

#### Kuwait International HSE Conference & Exhibition

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# Safety Economics and Sustainable Performance -Risk Based Implementation of Safety Measures

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ADVANCING CHEMICAL ENGINEERING WORLDWIDE



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## Costs of Lack of Safety

- Business costs
  - Plant rebuilding
  - Loss of production including future orders
  - Loss of reputation
- Regulatory costs (fines)
- Litigation/Compensation



#### Examples of Property Loss 2012/13 (from Marsh Inc)

Date	Plant Type	Event Type	Location	Country	Property Loss
05/05/2012	Petrochemical	Explosion/fire	Map Ta Phut	Thailand	US\$ 140 x 10 <sup>6</sup>
07/04/2012	Refinery	Explosion/fire	Bangkok	Thailand	US\$ 140 x 10 <sup>6</sup>
08/25/2012	Refinery	Explosion	Falcon State	Venezuela	US\$ 330 x 10 <sup>6</sup>
04/02/2013	Refinery	Flooding/fire	La Plata, Ensenada	Argentina	US\$ 500 x 10 <sup>6</sup>
06/13/2013	Petrochemical	Explosion/fire	Geismar, Louisiana	US	US\$ 510 x 10 <sup>6</sup>
07/01/2013	Upstream	Sinking	Atlantic Ocean, offshore	Angola	US\$ 240 x 10 <sup>6</sup>
07/23/2013	Upstream	Blowout	Gulf of Mexico	US	US\$ 140 x 10 <sup>6</sup>





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## **Compliance Framework**

- "Identify and apply all relevant good practice precautions whether they be inherent safety, prevention, control or mitigation measures, and whether they relate to hardware, systems of work, or people and their behaviour.
- Identify what further measures might be adopted and show that they are not justified (or are justified, as the case may be) on the basis that the monetary value of the safety and other benefits that would accrue are grossly exceeded by the costs of implementing that measure, the depth of the analysis being greater in higher risk situations.
- Maintain the system by means of measuring performance, audit and review."





## Compliance Framework – The 'Whats'

- What first? Good engineering practice, codes and standards
- What if? HAZID, HAZOP etc

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- What then? Source terms and effects modelling
- Then what? Frequency modelling and vulnerability assessment
- So what? Comparison with criteria
- Do what? Identification of further measures and cost benefit analysis
- What else? Ensuring the process stays safe using audit, review, KPIs, learning from accidents/incidents









From: HID Regulatory Model, Safety Management in Major Hazard Industries < http://intranet/hid/hid-regulatory-model.pdf> Contains public sector information published by the Health and Safety Executive and licensed under the Open Government Licence v1.0

#### Valuing Harms Averted (by not having accidents)

- Human
- Environmental
  - Natural
  - Built
- Other
  - Reputation
  - Loss of Permits etc





## Valuing Human Harms Averted (UK)

Harm	Values (2003 Q3)
Fatality	£1,336,800 (times 2 for cancer)
Permanently Incapacitating Injury	£207,200
Serious Injury	£20,500
Slight Injury	£300
Permanently Incapacitating Illness	£193,100
Other Cases of III Health	$\pounds$ 2,300 + $\pounds$ 180 per day of absence
Minor Illness	£530

 Full Definitions of Categories of Harm at: http://www.hse.gov.uk/risk/theory/alarpcheck.htm



#### **Other Data Needed**

- Policy on Discounted Cash Flow
  - Benefits 1.5% maximum
  - Costs 3.5% maximum
- Future Years of Plant Operation
  - Can be uncertain
- Bias in Favour of Safety?
  - UK 'Gross Disproportion'





#### Example

- Consider a chemical plant with a process that if it were to explode could lead to:
  - 20 fatalities
  - 40 permanently injured
  - 100 seriously injured
  - 200 slightly injured
- The rate of this explosion happening has been analysed to be about 1 x 10<sup>-5</sup> per year, which is 1 in 100,000 per year. The plant has an estimated lifetime of 25 years.
- How much could the company reasonably spend to eliminate (reduce to zero) the risk from the explosion?



# Example (continued)

Harm Type	Number	'Value'	'Frequency'	'Plant Life'	'Total Value'
Fatalities	20	£1,336,800	<b>10</b> <sup>-5</sup>	25	£6684
Permanent injuries	40	£207,200	<b>10</b> <sup>-5</sup>	25	2072
Serious injuries	100	£20,500	<b>10</b> <sup>-5</sup>	25	512
Slight Injuries	200	£300	10 <sup>-5</sup>	25	15
	£9,283				

- A Small Amount? Even with a 'Bias' in Favour of Safety
- Sufficiently Complex for Screening Out Expensive Safety Measures





#### Summary

- Not all Safety Measures are Justifiable
- Cost/Benefit policies help Decision Making
- Plant Property Loss usually Much Larger than Human/Environmental
- Regulators usually focus on Human/Environmental
- Shareholders usually focus on Plant Property Loss



## References

- The 100 Largest Losses 1974-2013, Large Property Damage Losses in the Hydrocarbon Industry, 23rd Edition – Marsh Energy Practice
- The Author's web site www.alarp.plus.com
  - Longer version of this presentation (including video)
  - Other papers and documents
- HSE (UK) Risk Guidance www.hse.gov.uk/risk/expert.htm

