Petroleum Development Oman

Process Safety Improvements in PDO

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Process Safety Improvement Manager
Contents

• What is Process Safety in PDO?
• The external view of Process Safety in PDO
• What are we doing about it?
• Changing the Culture
### What is a Process Safety event?

<table>
<thead>
<tr>
<th>Severity</th>
<th>People</th>
<th>Assets</th>
<th>Environment</th>
<th>Reputation</th>
<th>INCREASING LIKELIHOOD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CONSEQUENCES</td>
<td>INCREASED LIKELIHOOD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>No injury or health effect</td>
<td>No damage</td>
<td>No effect</td>
<td>No impact</td>
<td>A: Never heard of in the Industry</td>
</tr>
<tr>
<td>1</td>
<td>Slight injury or health effect</td>
<td>Slight damage</td>
<td>Slight effect</td>
<td>Slight impact</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Minor injury or health effect</td>
<td>Minor damage</td>
<td>Minor effect</td>
<td>Minor impact</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Major injury or health effect</td>
<td>Moderate damage</td>
<td>Moderate effect</td>
<td>Moderate impact</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>PTD or up to 3 fatalities</td>
<td>Major damage</td>
<td>Major effect</td>
<td>Major impact</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>More than 3 fatalities</td>
<td>Massive damage</td>
<td>Massive effect</td>
<td>Massive impact</td>
<td></td>
</tr>
</tbody>
</table>
Process Safety in PDO - Context

- Natih flowline incident
- Birba H2S incident
- CPP fire
- Barik flowline incident
- Nahada / MAF spill
- BVS6 spill
- Mabrook 1 well incident
- SR-84 gas well incident
- Fuel leak from SBM 3
- Gas leak from redundant gas-lift line
- Anzouz-Sahma 8" export line rupture
- Oil spill at Tank Farm
- K-5322 Fire incident
- Crude oil carry over to Al Ghubar flare
- SRDC K-5440 insulating gasket failure
- Burns injuries NRPS
- Leak from surge tank T-501, Fahud B
- High TVP in MOL
- BVS1 spill

Some recent HP incidents in PDO

Process Safety incidents this year
Lloyd’s opinion: Process Safety Risk in PDO is unacceptable

In support of their risk assessment on PDO, Lloyd’s have formulated the following 6 key findings:

1. PDO leadership has not effectively established process safety as core value
2. Compliance with systems, standards and procedures is not enforced
3. Declining competence profile, increasing risk profile
4. Barriers prevent open communication with and engagement of staff
5. Accurate process safety knowledge not developed, maintained and applied
6. Failure to learn from own experience

*Lloyd’s provided 69 pieces of evidence in support of the above findings*

*Lloyd’s commended PDO on being proactive and supported all the already ongoing AI-PSM improvement activities*
We construct and maintain the hardware barriers

We always consider the potential risks from hazards whilst operating our facilities within defined limits and with up to date procedures and effective communications

We design so that risks are As Low As Reasonably Practicable

We have competent people, with the right behaviours working with fit for purpose systems
AI-PSM - the Building Blocks

Technical Integrity
- Implementing TR-MIE
- Hardware Barrier Verification
- Ex Equipment
- Static Equipment Integrity Management

Operating Integrity
- Permit To Work
- Alarm Management
- Live Operating Envelopes

Design Integrity
- Demonstrate ALARP (retro HAZOP, IPF, FERM and OBRA)
- AI-PSM in new projects
- Design and Engineering Manuals (DEM 1/2)

People & Systems
- Leadership and commitment
- Organisation, roles and responsibilities
- Standards and procedures
- Discipline Control and Assurance Framework
- Critical Drawings
- Asset Register
- Operationalise HSE cases
- AI-PSM competence development
- AI-PSM KPIs
- Assurance
# PDO Equipment Dimensions

<table>
<thead>
<tr>
<th>Asset</th>
<th>OND</th>
<th>OSD</th>
<th>GGO</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wells (number) – total wells</td>
<td>2607</td>
<td>2996</td>
<td>233</td>
<td>5836</td>
</tr>
<tr>
<td>Pipelines (km)</td>
<td>2400</td>
<td>1238</td>
<td>1369</td>
<td>5007 km*</td>
</tr>
<tr>
<td>Flowlines (km)</td>
<td>8500</td>
<td>4500</td>
<td>527</td>
<td>13527 km**</td>
</tr>
<tr>
<td>On-plot Piping (number)</td>
<td>12584</td>
<td>8498</td>
<td>5613</td>
<td>26995</td>
</tr>
<tr>
<td>Production Stations (number)</td>
<td>29</td>
<td>22</td>
<td>5</td>
<td>56</td>
</tr>
<tr>
<td>Pumps (number)</td>
<td>1722</td>
<td>1509</td>
<td>611</td>
<td>3858</td>
</tr>
<tr>
<td>Compressors (number)</td>
<td>480</td>
<td>184</td>
<td>77</td>
<td>741</td>
</tr>
<tr>
<td>Tanks (number)</td>
<td>142</td>
<td>131</td>
<td>109</td>
<td>382</td>
</tr>
<tr>
<td>Vessels (number)</td>
<td>1778</td>
<td>1316</td>
<td>390</td>
<td>3484</td>
</tr>
<tr>
<td>Heat Exchangers (number)</td>
<td>554</td>
<td>1955</td>
<td>744</td>
<td>3253</td>
</tr>
<tr>
<td>Relief Valves (number)</td>
<td>1889</td>
<td>1641</td>
<td>804</td>
<td>4334</td>
</tr>
<tr>
<td>Control system (number)</td>
<td>15</td>
<td>14</td>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>Safeguarding systems (number)</td>
<td>14</td>
<td>15</td>
<td>28</td>
<td>57</td>
</tr>
<tr>
<td>Beam Pumps</td>
<td>1525</td>
<td></td>
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</tr>
</tbody>
</table>

* Muscat to Berlin (Germany)

**Muscat to Los Angeles (USA) going west

Around 50% of all equipment is safety critical
AI-PSM Risk Segmentation

Kicked off in Q4 2008

Critical Assets:
1. Birba
2. Al Noor
3. CPP
4. Main Oil Line

Pathfinder Assets:
1. Qarn Alam
2. Lekhwair

Added in 2010:
1. Nimr
2. Yibal GGP
3. Terminal
4. Marmul CCR
AI-PSM longer term asset / project coverage

2009
- Harweel
- QA Steam
- MAF Terminal
- Birba
- Al Noor
- MOL
- CPP
- Qarn Alam
- Lekhwair

2010
- Marmul CCR
- Nimr

2011
- Harweel
- GGP
- MAF Terminal
- Amal steam
- QA Steam
- Al Noor
- MOL
- CPP
- Qarn Alam
- Lekhwair

2012
- Nimr
- Marmul rest
- Bahja
- Power Systems
- Gas plants
- Fahud
- Yibal

2013
- Minor Projects
- Major Projects
- Minor Projects
- Fahud
- Yibal
AI-PSM Risk Reduction

- Minor Projects
- Harweel
- QA Steam
- Amal steam
- Nimr
- GGP
- MAF Terminal
- Marmul CCR

- Minor Projects
- Harweel
- QA Steam
- Amal steam
- Nimr
- Marmul rest

- Fahud
- Gas plants
- major Projects

- Minor Projects
- Fahud
- Yibal

RISK

2009 2010 2011 2012 2013

NO ASSURANCE
NO MANAGEMENT OF
CHANGE

SLOW AI-PSM
IN PROJECTS

SUCCESS

ALARP

GPA Seminar November 2010
Extensive Communication to change the Culture

Start at the top
Director and Shareholder engagements
• 2 Monthly Technical Directors meetings on AI-PSM
• 3 Technical Board sessions on AI-PSM

Extended leadership team engagements
• Dedicated sessions for Process Safety
• Extensive coverage of 2010 AI-PSM deliverables in all asset directorate business plans and Performance Contracts

Middle management and workforce engagements
• Consistent messages from the leadership
• Media and face to face engagements
Successful Communication: Taming the Two Beasts

**The Lion - Occupational Safety**
- Hunts in groups
- Is often visible (audible etc)
- Common in its own environment
- Is a killer
- Can never be fully tamed
- Can never be left unguarded
- Needs constant vigilance

**The Tiger – Process Safety**
- Hunts alone
- Is secretive and hard to detect (well camouflaged)
- Not commonly seen
- Is a killer
- Can never be fully tamed
- Can never be left unguarded
- Needs constant vigilance

Turn your back on either at your peril
Successful Communication: Alert Today – Alive Tomorrow

• Started in the summer of 2009
• 12 draft scripts being created before the final storyline was agreed by a PDO team of Communications and Engineering professionals
• In early November, a multi-award winning drama crew from Myriad Global Media started shooting the film in the recently converted Marmul B training facility in South Oman
• This involved mobilising a 25 person team to the Interior, including camera crew, sound, production management staff, actors and extras
• Ten professional Omani actors were employed
• Ten PDO operations staff were also employed as extras, adding authenticity to the operational activities and meeting sequences
• Launched in the summer of 2010
• The film is the first of its kind in the region in that it also includes an interactive section to be used for training purposes.
• Running off a DVD menu the interactive section helps reinforce lessons learned from key events in the film.
• PDO is sharing the movie with its national and regional Oil and Gas colleagues
Key Challenges

• Manage a large volume of work covering different disciplines across all directorates in PDO
• Demonstrate the success of the programme by passing an independent audit in Q4 2010 for the critical assets
• Manage sustainability through Assurance and Management of Change
• Improve the competence of staff to deal with current and future asset complexity and age
• Step-up the Engineering and Well Engineering coverage of Process Safety
• Continue the AI-PSM training and communication effort

These are linked to the 10% contribution of Process Safety on the 2010 corporate scorecard. We have to keep the momentum going!