PSV Interval Setting Using Target Reliability

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Overview - Maximising Hydrocarbon Recovery

• Continued focus in the industry to maximise uptime
  • This often means longer intervals between Shutdowns
  • Often Shutdown plan is updated during PSV intervals
  • Scope “challenge sessions”

• Current method (PSV RBI) does not allow easy interpretation of residual risk with interval extension.

• Reliability Approach allows instant direct calculation of effect on PSV reliability.
Background

- What is a Pressure Safety Valve? (PSV, RV, PSD)
  - Prevents overpressure of pipework, vessels etc. - prevention of major accidents
  - Includes “conventional” spring action valves, pilot operated, balanced bellows etc.

- Why do we assure them?
  - Safety Critical element - legal requirement to assure
  - Susceptible to various degradation mechanisms - corrosion, fouling, seat damage etc.

- How do we assure them?
  - Pop Testing
  - Strip down inspection
  - Rebuilt as-new with new soft goods.
  - In-situ testing - limited assurance
  - Normally need Shutdown to remove
How often to test PSVs?

• API 510 typically used as main guidance document.
  • Generally non-prescriptive- single page given in standard.
  • API 510 States:
    • Max 5 year intervals for valves in typical process services
    • Max 10 year intervals for clean, non-fouling, non-corrosive services

• General practice was to test valves at shut down intervals
  • Typically 2 yearly or 3 yearly
  • Trade off between reliability and lost production

• API 510 allows for longer intervals if a documented Risk Based Inspection assessment is carried out.
Pressure Safety Valve - Risk Based Inspection (PSV RBI)

- Semi-quantitative assessment process:
  - Assess valve consequence category - proprietary risk table
  - Assess valve demand rate - typically API 581 data
  - Assess valve susceptibility to failure - qualitative questions
  - Overlay confidence factor - semi-quantitative questions
  - Assign an overall grading and plug it all into a “magic” matrix - largely arbitrary

- Now common practice in industry; no standardised procedure.
  - Various offerings: DNV Procedure / Score Procedure
  - In house procedure: Shell, Centrica

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Example of a typical PSV RBI matrix:

- Durations in line with API 510.
- Not consistent across industry - depends on risk appetite?

<table>
<thead>
<tr>
<th>Consequence score</th>
<th>Maximum recommended interval between inspections (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade 0</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>36</td>
</tr>
</tbody>
</table>

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Downsides to this approach

• Criticality assessment is based on semi-quantitative data and qualitative questions
  • Different users may come up with different answers
  • Arbitrary final selection

• PSVs operate as part of a designed safety system
  • The SIL assessment is where the complete safety loop is captured
  • Potential for repeated and/or conflicting data

• Are your PSVs achieving the reliability assumed in your SIL?
  • SIL normally assigns 0.01 failure rate for PSVs
  • Yours may not be that reliable...
  • How do you deal with TAR interval changes?
Target Reliability Centred Approach - RTAMO Method

• 1) **Start with a target reliability for each valve**
  - Can have different targets for SECE / Non-SECE

• 2) **Analyse the past reliability of your valves**
  - Separate valves into distinct fluid services
  - Plot using Weibull distribution
  - Use failure data to derive Shape function and characteristic life values (β and η)

• 3) **Overlay maximum “user defined” interval lengths if desired**
RTAMO Software

- Software exits to carry out analysis for you (best fit to Weibull curve)
- Allows for visual interpretation and sensitivity checking:

**Target v Interval**

![Graph showing reliability and target values over intervals]

**Sensitivity Analysis**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Variance</th>
<th>Maintenance Interval (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Optimisation</td>
<td></td>
<td>0 10 20 30 40 50 60 70</td>
</tr>
<tr>
<td>Failure Rate</td>
<td>±25%</td>
<td></td>
</tr>
<tr>
<td>Time To Inspect</td>
<td>±25%</td>
<td></td>
</tr>
<tr>
<td>Time To Repair</td>
<td>±25%</td>
<td></td>
</tr>
</tbody>
</table>

- Current Interval
- Optimised Interval
- Selected Interval
- Optimised range varying with parameter
Everest / Lomond Case Study

- Sister platforms, so data shared across both platforms
  - 590 valves analysed
  - 85k months of valve operational history analysed

- Averaged change in valve interval = -36%
  - Previously averaged 146 PSVs/year
  - New regime 96 PSVs/year

- Several intervals shortened based on 95% target reliability

- Many systems were not achieving 99% reliability
Disadvantages of this approach?

- Not well set up for low confidence testing (e.g. Trevi testing)
  - Can use Bayesian logic to integrate this data - future work to update tool

- Data set size

- Not as intuitive as PSV RBI

- You may learn that your PSVs aren’t as reliable as you thought *(not really a disadvantage!)*
Maximising Hydrocarbon Recovery

- Continued focus in the industry to maximise uptime
  - This often means longer intervals between Shutdowns
  - Often Shutdown plan is updated during PSV intervals
  - Scope “challenge sessions”

- PSV RBI does not allow easy interpretation of residual risk with interval extension.

- Reliability Approach allows instant direct calculation of effect on PSV reliability. Fully recognised approach in API 581.

- Data can then be fed back into SIL assessment
  - Other safety functions can be altered in order to compensate
  - Can confirm that overall design intent of safety system is still met.
Questions