advance the use of performance-based regulations in the US Oil and Gas Industry, several criteria must be met. The main factors in whether or not the programs are accepted and successful include the following:

- There must be convincing statistical evidence that the performance-based measures will outperform the prescriptive-based measures they are replacing.
- There must be a fair way to implement these performance-based measures in relation to the prescriptive-based measures (not overregulated, not too much burden on companies to comply too quickly) as well as in relation to the differences in situations that the companies currently have (large vs. small, no one taking advantage of rules).

- There must be an economic benefit to the switch where the financial sunk costs and operating cost increase is counterbalanced by a tangible economic benefit, whether that benefit is decrease in incidents/fatalities or a decrease in cost through more efficient use of resources and innovation.

These concepts are graphically represented in the following flowchart.

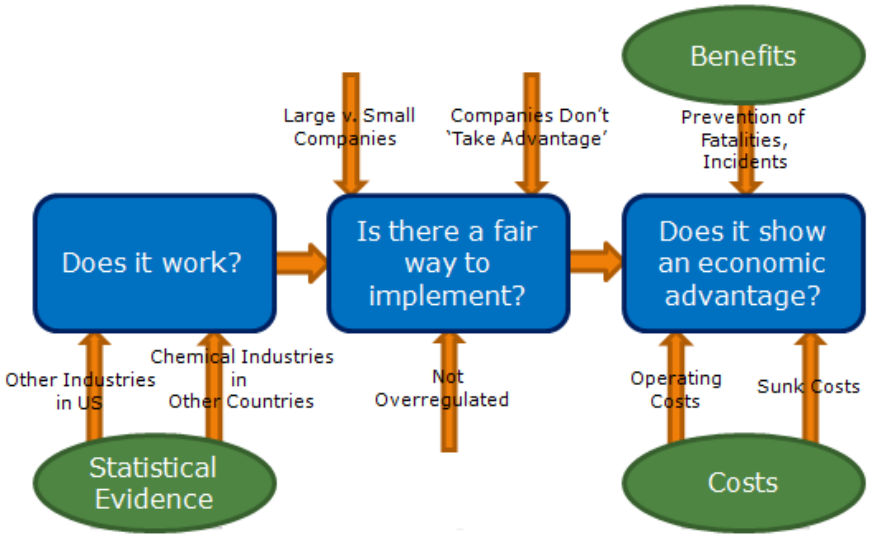

Figure 2. Advancement of performance-based regulation

These points are further discussed in the paragraphs that follow.

Statistical evidence

It is simple human nature to resist change if the change proposed does not fulfill the need it is intended to satisfy. So, it is natural to expect resistance to change from the current types of regulation if it cannot be proven that the safety performance stands a significant chance of improving. There is precedent for the advancement of performance-based regulation, both in other industries in the United States (nuclear industry and their Performance-Based and-Risk Informed regulation), and in the oil and gas industry in Europe (UK and Norway).

The question becomes, then, have these industries seen any tangible increase in safety statistics by either PSM or Safety Case? Unfortunately, the answer to this question is that it is hard to tell for several reasons (Figure 3 and Figure 4). Based upon the statistics from the UK HSE [23] and U.S. API [24], it is hard to tell whether the statistics show any real upward or downward trend.

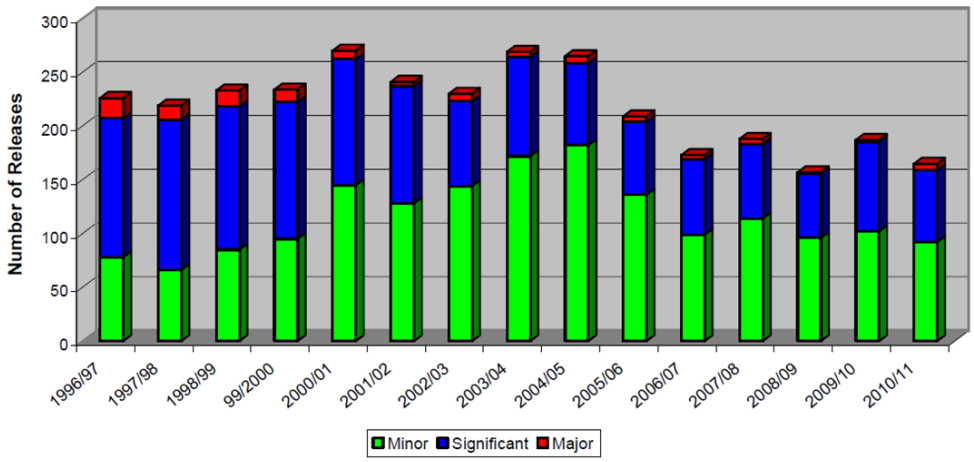

Figure 3: HSE data for offshore hydrocarbon releases in the period from 1996-97 to 2010-11[23]

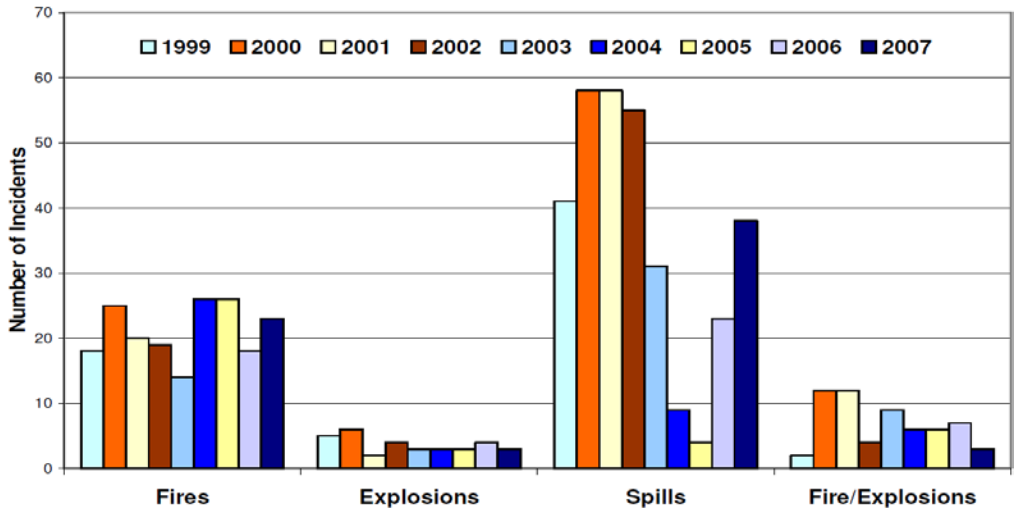

Figure 4: API Process Safety Performance Measurement Report 1999-2007[24]

If there is a trend, upward or downward, it would also be very difficult to tell whether it was due to the regulatory regime or whether it was a function of some other factor (*e.g.,* an increase in minor accidents due to better reporting or a decrease in major accidents due to more of them being reported as significant. As such, the regulatory bodies would have to prove that these gains that other industries and other countries are making are not just “smoke and mirrors” based on other influencing factors.

Finally, it is difficult to say that any trends can be taken from a mere 15 years of data, especially when the goal of the regulation is to decrease significant events that may happen once every 10, 25, or even 50 years. Furthermore, an extended amount of time

may be needed to get the programs fully implemented and working properly before results can be seen. Thus, many years of data collecting may be needed before one can conclusively state that the program is working as intended.

Is there a fair way to implement?

When PSM was first implemented and RMP was on the horizon, industry had several doubts and fears for the two seemingly overlapping regimes with new procedures for compliance. In the two decades since, many of the same fears would apply to the advancement of new regulation.

Not overregulated [25]: When PSM started and RMP was around the corner, one of the main concerns that industry had was whether or not they would be overregulated by the dual regulations. Since PSM and RMP have different aims (occupational vs. environmental), there was concern that each would be quite different although aimed at basically the same end. Thus, Andrews, speaking for industry through his paper, made several key requests:

- EPA chemicals be a subset equal to or less than the chemicals in OSHA PSM
- EPA threshold quantities be greater than or equal to the threshold quantities of PSM, arguing that if they were less, it would effectively extend PSM to operations that OSHA didn't deem it necessary for PSM to be extended to
- Exclusions for certain (unmanned low-hazard) facilities
- Recognition that compliance with PSM would constitute compliance with RMP

This shows the level of concern with what industry saw as "fairness" in overregulation. They wanted two mutually inclusive regulations that would not increase their burden, even though the regulations had different goals.

Companies don't take advantage [26]: companies, under a performance-based regime, since it is not as concrete as a prescriptive-based regime, may attempt to take advantage of the added flexibility (not in an innovative way, but in a way such that they would be 'cheating' the system).

May and Koski [26] suggest that extra education could be a helpful way to keep this from happening, basically arguing that it will lead to the owners, operators, and engineers 'owning' safety, thus making it so that they will not be morally capable of cheating. However, they also note that due to differing capabilities and willingness to learn, this may not be the most effective method.

The second method suggested was to hold engineers (and whomever does safety reviews, tests, etc.) responsible for the accuracy of the results, saying that if it is found that anything is forged or unreal they can be held legally responsible. They also take it one step further and say that engineers could be held liable for performance (whether they did a good job complying with the regulation or not). They admit that this may cause insurance costs for liability to go too high to afford, causing engineers and consultants to charge more, possibly pricing them out of a job.

The third method mentioned was a sort of peer-review process where documents are reviewed by others for adequacy. The quality of results would depend on the quality of the reviewer and how enthusiastic they are about making suggestions and questioning safety cases presented.

Large vs. Small Companies [18]: Small companies face their own specific set of challenges in the move to performance-based regulation. Coglianese, Nash, and Olmstead [18] posit that small firms may not have the resources to look for a way to achieve a performance-based goal and that it is oftentimes easier for them to do what they are told to do rather than innovate for the simple reason that they may not have the money, manpower, or time to find a better way than the prescribed method. They also point out that it is the job of the government and industry to work together so that the government can understand exactly how difficult it could be for a small firm to implement a performance-based regulation and their possible preference for a prescriptive-based regulation. In such a way, the large companies must help to protect the smaller companies from unduly strenuous regulation by an open communication with those creating the regulation.

Does it show an economic advantage ?[25]

It is simple economics that, above all else, a company (whose motive is to maximize economic return -- without that they will not stay in business) needs to see an economic benefit in order to accept new regulations. Andrews specifically mentions that many in industry believe that OSHA underestimated the cost of compliance with the new PSM system (OSHA said $810 million per year for the first five years, while Andrews argued it would be 5 times that). He also argues that though there will obviously be some economic benefit through lower fatality rates and incidents and increased reliability, industry was still concerned about trying to gain a competitive advantage (being able to gain a competitive advantage means being able to maximize economic benefit) in the face of such a large resource investment.

4. Effectiveness of U.S. Agencies Oversight

Before we transition from one regulatory regime to another, we should first ask this question: if the performance is not good enough, is it because current regulatory regime is not good or the current one has not been fully complied with? Until now, nearly every incident investigation has indicated that one or more PSM elements haven't been complied with well enough. Therefore, the first priority should be consideration of how to improve the implementation of the existing regulation oversight.

In order to improve oversight effectiveness, it is essential to identify the challenges that government agencies are facing to enforce performance-based regulations. In this section, we will discuss enforcement mechanisms and oversight effectiveness of different government agencies. Then, we will discuss potential opportunities to improve enforcement and oversight strategies for agencies using performance-based regulations, including the Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), the Pipeline and Hazardous Materials Safety Administration (PHMSA), U.S. Coast Guard (USCG), Bureau of Safety and Environmental Enforcement (BSEE) and Bureau of Ocean Energy Management (BOEM).

Occupational Safety and Health Administration (OSHA)

In 1992, OSHA established the process safety management (PSM) rule to prevent and minimize consequences of catastrophic accidents [27]. PSM provides 14 elements as guidance for the standard compliance and the company has the freedom to select the method to meet those requirements [28]. To ensure compliance, OSHA performs different type of inspections [29], including, routine inspections, screening inspections, and inspections due to an employee complaint or due to catastrophic incidents. The effectiveness of the PSM program is closely dependent on the quality of these inspections.

Beneficial effects of PSM standard have been discussed by some reports, given that the number of fatal or catastrophic events have declined from 24 in 1994 to 5 in 2005 [30]. However, it is unclear if this evident reduction on catastrophic accidents can be specifically attributed to the PSM program. Different conclusions about the standard effectiveness can be obtained depending on how the data is reported. For example, D. Weil showed that until 1993, causes of accidents were in poor agreement with the type of OSHA citations [31]. The Chemical Safety Investigation Board (CSB) has also reported failures on OSHA inspections. For instance, based on the CSB's incident report issued in 2007 [32], OSHA performed several inspections before the BP Texas City accident; however, they did not identify the likelihood for a catastrophic accident. On the other hand, H. Luo [27], showed an increased agreement of OSHA PSM inspection citations and the cause of accidents found by CSB, using data from 1992 to 2006. In general, the lack of adequate data and proper process safety indicators complicates the assessment of the effectiveness of the regulation [33].

Even if it is agreed that the effectiveness of, for example, the PSM regulation has increased over the years [27], and more training and guidance is provided to OSHA's compliance officers to perform their audits [30], some issues that still need more attention as follows:

- Improved training for OSHA compliance officers is essential to ensure quality of inspections;
- Increased inspections frequency [33]. For example, the percentage of complaints and incident-related inspections had reached almost 75% [27]; however, the percentage of programmed inspections should also increase to a larger percentage;
- Improved tracking and resolution of violations [34];
- Establish a more severe citation strategy, small penalties can reduce the incentive to accomplish standard requirements [33]; however, this should be done in conjunction with an increased correlation of citations with the actual incident and/or the potential for catastrophic incidents;
- Expand coverage of the standard enforcement, not only focus on facilities at the greatest risk of catastrophic accidents, but also include inspections of companies having a potential for accidents with high consequences and low probability [27];
- Perform a conscientious data analysis to evaluate more objectively the performance of the regulation.

The Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA) has implemented the Risk Management Plan (RMP) Rule to prevent releases of hazardous substances into the environment [28]. Using numerical risk thresholds or ranges of tolerable risk [35], this agency set the minimum requirements for developing risk management programs and the plant is responsible to define the strategy to achieve those requirements and prevent toxic releases [28]. To ensure compliance, EPA uses a variety of methods including, checklists, surveys, pre-tests and post-tests [36]. In addition, EPA has a policy called “Incentives for Self-Policing: Discovery, Disclosure, Correction and Prevention of Violations”. This policy was created to encourage the regulated entities to voluntarily discover, disclose to EPA, correct, and prevent recurrence of the environmental violations [35]. Despite EPA’s efforts to ensure effective oversight, based on the report No.12-P-0113 issued by the Office of Inspector General (OIG), EPA should improve oversight of State enforcement” [37]. EPA lacks national baselines and it has 10 regional independent enforcement programs rather than one single national workforce strategy, leading to inconsistent interpretation and enforcement actions throughout the country [37].

Additional issues of EPA oversight include the lack of details in their check lists, which can reduce the efficiency of EPA inspections [37]; delayed document and data review of state programs which can limit the use of the results for decision making at national level [37], financial challenges in some states on long-term maintenance and monitoring [37], and poor collection and maintenance of workload data/cost accounting system which can make difficult resources planning [37].

After OIG comments, EPA developed a Strategic Plan (2012–2016), to promote economy, efficiency, effectiveness, and prevent and detect fraud, waste, and abuse through independent oversight of the programs and operations of the EPA [38].

Pipeline and Hazardous Materials Safety Administration (PHMSA)

In order to monitor and ensure compliance with pipeline safety regulations, PHMSA has implemented the Pipeline Safety Enforcement Program. Compliance is monitored through federal and state inspections of pipeline operator programs, facilities and construction projects [39]. In case a violation is identified, PHMSA uses a variety of enforcement mechanisms to ensure operators take appropriate and timely corrective actions [40]. The federal government develops, issues, and enforces pipeline safety regulations, while states assume intrastate regulatory responsibilities, inspections and enforcement under an annual certification [41].

After concerns resulting from pipeline incidents in San Bruno, California on September 9, 2010, and in Marshall, Michigan on July 26, 2010, the Office of Inspector General (OIG) conducted an audit to evaluate the effectiveness of PHMSA's oversight of pipeline safety. In particular, the audit assessed inspection and enforcement activities, requirements for non-line pipe facilities and data management and analysis capabilities [42]. The audit revealed that in spite of PHMSA's inspection and enforcement program accomplishments, there are multiple issues that must be resolved in order to achieve more effective oversight. Some of the issues identified in the audit include: accumulated backlog of integrity management (IM) inspections, insufficient onsite visits to facilities, less stringent IM requirements for non-line pipe facilities, data management and quality deficiencies, lack of systematic data analysis to identify pipeline safety and accident trends, lack of capability to identify high-risk pipelines by linking data to geographic location and lack of performance metrics to monitor IM program's effectiveness.

United States Coast Guard (USCG)

In order to ensure the security of Outer Continental Shelf (OCS) facilities and deepwater ports, the USCG conducts security inspections and reviews security plans written by operators and owners of OCS facilities. During the inspections the inspector interviews security officers and ensures that appropriate security measurements are in place. Any deficiencies identified during the inspection, as well as appropriate enforcement actions

to ensure compliance are recorded in the Marine Information for Safety and Law Enforcement (MISLE) database [43].

After the *Deepwater Horizon* incident in 2010, the US Congress requested the US Government Accountability Office (GAO) to conduct an assessment of Coast Guard actions to ensure the security of OCS facilities and deepwater ports and determine additional actions necessary. This assessment also determined the limitations in oversight authority of the USCG to ensure security [43]. According to the report provided by the GAO to Congress, the USCG has conducted only one-third of the annual OCS security inspections required from 2008 through 2010 and during the same period of time, it has only inspected one deepwater port [43]. Additionally, the assessment identified serious deficiencies in the database used by the USCG to record inspections data. These database deficiencies not only limit the use of data as a tool for decision making, but they also make difficult to determine whether deepwater ports are complying with maritime security requirements or not [43]. Another issue discussed in the GAO report is the limited authority of USCG over Mobile Offshore Drilling Units (MODUs) registered to foreign countries [43]. However, after the Deepwater Horizon incident, the USCG has implemented a policy to conduct additional inspections of high-risk MODUs. This policy will increase oversight over foreign flag MODUs operating in US waters [44].

With regard to the inspections conducted by the USCG, it appears that enforcement of performance-based regulations, such as maritime security regulations, are being subject to prescriptive regulation enforcement methodologies, such as checklists [19]. Moreover, some inspectors request amendments to security plans based on their personal opinion and without appropriate justification. This is mostly due to lack of training and experience of inspectors, which has led to inconsistent interpretations and enforcement of the regulation [45].

Bureau of Safety and Environmental Enforcement (BSEE) and Bureau of Ocean Energy Management (BOEM)

BOEM and BSEE are two interdependent agencies that officially replaced Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) [46, 47]. BOEMRE had implemented a variety of measures and metrics to evaluate overall regulatory compliance performance of offshore oil and gas program. After the Macondo blowout, the offshore oil and gas industry has been moving toward performance-based regulations. On October 2010, BOEMRE adopted the safety and environmental management system (SEMS elements) based on the API RP 75 [48], except that the audits are performed by third parties. SEMS is a non-prescriptive approach[49] with the main purpose of improving safety of operations to reduce human and organizational errors and prevent accidents and oil spills [48]. In this case, one of the main challenges to ensure effective oversight is the proper development of guidelines for risk assessment and risk management. If a risk-based approach is followed, scenarios that

pose a risk with low probability and high consequences may be ignored, so the allocation of resources and planning may be insufficient if that catastrophic accident occurs. Additional issues with the SEMS enforcement effectiveness are related to the lack of numeric thresholds for unacceptable, tolerable and acceptable risk during planning and setting of standards [35], and deficient inspector training to promote safety [50].

Recommendations to improve the effectiveness of oversight

Based on the discussion presented here, some general recommendations to improve the effectiveness of oversight systems are mentioned below:

- Increase inspectors training and experience
- For overlapping regulations (*e.g.,* PSM, RMP, SEMS), develop expertise in only one agency (so that adequate number of highly trained and knowledgeable personnel are available). This would definitely lead to more effective oversight but also has the potential to reduce cost in that multiple agencies would not have to hire and train experts.
- Develop a clear enforcement methodology in order to avoid prescriptive regulation enforcement methodologies to be used for performance-based regulatory systems
- Develop performance indicators that evaluate objectively the effectiveness of regulation or oversight programs
- Target available resources based on risk of each facility
- Use special government employees (SGE's) for incident investigations, compliance enforcement and other regulatory activities
- Develop and use a carefully monitored system for certified third-party auditors
- Use of expert panels by the agencies to help facilitate the review of the effectiveness or regulations and enforcement methods

Finally, one of the most important issues identified across different agencies is related to data management deficiencies. Agencies must be able to effectively collect and analyze relevant data in order to identify trends, assess program effectiveness and provide enough information to decision makers. In this respect, a carefully planned national database system for collecting and tracking incidents is recommended.

5. Multiple Agency Jurisdiction Issues

5.1 Duplication of regulations

Reduction of regulatory overlaps is a theoretically attractive way to streamline operations and simplify compliance for industry where there may currently be situations in which similar hazards are managed in seemingly different ways. The following paragraphs explain the origin of some overlaps, advantages that could possibly be gained as well as the disadvantages that may be created in the elimination of regulatory overlap.

Origins:

Aagaard [51] has presented several ways in which regulatory overlap could occur. Overlap can occur organically, as a function of the growth of a regulatory body or as an attempt to gain more power, prestige, or oversight for a body, either because they want the extra power or because they believe they can do a better job or fill some gaps in the regulation. It can happen arbitrarily, when two regimes' missions somewhat overlap, giving them both the power to regulate like areas. It is possible that overlap may arise intentionally, such as with OSHA PSM and EPA RMP, where Congress specifically mandated that both be developed in conjunction with one another, or unintentionally when the delegating bodies are unsure which regulatory body should be responsible for what, or if there is political conflict. It could also arise from overlapping legal fields, which is difficult to avoid and nearly impossible to change in hindsight. For example, OSHA regulates employee health while EPA regulates environmental and public health. Their legal fields necessarily overlap because in many cases what is dangerous to a worker is dangerous to the public or environment, so the legal overlap could not have been avoided, nor can it be eliminated.

In some ways, this overlap could be used to the advantage of the regulators, specifically when the overlap is intentional and is meant to fill gaps in between regulatory bodies that may have similar fields but differing missions. In other ways, the overlap could be destructive, particularly when it is inadvertent and causes conflict in how to deal with compliance in industry. Thus, when handled properly, overlap can be a powerful tool in making sure that regulations cover the largest span possible while causing minimum inconvenience to industry, who must comply, report, and improve.

Disadvantages:

It is obvious that disadvantages would arise from overlap, mostly because of efficiency issues. The extent of these disadvantages depends mainly on the coordination between the regulatory bodies and the degree of the overlap. Four categories were identified by Aagaard [51] as the classical arguments against overlap:

- Duplication – a waste of resources if the functions can be consolidated or eliminated from one of the overlapping bodies, though it is not a complete waste if there is benefit to the duplication

- Conflict - opportunities for conflicting regulations, whether directly conflicting (cannot satisfy both) or indirectly conflicting (can comply with both with increased effort)

- Coordination – necessity of increased coordination between the regulatory bodies

- Complexity – difficult to monitor who is in charge of what, or assign blame for failures, etc.

Rectanus and Natalicchio [52] further posit that overlap may have harmful effects during regulatory functions such as incident investigation, stating that regulatory bodies may prefer to independently work on investigations so as not to get delayed by other bodies. They state that it may be difficult or time-consuming to have to coordinate investigations and in the end the regulators may not be able to obtain all of the necessary information or work on the timeline of another regulator. Thus, they trade the inconvenience to the operator (having multiple investigations, procuring the same documents multiple times, etc.) for the convenience of being able to work on their own terms. Other overlaps exist, such as creation and administration of training materials, development of emergency response procedures, and record-keeping.

Industry itself has also expressed concern over some of the disadvantages of duplicative and inconsistent regulation. For example, Andrews [25] in his paper on industry views of regulation in the early days of PSM stated that if a regulation (RMP) was implemented after and in conjunction with PSM and included PSM controlled chemicals at lower than PSM threshold values, it would effectively be extending PSM to sites that OSHA did not deem appropriate. This is an example where, with poor coordination, industry could have been severely affected by an overlap in regulation. Thus, care must be taken in the implementation of closely-related regulations so that a regulation is not inappropriately extended into a realm where it is not necessary.

Advantages

Perhaps counter-intuitively, there are also advantages that can be gained by these overlaps, particularly when they are intentional, well-thought out, and allow opportunity for collaboration between regulators that work in similar areas, but have differing missions and expertise.

Rectanus and Natalicchio [52] found that advantages could be gained in precisely these areas through overlap. They state that it is often reasonable to have some degree of

overlap in such closely related fields, and that it is not necessarily a bad thing if it allows for competition between agencies, better service delivery, or emergency backup. They do; however, state that overlap must be properly managed in order to retain these advantages. Aagaard [51] further states that overlap can increase reliability by reducing the number of errors in action (regulators don't act when they should have acted) and can foster policy innovation where regulators have a heightened sense of what other bodies are doing and can thus act in a more informed manner, such as making better policy decisions in conjunction with one another, and learning from the successes and mistakes of others.

Should Overlap Be Eliminated?

It is intuitive to want to eliminate as much overlap as possible, especially from the industry standpoint where this elimination could possibly result in less work, greater efficiency, and less confusion over compliance. However, care must be taken to avoid eliminating overlap that was put in place intentionally to gain the possible benefits of competition and collaboration. Thus, much as one would perform a risk analysis in a hazardous process if they were considering making a change, if overlap is to be eliminated, it must be as a result of careful analysis of the risk of the elimination.

5.2 Implement PBR uniformly by multiple agencies

Initially, it is important for every agency to determine how they are going to implement performance-based regulations individually and then uniformly across the industry. Primarily, agencies will have to develop strategic plans that cover the functions and operations of the agencies; then, they will have to identify the strategic goals and objectives. Further, a detailed description of the required resources and processes needed to fulfill the goals and objectives. Later on, the agencies will have to identify which are the factors that could affect the achievement of the goals and objectives suggested earlier by the agencies. Finally the agencies will have to describe how the performance goals included in annual performance plans will be related to the agencies goals and objectives [1, 53 - 54].

Once all the elements mentioned in the previous paragraph have been addressed, the agencies must receive feedback from the US Congress, the Board of Directors of the companies, the public and the stakeholders (as shown in Figure 5).

Congress will have to review the plan for every agency to achieve the corresponding goals and objectives and analyze the processes and resources required to meet such goals. This is necessary information for Congress to assign the appropriate budget for the agencies to fulfill their objectives. However, for this to be completed a performance

plan has to be analyzed and discussed between the agency and Congress. Some points that must be addressed in this plan are:

- Description of the processes and resources required to meet the performance goals;
- Determine which are the performance indicators to be used in measuring or assessing the relevant outputs and outcomes of each activity;
- Provide a comparison basis of the actual program results to the established performance goals [53].

Figure 5 Feedback path for the agencies

Furthermore, before this plan is given to Congress, several perspectives have to be considered. For instance, the expertise of the Board of Directors of the companies (experts), stakeholders and the public will strengthen the performance regulations by making them more achievable and realistic. Wholey *et al.* [53] proposed a six criteria methodology to grant the political, senior management and analytical support for the successful implantation of performance-based regulations. These criteria are:

- Agreement on goals and strategies by using the professional judgment of experts;

- Performance measurement systems of sufficient quality. In this respect, the national database system recommended and discussed earlier could be used to develop the performance measurement systems.

- Performance-based management systems to build the communication of the performance information to the relevant agency;

- Accountability, demonstrating effective or improved performance, and supporting policy decision making, establishing communication between the agencies with the stakeholders and the public.

Moreover, it is recommended that a proper inspection methodology for agencies to enforce regulations is established, as well as a uniform terminology across agencies and industries. Finally, a training program has to be implemented. This training should include the political and bureaucratic context for performance-based management and should focus mainly on the following issues [53]:

- Measuring, evaluating, and reporting on performance to analyze the implications of alternative policies and program approaches;

- Using performance information to support resource allocation and other policy decision making;

- Reinforcing performance-based management and building expertise in performance-based management.

6. Apply Risk Assessment in Performance-based Regulatory Regime

Risk assessment will definitely play an important role in performance-based regulatory regime if the performance objective is to control risk level within specified acceptance criteria. Additionally, it can be extended to support decision making, including design, construction and operation of Oil & Gas plants.

The objectives of a risk assessment study include [55]: (1) Evaluating risk; (2) Identifying the main contributors to the risk; (3) Defining accident scenarios; (4) Comparing design alternatives; (5) Evaluating risk reduction measures; (6) Demonstrating acceptability to regulators. For example, the risk assessment can be used to judge if the risk has been reduced to As Low As Reasonably Practicable (ALARP).

Risk assessment methodologies (qualitative and quantitative) can identify the hazard scenarios and estimate the frequency of occurrence and the severity of the consequence. In performance-based regulatory regime application, two regulatory agencies have been applying quantitative risk assessment (QRA) in the offshore

industry for decades: Norwegian Petroleum Directorate (NPD) of Norway and UK Health and Safety Executive (HSE).

The NDP issued “Guidelines for Safety Evaluation of Platform Conceptual Design,” in 1981, which was the first formal regulatory requirement for offshore QRA [55]. The Concept Safety Evaluations required by this regulation intended to control the total probability of occurrence of safety functions impairment under 10^{-4}/year [55]. This performance-based regulation targeted a specific risk criterion and was considered to produce a major improvement in Norwegian platforms. However, to enhance the operator’s management attitudes, the 1990 NPD regulations required the companies to manage safety in a systematic way, and documenting their own safety objectives and risk acceptance criteria [55]. In this way, the operators could take greater responsibility for their own operations.

Regulated by UK HSE in 1992, each operator is required to submit a Safety Case for its installations. In the Safety Case document, they should ensure that the risks of major accidents have been assessed and measures to reduce risks to the lowest level reasonably practicable (ALARP) have been taken. QRA is consequently considered as most important technique used to identify the major accident hazards and that the risks have been reduced to ALARP. HSE instructs that safety cases should demonstrate that risks in any given area are not higher than 1 in 1000 fatalities per year and that preventive measure do not result in expenditures more than £1 million (about $1.6 million). HSE also proposes applying QRA for certain situations, such as complicated plants, important stages, high inventory/pressure/temperature processes etc [56].

Several other countries have followed the Norwegian/UK approaches and recommended QRA applications, including Canada, Australia, Denmark and the Netherlands.

Some concerns that should be paid addressed to when applying risk assessment for performance-based regulatory regime [55-56]:

- The selection of risk assessment methodology should be considered cost-effectively and the rigor of assessment should be proportionate to the complexity of the problem and magnitude of risk. The risk assessment should be updated through the whole life cycle of the facility, using proper methodology. In extremely high risk situations, QRA is strongly recommended, and semi-quantitative and qualitative methodologies can be adopted for less hazardous situations.
- To ensure the good quality of the risk assessment, specific standards or guidelines should be stringently followed. The regulation should provide sufficient information about the methodology that should be applied in a specific situation

(*e.g.,* UK HSE proposes situations for QRA). The format needs to satisfy the judgment of the authorities. Sufficient confidence must be provided to support decision making.

- Risk assessment should address and/or quantify the impact of uncertainties. Uncertainty analysis is very important because the development of an accident scenario may depend on the numerous combinations of input variables. Monte Carlo simulation can simplify complex interactions of different parameters and has been considered as the most widely used technique for combining uncertainties.

- Risk presentation: expected number of fatalities per year, FAR, f-N curves. The risk presentation should be comparable with the acceptance criteria. The impact to humans can be expressed with “expected number of fatalities per year”, “Fatal Accident Rate” or “f-N curves”. Loss of safety functions can be expressed by the frequency of impairment accidents. A very important issue that needs to be addressed is that risk presentation and risk communication should be uniformly consistent across different agencies, industry and all other stakeholders.

- Risk goals/criteria: in a performance-based regulatory regime, risk acceptance criteria must be established to set performance goals. The criteria can be regulated by the authorities or the operators on their own. Especially in quantitative risk assessments, the risk estimates should be compared with quantitative risk acceptance criteria. The risk goal can be a numerical value or ALARP.

- Human factor consideration: people should also be considered as a key factor in a potential major accident, including evaluating the feasibility of various tasks, implementing control measures and training, etc. The complexity of this analysis can be based on the severity of the consequences. Human evaluation is also important to estimate the capability to implement evacuation.

7. Conclusions

For all the various combinations of agencies and regulatory programs, it is very difficult to judge which regulatory regime is more effective. To answer this question, performance data should be collected adequately and uniformly under consistent incident reporting system. Otherwise, biased data collection will always lead to incorrect conclusions.

Secondly, it has been discussed that a “one size fits all” regulatory approach is not appropriate due to the diversity of existing industries, processes and company sizes. It is therefore necessary to determine the most adequate regulatory approach to

implement according to the situation. Some situations in which prescriptive regulation is preferred are mentioned below:

- High risk situations, particularly, when there are technologies known to work well. For example, in the case of the airline industry where the consequences of an accident are severe, there are prescriptive methods to achieve the required level of safety, which have shown successful results.

- When companies have limited capabilities to develop their own approach to achieve performance targets, such as small companies. These companies would benefit from prescriptive regulations or prescriptive components given as optional guidance to complement performance-based regulations.

- Standard procedures that have little need for innovation.

- Situation where experience exists, or there is little room for innovation, a prescriptive regulation should be preferred. Instead, when the rate of change of technology or innovation is an important consideration, performance-based regulations might be desirable.

- Businesses could benefit from prescriptive components as a complement to performance standards to provide more concrete guidance.

Finally, to answer the question that if we should consider further changes in the regulatory framework, we should figure out how to improve our existing program instead of changing the whole system and allow time for existing regulations (*e.g.,* PSM) to be implemented properly. We could increase training and reinforce the regulation compliance, gradually add regulatory reform and efficiencies to the existing system, and implement overall quantitative risk assessments for plants. We should put in place a well-planned national database system to collect appropriate and statistically significant data on incidents to be able to evaluate the performance of regulatory agencies as well as the regulated entities.

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From: Carl Southwell
To: chevroncomments
Subject: Chevron Regulatory Report Draft - Public Comment
Date: Friday, January 03, 2014 7:19:22 PM

The safety case regulatory regime is touted as a “tripartite system consisting of active and equal participation from the regulator, workforce, and industry.” Indeed, a potentially, more socially beneficial regime would be a quadripartite system that includes the neighbors of the regulated facilities. The neighbors are often aware of problems that workers don't or won't address, the neighbors are the only potential participants who are continually subject to the the vagaries of the refineries, and the neighbors have an important stake in the refineries' safe operation.

The neighbors of oil refineries in Southern California are subject to a psychological linear no-threshold scenario. While there is hormesis insofar as such facilities employ some of their neighbors, there is also the cumulative stress of millions of people living near facilities that are constantly subject to very low probabilities of catastrophes. In part, this is due to management and safety practices that have been conditioned by decades of relatively rigid and irreversible land use laws and zoning (including the absence of sunset provisions (i.e., “grandfathering”) on exempted standards and regulations) and endemic regulatory antipathy to strict rules with meaningful penalties for noncompliance.

In the case of grandfathering, the original rationale was that significant, sudden regulatory change hurts existing facilities and discourages future investment. Arguments centering on “fairness” and “economic feasibility” (e.g., it is less expensive to implement pollution controls at the time of new construction rather than as a retrofit) were developed to favor the owners of infrastructure. In retrospect, some obvious problems emerged. By creating a regulatory environment favoring existing facilities, grandfathering has perpetuated perverse incentives to keep aging facilities open. Protecting such assets has meant downplaying public safety, deferring maintenance and upgrades, and operating less efficiently. Instead, when an area’s zoning changes or when safety and health regulations are updated, the implementation of grandfathering, at least with respect to public safety and environmental compliance issues, should either be eliminated or strictly delimited in scope and time. As such, improved land use regulations are part of the pathway to safer refineries.

And, wherein the proposed safety case regulatory regime is a vast improvement over the status quo, an enhanced regulatory approach might also include the implementation of weak and strong precautionary principle regimes with respect to two (new) classes of refinery:

1. A weak precautionary principle regime (similar to the Rio Declaration principles) would apply to new refineries or existing refineries that had undergone a risk analysis, cost-benefit analysis, and the implementation and approval of these analyses' recommendations. These analyses would be conducted by regulators (or their agents) and funded by the owners.

2. A strong precautionary principle regime (similar to the Earth Charter principles) would apply to existing refineries.

Concurrent with the implementation of these regimes, new indemnification and liability provisions would be implemented. Indemnification would be unlimited and, in certain instances (e.g., gross negligence or willful conduct), inure personally to management, officers, and board members. Acceptable liability insurance limits would be determined during the risk analysis and cost-benefit analysis process.

Such changes would help describe and delimit the intent and scope of what “ALARP” means in this new context, would assist in transitioning from PSM to safety case regulation, and would set the stage for fuller implementation of an updated, comprehensive regulatory regime partnership between the state and federal governments which eventually covers all aspects of the oil and gas industry.

Best regards,

Carl Southwell

carl.southwell@gmail.com

From: Tim Smith
To: chevroncomments
Subject: Comments on Chevron Regulatory Report
Date: Friday, January 03, 2014 4:58:27 PM

CSB Board,

I am a Chemical Engineer with many years of experience. I am employed by an engineering company that has several refinery clients, but these comments are my own, and have not been reviewed by my employer.

After reviewing the Regulatory Report, I believe there is a need for a broader explanation of the technical issues concerning the role of silicon in the corrosion resistance of carbon steel, and how this relatively short section of off-spec pipe went undetected for so long. I am hopeful the CSB will release an additional factual or technical report in the future. The Interim Investigation Report seems to indicate the majority of the remaining carbon steel pipe (A106) containing adequate silicon levels would have easily made it to the next maintenance turnaround without failure.

I know many people who work in refinery operations, and I often visit live operating units as part of my work, so I have a personal interest in process safety. However, I am not convinced that public involvement in a politically charged process is the best answer.

For example, there was a proposal that I believe originated from a public advocacy group to consider the use of 316 Stainless Steel (316 SS) to replace the failed pipe at Chevron because of its superior corrosion resistance. I recall that in a very carefully worded statement (no longer available on the CSB website), the CSB seemed to partially endorse the idea that this proposal should be considered. The CSB statement did not rule out 316 SS on the technical merits as it should have. The idea then went through a political process with the Richmond City Council with additional debate that was incompetent in my opinion.

As the technical experts at Chevron correctly stated, 300-series stainless steels are highly susceptible to stress corrosion cracking (SCC) which is very difficult to detect by routine inspection, and they should never be used in any application where SCC is a possibility. Better materials are available. In most applications A106 carbon steel is a better choice than 316 SS. Although grades 321 SS and 347 SS are used in some areas, 316 SS is very rarely if ever used in critical applications. This fact is well known in the industry, but the statement from the CSB became part of the politically charged atmosphere in Richmond with advocacy groups making claims that are not accurate.

Another issue is the reporting that 15,000 people “sought medical treatment due to the release”. Local media reports are that fewer than 20 were hospitalized, and all who were admitted had preexisting conditions. Photos and videos tend to show the smoke from the fire was at higher elevations in the atmosphere, and air monitors at ground level did not show significant levels of any hazardous substances in the city of Richmond. Ironically, local media reports reveal that in downwind cities such as Martinez and Benicia, where the smoke plume eventually reached the ground and people could smell the smoke, there were

no reports of hospital visits in these communities. I am hopeful that an additional factual report will address the issue of why so many people went to the hospital perhaps due to the effects of fear and anxiety.

There is no question that refinery safety is a vital concern. There is also a concern in the public about the price of motor fuels with many people under the mistaken belief that refineries have huge profit margins. Cost is an interest of public concern and cannot be ignored in the pursuit of risk reduction. Currently, most refineries balance these concerns during the Process Hazard Analysis (PHA) and Management of Change (MOC) process with some form of risk ranking that acknowledges zero risk is not possible to achieve, and that resources should be directed where they are most effective. This risk ranking process also has the ability to identify issues that are urgently critical and require immediate attention or must be corrected regardless of cost. It is my experience that Operators who work rotating shifts are involved in this MOC risk ranking process. It is not clear what role an outside regulator would have in the day to day MOC process in an operating refinery under the proposed regulatory scheme. Consistent rules for risk ranking applied industry wide to improve a system that is already working may be more practical and rational than a massive new regulatory bureaucracy with inherent uncertainties and inefficiencies.

It is my experience that refineries take the issue of process safety very seriously. Everyone who works in the industry, especially management, is in favor of improved process safety. Accidents do not benefit anyone involved in any way. I firmly believe that safety improvements should primarily involve people with the most knowledge and experience within the industry rather than politically motivated people from outside the industry who could do more harm than good. In effect, this regulatory proposal is an insult to the very dedicated people who work in these refineries that regulators are needed to make them more effective. Proposing the use of 316 SS in a refinery application where SCC could develop is an example where limited knowledge in the hands of a regulator with authority could lead to a tragic mistake.

I believe the contribution of the CSB to investigate accidents and make recommendations is an extremely valuable resource to the public and to the people who work in the industry. However, I have what I believe are legitimate concerns with this regulatory recommendation that has the potential to take technical authority away from the people with the most knowledge and experience and put it into the hands of politicians and regulators who may not be fully competent.

Tim Smith

Comments of the United Steelworkers International Union on the U.S. Chemical Safety and Hazard Investigation Board's Draft December 2013 Regulatory Report on the August 6, 2012 Fire at the Chevron Refinery in Richmond, California

January 3, 2014

The United Steel, Paper and Forestry, Rubber, Manufacturing, Energy, Allied Industrial and Service Workers International Union (USW) welcomes the CSB's most recent draft report on the August 6. 2012 pipe rupture and fire at the Chevron Richmond Refinery. We especially appreciate the Board's willingness to look beyond the details of the accident itself, and examine how the regulatory system might be improved. We have an important stake in this issue. Our union represents the workforce in 71 U.S refineries, including Chevron Richmond. Our members also include thousands who face the risk of catastrophic accidents in chemical plants, metal processing and other workplaces. No other union, and no company, has been involved in as many investigations by the CSB, OSHA under the Process Safety Management (PSM) standard, or EPA under its Risk Management Program (RMP) regulations.

The CSB draft report notes that the federal and California PSM standards (and, by extension the RMP rules) "function primarily as reactive and activity-based regulatory schemes," and that they do not adequately account for "advancing best practices and technology." (p. 9) This is not entirely true; OSHA has used the PSM standard to cite employers who fail to follow "recognized and generally accepted good engineering practice" (RAGAGEP). However, OSHA has not enforced – and probably cannot, enforce – the more protective imperative to reduce risks to "as low as reasonably practicable" (ALARP). And although federal OSHA implemented a national emphasis program in the oil industry, many refineries escaped inspection because they were in states which administer their own OSHA programs, or were exempt under the Voluntary Protection Program. OSHA's resources do not permit a PSM inspection of more than a small fraction of high hazard operations in any given year. The situation in most state plan states is even worse. There is no requirement that refineries – or any other employers – seek OSHA approval for a new and potentially dangerous process. There is a requirement that such processes be evaluated, but the evaluations are given to OSHA only on request. In fact, facilities which meet the PSM criteria are not even required to report their existence to OSHA. EPA at least requires that Risk Management Plans be submitted to the Agency, but it does not evaluate or enforce them.

The CSB report advocates a different regulatory system requiring covered facilities to generate a "safety case report," outlining how risks will be reduced to as low as reasonably practicable. The report is then reviewed, audited and enforced by the regulatory agency, which would have the power to require changes to the safety case and to punish an employer who did not follow their own approved safety plan.

We commend the CSB for putting forth the safety case approach as a possible model for the regulation of high-hazard facilities. The draft report provides a very good overview of the advantages of a safety case system, and how the system operates in other countries and in the U.S. jurisdictions that have adopted elements of it. Yet as the report itself suggests, there are a number of serious issues that need to be resolved as the discussion moves forward.

Resources: The draft report states that in a safety case system, the safety case reports are to be "rigorously reviewed, audited and enforced by highly technically competent inspectors with skill sets familiar to those employed by the industries they oversee." (p. 9) There is no question that this will require considerably more resources than the present system. The best examples of safety case regimes are in offshore oil, but an offshore oil rig has fewer processes and much less equipment than a large oil refinery. An OSHA-required Process Hazards Analysis (PHA) for a refinery can occupy several filing cabinets. Management of Change (MOC) documents are written almost daily. A regulator would need a large staff to keep up. The folly of adopting a safety case approach without the resources to properly implement it is shown by BP's infamous 2009 plan for mitigating an oil spill in the Gulf of Mexico, which listed walruses as a species to be protected, and which the regulators clearly never read.

The draft report uses the Nuclear Regulatory Commission as an example of safety case system. Every reactor plant governed by the NRC has two resident inspectors. Many additional NRC specialists are also available for inspections, audits and document review. Of course, the number of safety case inspectors would depend on the number of covered facilities, but oil refineries are not the only high-hazard plants. In addition, as the report makes clear, staff salaries would have to be substantially increased for the regulator to compete with the regulated.

These are not arguments against the safety case approach; the cost of one catastrophic accident could easily exceed the cost of the additional resources. But the lack of resources is an obstacle to overcome for the safety case system to work. One way to overcome it would be fees on covered employers. The fee structure that passed the California legislature last year is a step in the right direction, but considerably more funding would be necessary for a full safety case system.

Defining ALARP: OSHA has used the concept of RAGAGEP in a number of PSM enforcement cases. This has usually led to contested citations, where the employer challenges OSHA's definition of RAGAGEP in a particular situation. ALARP sets a higher standard, but it is even more open to dispute because it depends on what is "practicable," rather than on measures that are already in use at other locations, or which are recommended by a consensus group. Of course, the NRC uses the ALARA (substitute "achievable for "practicable") principle, but not without challenge. American reactors are far more homogenous than oil refineries, let alone high-hazard chemical plants, and have fewer processes. It will take a great deal of thought and effort to craft a system that gives clear guidance on what is ALARP, without succumbing to the inflexible rules-based approach that safety cases are intended to overcome.

To give just one example, the USW and other organizations have repeatedly warned against the risk of a large hydrogen fluoride release from a refinery using the chemical as a catalyst in the alkylation process.[1] Fifty American refineries use the process; two are in California. Across the U.S., more than 26 million people risk death or serious injury from catastrophic accidents in hydrogen fluoride alkylation units. Proven technologies exist for reducing the risk somewhat.[2] Technologies which fully eliminate the risk exist at the pilot stage. Presumably, ALARP would require the implementation of proven technologies. Would it also require the research necessary to move a pilot stage technology forward, for a hazard of such magnitude? Who would make that decision? And how?

Workers and Their Representatives: In its analysis of the Chevron Richmond fire, the CSB discusses "significant evidence that workforce participation could have reduced the likelihood that unchecked corrosion would lead to the August 2012 incident." (p. 79) One example cited in the report is concern repeatedly expressed by the United Steelworkers local union about sulfidation and broader safety issues. (p. 78) The CSB goes on to recommend that California adopt, as part of a safety case framework, a "tripartite model where the regulator, the company and workers and their representatives play an equal and essential role in direction of preventing major accidents..." (p. 90) Such a model is an essential part of the regulations in Norway and the UK.

The USW strongly endorses a tripartite approach, not only for safety cases but for safety in general. Unfortunately, the CSB itself has sometimes failed to promote an equal voice for workers and their representatives. After the 2005 BP Texas City explosion, the CSB recommended that the American Petroleum Institute and the United Steelworkers work together, presumably as equals, to develop consensus standards on fatigue and on metrics for refinery incidents. The API insisted on a process in which USW was consistently outvoted by more than a dozen oil companies. After months of frustration, we declined to participate further. Nevertheless, the CSB found the API's response to its recommendation to be "acceptable."

Accountability: Too much of the media coverage of the Chevron fire focused on the alleged failings of Cal/OSHA. Cal/OSHA did not cause the fire; Chevron did. Unfortunately, the draft report strays into dangerous territory in the way it describes the roles of the regulator and the regulated. "The existing regulatory regimes...(p)lace the burden on the regulator to verify compliance with the regulations rather than shifting the burden to industries..." (p. 12). "The safety case regulatory regime...shifts risk management responsibility to the company..." (p. 20).

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[1] See, for example, the USW's April, 2013 report "A Risk Too Great," at http://assets.usw.org/resources/hse/pdf/A-Risk-Too-Great.pdf

[2] That technology, called "modified HF," adds chemical to the hydrofluoric acid which limits, but does not eliminate its dispersion in a release. The technology has never been fully tested, and it might fail altogether if the acid was lofted by a refinery fire accompanying the release. Both California refineries use this technology.

Risk management has always been the responsibility of company. The safety case approach is different in that it requires the company to demonstrate how it plans to meet that responsibility. But it does not shift the responsibility for safety. Nor does it take the burden of verifying compliance away from the regulator. In fact, it adds to that burden. Federal OSHA and Cal/OSHA will continue to do programmed and complaint inspections to verify compliance with specific regulations. The safety case approach adds the job of verifying compliance with the safety case report.

The increased resources required by an effective safety case regime, coupled with enhanced participation by workers and the union, might have caught and corrected the factors that led to Chevron fire before the fire occurred. But it is hard to see how enforcement would have differed under a safety case regime. Six months after the fire, Cal/OSHA issued 25 citations to Chevron with a total penalty of $963,200. Most of citations were for Chevron's failure to follow its own written procedures and the recommendations of its engineers. Had a safety case system been in place, the same citations would probably have been issued, the only difference being that they would have been issued for failure to follow the safety case, rather than failure to comply with the PSM standard.

A safety case system might help both Cal/OSHA and the regulated industry do a better job. But it should not change their respective roles. In fact, there is a danger that Cal/OSHA might be partially blamed in the media or even in the legal system for an accident in a plant where the company was in compliance with an approved safety case. But even with increased resources, a regulator will never have the intimate knowledge of equipment, processes, work practices and conditions that facility engineers and managers do. The fact that a regulator has "approved" a safety case report must not relieve the employer of liability for accidents. The burden of assuring a safe facility must always remain with the facility operator.

To summarize, the safety case approach has considerable advantages. We commend the CSB for its analysis and its recommendations. However, a great deal more work needs to be done before a safety case system can be fully considered as a regulatory model for California or the United States. That work should continue. One way to do so would be through a panel of stakeholders and experts. The draft report does an excellent job of describing the problems inherent in the current regulatory system, and the advantages of the safety case approach. It is equally important to consider the difficulties of the approach, and how they might be overcome. The panel could benefit from a detailed study of past accidents in refineries and other high hazard workplaces, and how a safety case regulatory system might have prevented them. The ultimate goal would be to describe how a safety case system might be implemented, not only in California, but nationwide. California provides an important example, but as the CSB is a federal agency, its work should have a national focus.

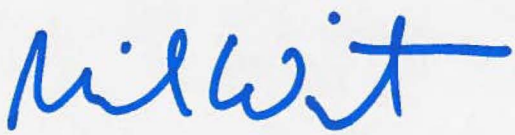
In the meantime, we cannot let the perfect be the enemy of the good, or forgo useful incremental changes in the search for a more major change. There are many

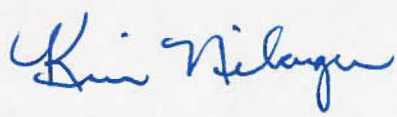
things that federal OSHA and Cal/OSHA can do to improve the regulation of oil refineries and other high-hazard plants short of adopting a full safety case framework. These include modifying the PSM standard to include reactive chemicals and explosive solids, eliminating the PSM exemption for retail establishments (such as the West, Texas fertilizer plant), modifying the VPP rules to allow PSM inspections at VPP sites, adopting measures against operator fatigue, requiring PSM-covered facilities to report their existence to OSHA, and requiring the reporting to OSHA and EPA of a broad range of incidents affecting safety, even without an injury. These steps would be useful even if a safety case model is ultimately adopted. Some have already been recommended by the CSB.

EPA could take perhaps the most significant step toward a safety case approach and overall risk reduction by using its authority under Section 119 of the Clean Air Act to require a consideration of inherently safer technology. We hope the CSB's forthcoming third report on the Chevron Richmond accident will address this possibility.

Again, the USW commends the CSB on the December 2013 draft report. We look forward to the continuing discussion of these important issues.

Respectfully submitted,





Michael J. Wright
Director

Kim Nibarger
Specialist

United Steelworkers
Health, Safety and Environment Department