Process Safety Management in Oman LNG

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Presentation Outline

- Introduction to Oman LNG
- Process Safety Management
- Key elements AIPSM
- Implementation & tools
- Real example: Condensate Tank
- Conclusions
- Questions
**Introduction to Oman LNG L.L.C**

Location: Qalhat, near Sur  
Product: Liquefied Natural Gas (LNG) & Condensate  
Feed: Natural Gas from Central Oman  
Export: 10 mtpa LNG / 3 trains  
Age: Train 1/2 and utilities 10 years, Train 3 : 4 years  
Design: Shell Design and Engineering Practices

### Oman LNG – 2 TRAINS

<table>
<thead>
<tr>
<th>Company</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sultanate of Oman</td>
<td>51%</td>
</tr>
<tr>
<td>Shell</td>
<td>30%</td>
</tr>
<tr>
<td>Total</td>
<td>5.54%</td>
</tr>
<tr>
<td>Korea LNG</td>
<td>5.00%</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>2.77%</td>
</tr>
<tr>
<td>Mitsui</td>
<td>2.77%</td>
</tr>
<tr>
<td>Partex</td>
<td>2%</td>
</tr>
<tr>
<td>Itochu</td>
<td>0.92%</td>
</tr>
</tbody>
</table>

### Qalhat LNG – 1 TRAIN

<table>
<thead>
<tr>
<th>Company</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sultanate of Oman</td>
<td>46.84%</td>
</tr>
<tr>
<td>Oman LNG</td>
<td>36.8%</td>
</tr>
<tr>
<td>Union Fenosa Gas</td>
<td>7.36%</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>3%</td>
</tr>
<tr>
<td>Osaka Gas</td>
<td>3%</td>
</tr>
<tr>
<td>Itochu</td>
<td>3%</td>
</tr>
</tbody>
</table>

PSM in OLNG - 3
The Management of Hazards that can give rise to major accidents involving release of

- Potentially dangerous materials,
- Energy (such as fire or explosion) or
- Both

OLNG’s Mission: To produce, market and deliver LNG safely, reliably and profitably.
Industry Process Safety Incidents

- BP's Texas City Refinery (March 23, 2005): 15 deaths & >170 injuries
- Buncefield fire (December 11, 2005): 43 injuries & a series of explosions
- Indian Oil Company (IOC) Terminal Explosion (October 29, 2009): 11 deaths & 45 injuries
- Tesoro Anacortes Refinery Fire (April 2, 2010): 7 deaths
- Deepwater Horizon oil spill or BP oil disaster (April 20, 2010): 11 deaths & massive oil spill in the Gulf of Mexico.
- UK Lindsey oil Explosion (Jun 29, 2010): 1 death
- CNPC Dalian China pipeline rupture (July 17, 2010): ? deaths
2009/2010 - Are we learning?

- BP's Texas City Refinery
- Buncefield fire
- Tesoro Refinery
- Indian Oil Company
- Dalian Pipeline explosion
- Deepwater Horizon
Swiss Cheese Approach

Barriers to Prevent Incidents

PSM in OLNG - 7
• Triggered by major incidents in hydrocarbon industry

• OLNG have voluntarily adopted the Shell HSSE Control Framework. Includes a manual on Asset Integrity – Process Safety Management (AI-PSM)

• Although already >90% of the AIPSM elements are in place, a significant amount of work remains with respect to the structural approach and completeness demonstration

• OLNG have committed to complete the implementation of this standard by end 2013.
AIPSM Key Elements

**Process Safety Culture**
- Single-point accountability
- Management reviews & HSSE performance monitoring
- Knowledge of the Hazards, demonstration of HSSE leadership

**Design and Construction**
- Technical Integrity of design and construction, design standards, documentation and safety reviews

**Risk Management**
- Identification, assessment and management of risks
- Hazard & Effect register, HRA, Bowties and ALARP demonstration
- Competence, fitness to work, contactor HSSE management and MoC

**Operations, Inspection and Maintenance**
- Access/use and working procedures
- Operation within the Operating limits
- Inspection against standards, segregate responsibility
  - Inspection records
- Maintenance of HSSE critical equipment
  - Permit to work system
**Hazard & Effect Management Process**

**Identify Hazards**
What are the hazards? What can be released that can harm people, assets, the environment or the company’s reputation.

**Assess Risks**
Identify the hazard release scenario/ consequence - what can be released, how and what are the consequences.

**Control**
Identify the controls in place that will prevent the hazard release scenarios from being realized.

**Recovery**
If the hazard is released what controls do we have in place to mitigate the potential consequences?

**ALARP**
To demonstrate ALARP, controls must be assessed, alternatives / options must be explored as appropriate and the final decision documented.

**HEMP**

**SEVERITY**
- **Major impact**
- **Major effect**
- **Major damage**
- **PTD or up to 3 fatalities**

**CONSEQUENCES**
- **Moderate impact**
- **Moderate effect**
- **Moderate damage**
- **Major injury or health effect**

**LIKELIHOOD**
- **Has happened more than once per year at the Location**
- **Has happened at the Location or more than once per year in the Organisation**
- **Has happened in the Organisation or more than once per year in the Industry**
- **Heard of in the Industry**
- **Never heard of in the Industry**
What is ALARP??
Reducing risks to a level at which the cost and effort (time and trouble) of further risk reduction are grossly disproportionate to the risk reduction achieved.
Maintaining Integrity of Barriers

Audits & Inspection
- Check accuracy & currency
- Verify performance

Activities Ensuring Barriers

HSE Critical Activities

HSE Critical Equipment

Hardware Providing Barriers

Identified in Job Description Competency Requirements

HSE Critical Element Performance Criteria
In December 2005 at Buncefield Oil Depot 200 tons of fuel escaped from a storage tank resulting an explosion and fire whereby 43 people were injured and the facility was severely damaged.

In April 2008 a Learning From Incident (LFI) recommended to conduct a risk assessment for overfilling of tanks containing gasoline.
In OLNG Condensate is produced as a by-product from LNG production – mainly C5+ and RVP of 12 psia
- Qualified facilitator
- Qualified contributors
- Specialized software
- Current control & recovery barriers identified
- 3 valid barriers not sufficient for risk classification of hazard (yellow)
- LOPA required for detailed analysis
LOPA is a simplified form of quantitative risk assessment.

- Initiating Event frequency
- Likelihood of failure of independent protection layers (IPLs)
- Enabling Factors and Conditional Modifiers
LOPA outcome and follow up

HAZARD: Condensate
Top Event: Loss of containment
Consequence: Environmental spill / fire explosion / fire expl + fatality

**Threats**
- Instrument failure leading to tank overfill
- Wrong line up of tank (operator error)

**Barriers**
- High level alarm + op action
- Control of personnel
- Control of ignition sources

Based on LOPA remaining risk = 10E-3, reduction of factor 10 required to make it tolerable
Conclusions & Lessons learned

- Industry seems to be lagging in PSM implementation as 5 years after BP Texas / Buncefield number of incidents keeps rising
- Oman LNG has recognized this and has therefore adopted the Shell HSSE-CF to ensure safe and reliable production
- Significant effort & time is required to implement the structure & documentation requirements.
- Specialized tools, competent staff and resources are key to successful implementation
- Implementation on track and no major surprises found so far.
- PSM in Oman LNG is an integrated system involving all disciplines from operation, maintenance, inspection, contractors to the human resources department.
• **Process Safety**
  The management of Hazards that can give rise to major accidents involving release of potentially dangerous materials, release of energy (such as fire or explosion) or both.

• **Asset Integrity**
  The ability of the Asset to perform its required function effectively and efficiently whilst safeguarding life and the environment.

Ref: Shell HSSE & SP Control Framework GLOSSARY
HEMP = used to:
- **Identify** the hazards & **Assess** the risk  And
- **Identify the Controls and Recovery** measures to manage that hazard to levels As Low as Reasonably Practicable (ALARP)

- Environmental Impact assessment
- Health risk assessment
- Bow Tie analysis
- Reactive Hazard Analysis
Swiss Cheese Model

- Safe Operation
- Design
  - Alarm and operating procedures
- Maintenance
  - Integrity Management (Inspection)
  - Safety Instrumented Systems
- Ignition control
- Fire fighting & ER
- Major Incidents
- Training & Competency
- PTW
- PSA
- MOC
- IPF
- Drills

Safety Culture (owner: QCM)

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