GPA-GCC Specialized Seminar

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	
Sultanate of Oman	*51%*
Shell	*30%*
Total	*5.54%*
Korea LNG	*5.00%*
Mitsubishi	*2.77%*
Mitsui	*2.77%*
Partex	*2%*
Itochu	*0.92%*

Qalhat LNG – 1 TRAIN	
Sultanate of Oman	*46.84%*
Oman LNG	*36.8%*
Union Fenosa Gas	*7.36 %*
Mitsubishi	*3%*
Osaka Gas	*3%*
Itochu	*3%*

Process Safety Management

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**

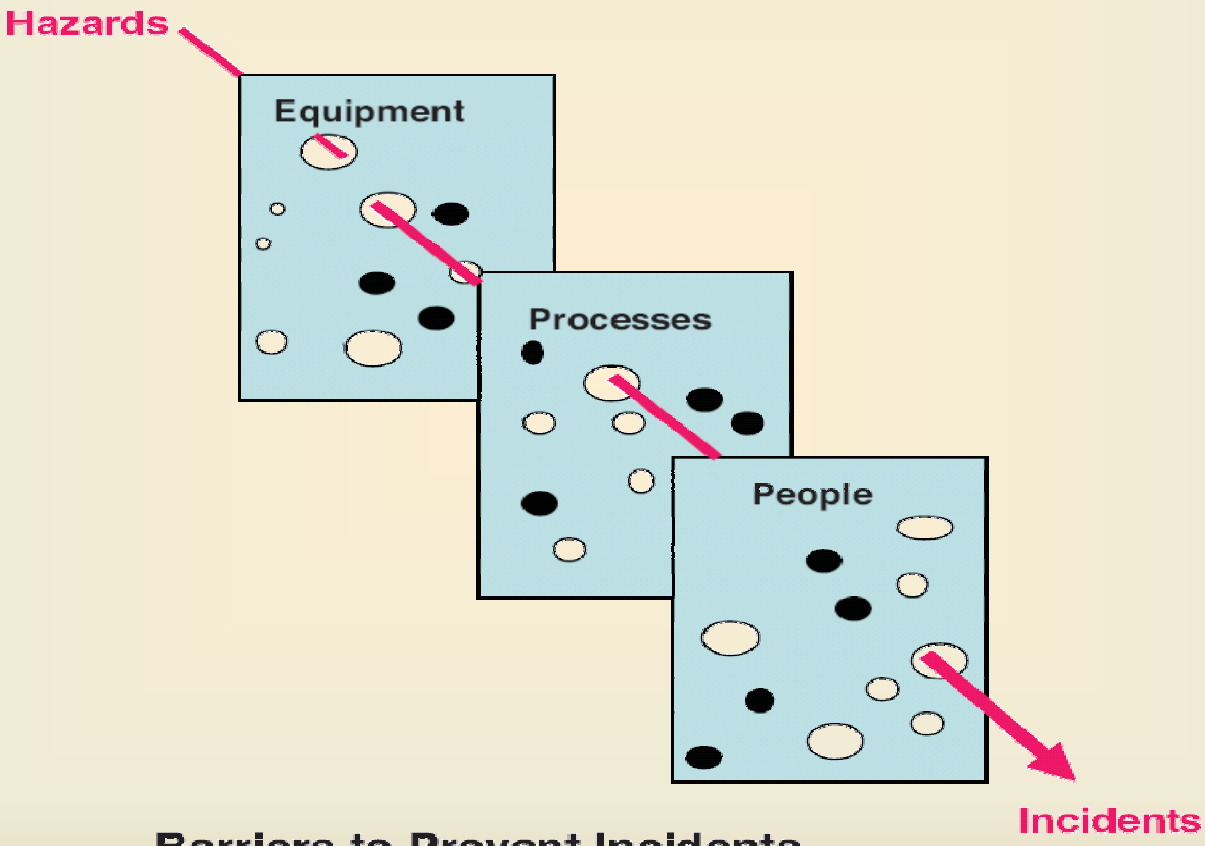
OLNG's Mission: To produce, market and deliver LNG safely, reliably and profitably.

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): 11deaths & 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?

Swiss Cheese Approach



Barriers to Prevent Incidents

Asset Integrity - PS Management

- **Triggered by major incidents in hydrocarbon industry**
- **OLNG have voluntary 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

ALARP

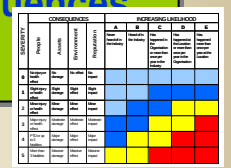
To demonstrate ALARP, controls must be assessed, alternatives / options must be explored as appropriate and the final decision documented.

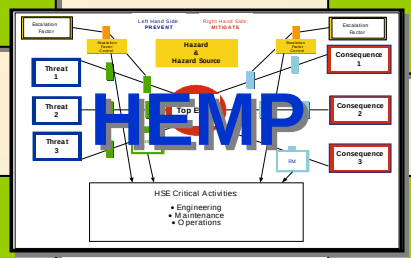
Identify Hazards

What are the hazards? What can be released that can harm people, assets, the environment or the company's reputation

Assess Risks

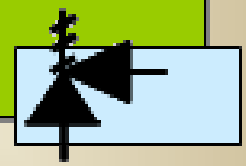
Identify the hazard release scenario/ consequence - what can be released, how and what are the consequences





Control

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



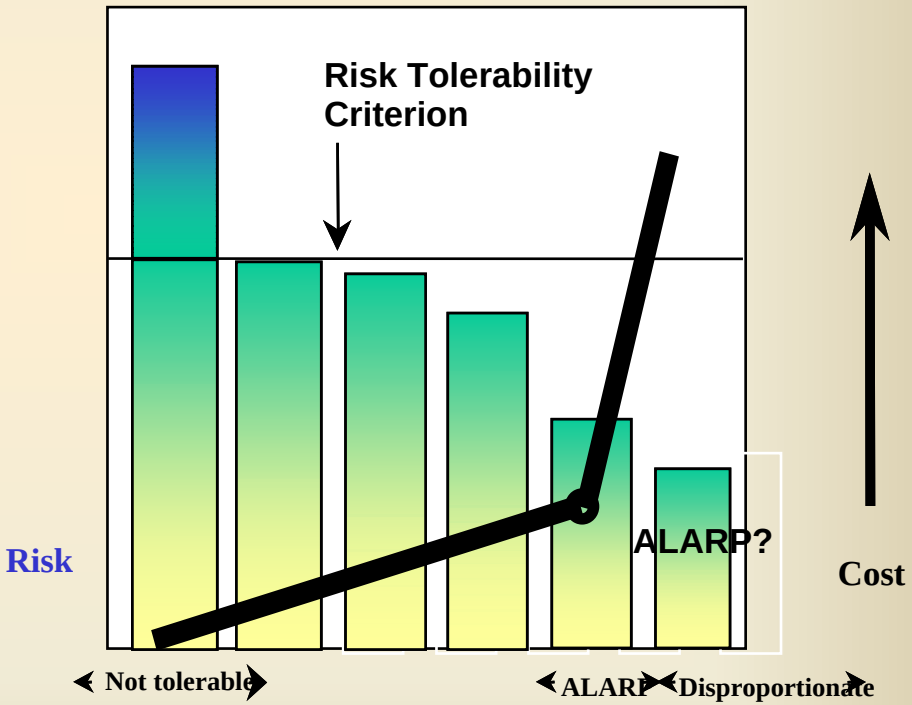
Recovery

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

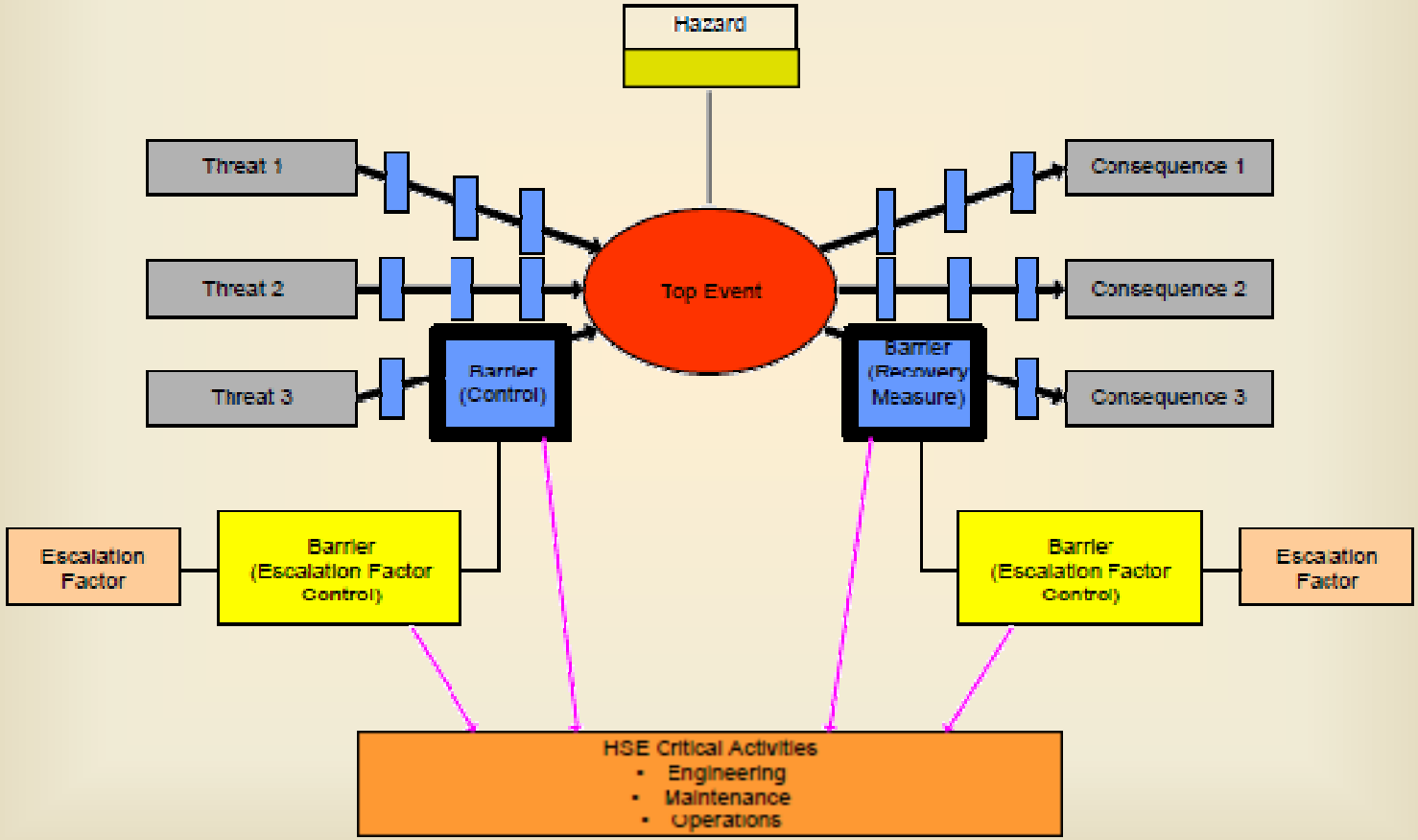
Determination of ALARP

What is ALARP??

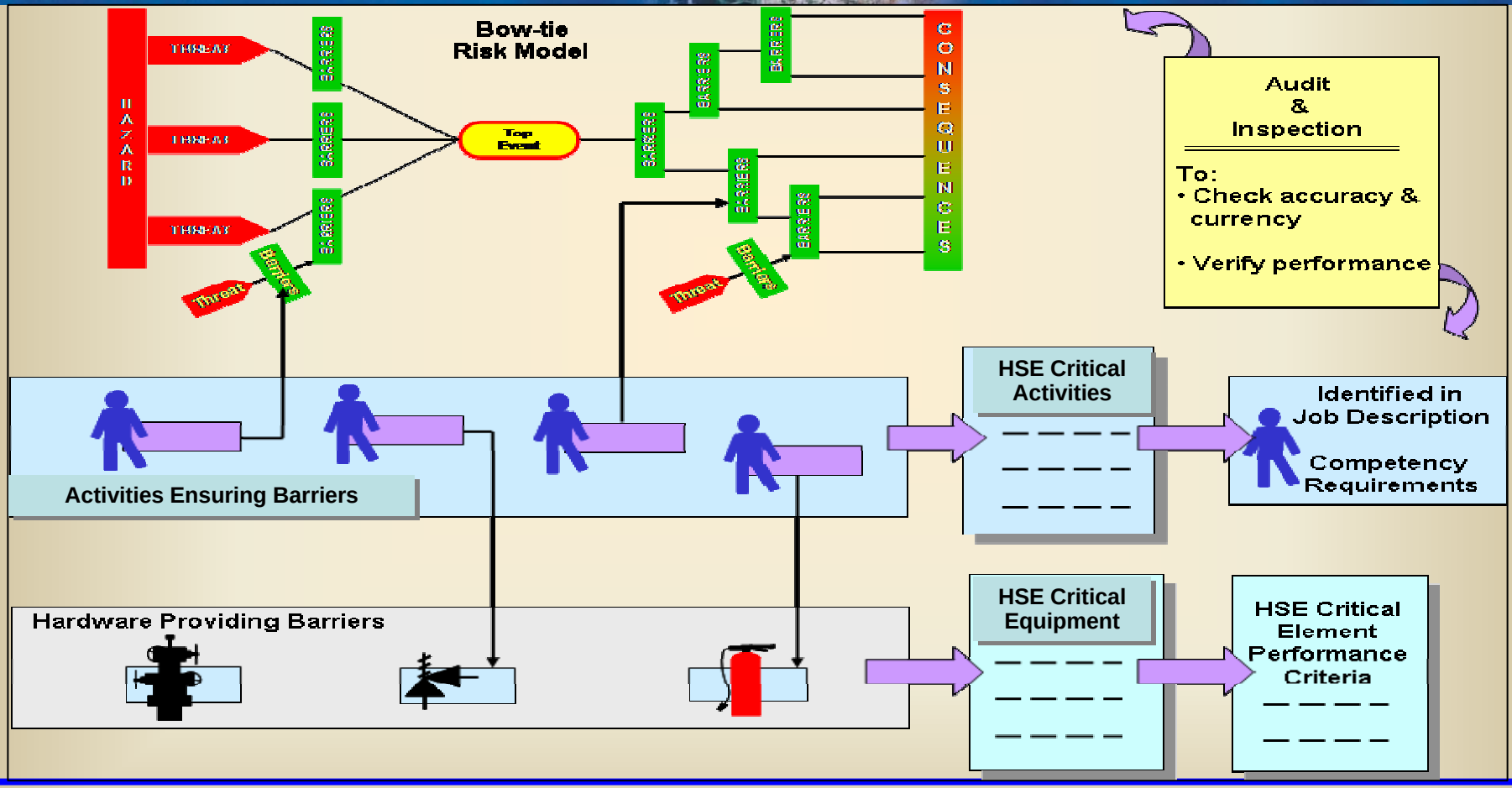
Reducing risks to a level at which the cost and effort (time and trouble) of further risk reduction are grossly disproportionate to the risk reduction achieved.



Bow-tie Diagram



Maintaining Integrity of Barriers



Condensate Tank Overfill

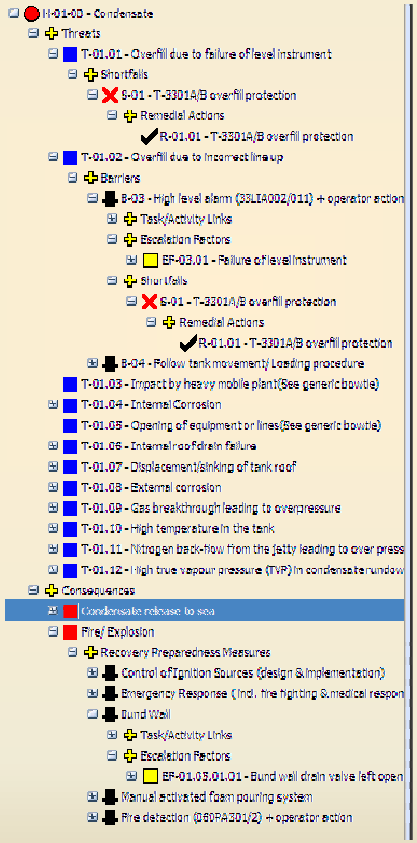
In December 2005 at Buncefield Oil Depot 200 tons of fuel escaped from a storage tank resulting an explosion and fire whereby 43 people were injured and the facility was severely damaged.

In April 2008 a Learning From Incident (LFI) recommended to conduct a risk assessment for overfilling of tanks containing gasoline.

Condensate Tank layout

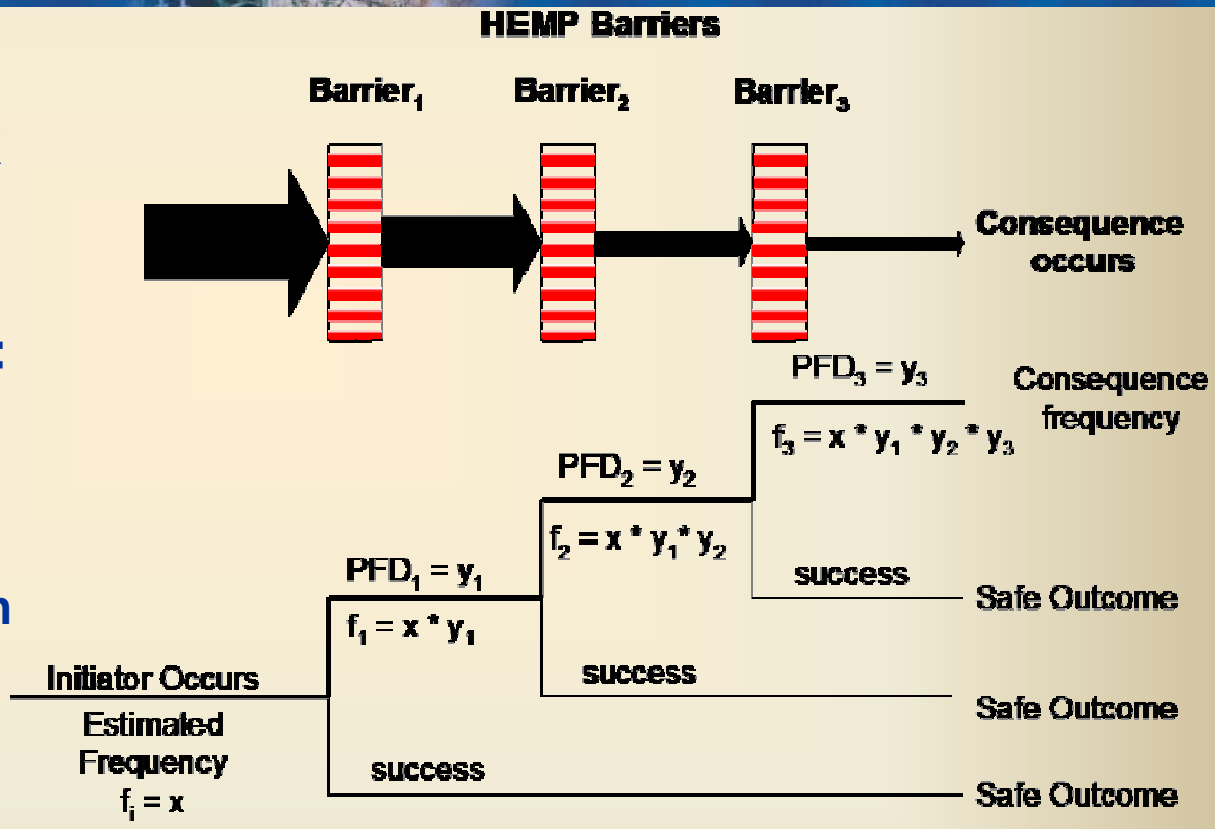
Condensate Bow-tie

- 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



Layer of Protection Analysis

- LOPA is a simplified form of quantitative risk assessment
- LOPA Uses order of magnitude numbers for:
  - Initiating Event frequency
  - Likelihood of failure of independent protection layers (IPLs)
  - Enabling Factors and Conditional Modifiers



LOPA outcome and follow up

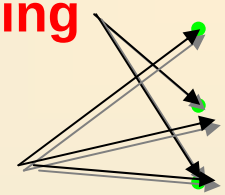
HAZARD : Condensate

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)**

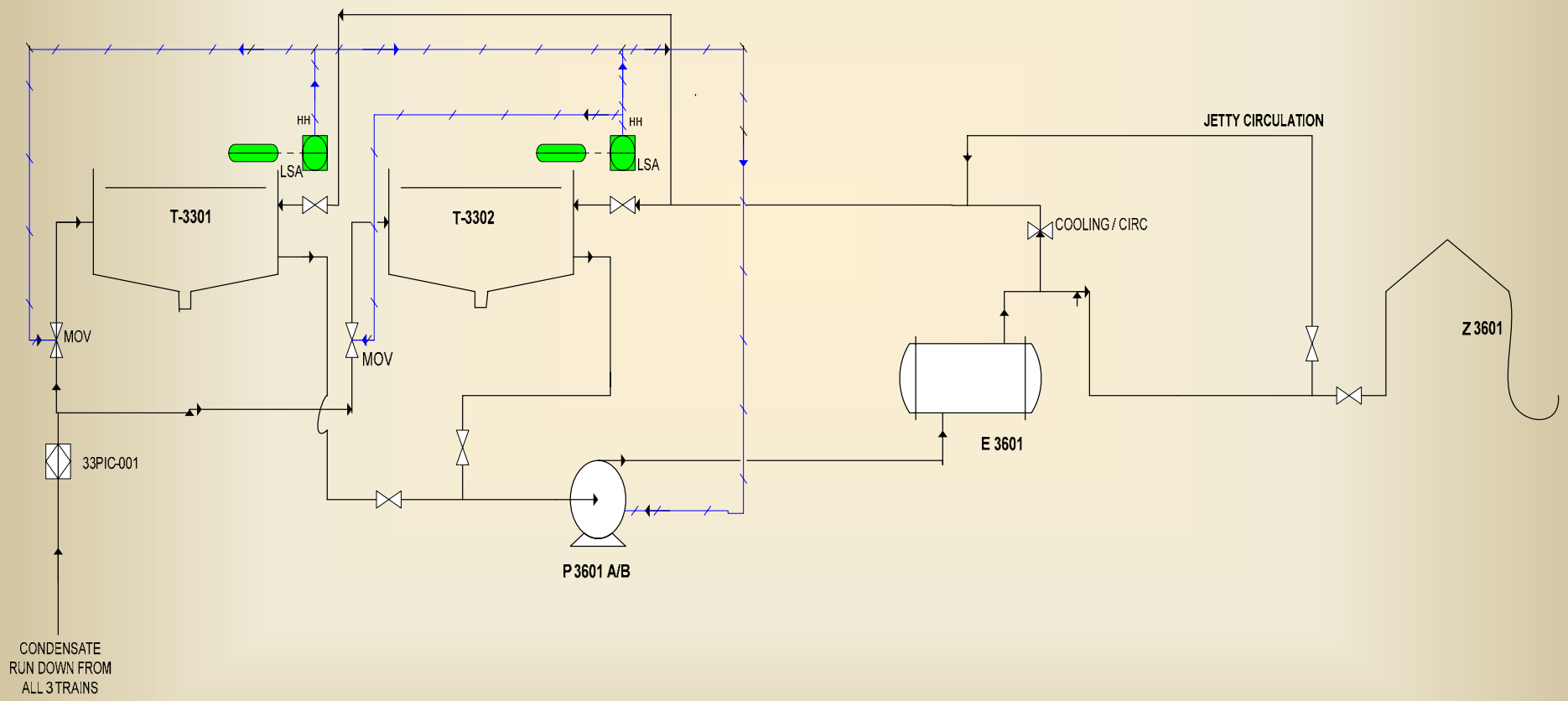


Barriers

- **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

High Level Trip on Tanks



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.**

Questions ?

Back-up: Process Safety v.s Asset Integrity

- **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

Hazard & Effect Management Process

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