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Geothermal Steamfield Asset Management

Pressure Protection Plan Case Study



Overview

- Steamfield Pressure Protection System Design impacts steamfield asset lifecycle costs:
 - Vessel & piping process design: HMB, sizing & selection
 - Design code and hazard assessment for vessel & piping
 - Vessel design & piping design & specifications,
 - Pressure protection design & specifications,
 - Regulatory compliance DV, ITPs, NDT & annual inspections & maintenance





Steamfield – Pressure Protection

- Pressure Zones:
 - Wellheads
 - Steam
 - Brine
- Pressure Protection Methods:
 - Design Pressure
 - Pressure Control
 - Pressure relief devices:
 - N+1, PSEs & PSVs, primary & secondary etc.



Steamfield – Pressure Protection

- Health & Safety & Environmental Issues:
 - -Noise > 120 dBA
 - -Steam & condensate discharges to environment
 - -H₂S exposure
 - -Heat
 - -Debris



Lumut Balai Case Study

- 'Complex' 55 MW Steamfield (FCRS):
 - 3 cluster single flash system,
 - Gravity brine reinjection,
 - 663 m elevation difference between wellhead clusters & reinjection
 - Multiple pressure zones with intermediate isolation
 - Station steam vent system



Design Pressure Zones







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Design Pressure

- Pipe schedule selection:
 - **–Operating Pressure**
 - »Maximum operating pressures
 - -Corrosion allowance
 - **–Dynamic Losses**
 - -Cost



Design Spec Example

Pipe Spec	Use	Pressure Rating bar(g)
CB15A	Large Bore Steam Mains	9
CB15C	Two Phase and Steam Lines	10
CB30B	Brine	29
CB30A	Production Wells and Brine Lines	41.6
CB60A	Reinjection Wells and Brine Lines	72





Pressure Protection Zones

- Wellheads:
 - Full shut in pressure
 - No pressure protection devices required





Pressure Protection Plan

- Two-Phase lines:
 - Down stream of wellhead piping isolation. Increased risk of over pressure – Not rated to wellhead pressure
 - Larger bore to reduce losses
 - Pressure protection required





Pressure Protection Plan

• Steam line:

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- Large bore lines:
 - Reduced Losses
 - Increased hoop stress
- Pressure protection required:
 - Typical protection options:
 - Pressure control system with rock mufflers
 - Pressure relief valves
 - Rupture discs
 - Vacuum relief devices





Vacuum Relief

- Large lines not rated to full Vacuum
- Isolated lines and condensing steam will cause a Vacuum
- Vacuum rupture disc sized for rate of condensation in cooling pipe
- ITPs & maintenance of vacuum relief system OPEX costs ongoing



Brine System

- Brine lines:
 - Static water pressure and steam pressure of steam relief devices
 - Lines are typically small bore and can withstand higher pressures
 - Pressure protection on steam lines:
 - Upstream relief from wellhead pressures



Vessel Pressure Protection

- Separator vessels
 - rated for 12.0 & 9.5 bar & FV (not 40 bar wellhead pressure)
 - protected by pressure relief on steam system



Steamfield Pressure Control

- Separator vessels:
 - 'Trim' flow control valve on one 'index' well to separator for each cluster
- Station vent system / steam header pressure control to 6 bar +/-:
 - -2 x 100% duty 0-55 t/h trim PCVs
 - 4 x 33% duty 40-167 t/h steam vent valves to rock mufflers



Lumut Balai Pressure Protection Zones Initial





Initial Design - PSEs & PSVs

- One set of rupture discs:
 - LMB 1, 6 & 9 Steam 3 x 8.0 bar(g) N+1 each
- One set of pressure relief valves:

- LMB 1, 6 & 9 Steam - 1 x 7.2 bar(g) each



Lumut Balai Pressure Protection Zones Required Changes

- Separator isolation valves requested:
 - Additional set of pressure safety relief equipment to protect cluster piping
 - Higher rupture disc pressure required
 - Additional vacuum protection devices required
- Vessel rupture discs or relief valves requested for regulatory compliance

Lumut Balai Pressure Protection Zones Final



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Final Design - PSEs & PSVs

- Four sets of rupture discs:
 - LMB 6 Separator 1 x 12.0 bar(g)
 - LMB 1 & 9 Separator 1 x 9.5 bar(g) each
 - LMB 1, 6 & 9 Steam 3 x 9.0 bar(g) N+1 each
 - Steam manifold & mist eliminator 1 x 8 bar(g) each
- One set of pressure relief valves:
 - LMB 1, 6 & 9 Steam 1 x 7.2 bar(g) each





Steam Line Pressure Protection

Implications on Asset Management

- Increased number of burst discs.
- Increased number of isolation valves.
- Operating constraint due to tighter tolerance (0%) burst pressure
- Higher cost for tighter tolerance rupture discs

How a Designer can help?

- Keep it simple
- Limit number of pressure zones
- Common rupture discs
 - Physical size difference for each pressure zone
- Burst pressure tolerance (0 +5%)
 - Cheaper rupture discs
- Increased operating pressure flexibility.

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