PSV Interval Setting Using Target Reliability

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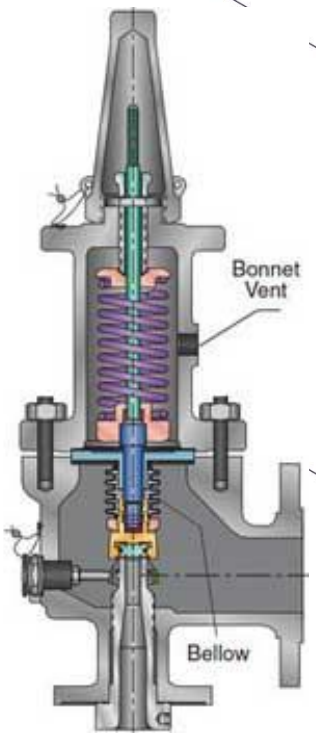
Overview - Maximising Hydrocarbon Recovery

- 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
  - Asses 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

CONSEQUENCE CATEGORY						
	ECONOMICS (US$) (Assets)	slight damage (<10k)	minor damage (10-100k)	local damage (0.1-1m)	major damage (1-10m)	massive damage (>10m)
	HEALTH & SAFETY (People)	slight injury	minor injury	major injury	single fatality	multiple fatalities
	ENVIRONMENT	slight effect	minor effect	moderate effect	major effect	massive effect
	REPUTATION	slight impact	minor impact	moderate impact	major impact	massive effect
CONSEQUENCE CLASS		NEGLIGIBLE	LOW	MEDIUM	HIGH	EXTENSIVE

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

PSV RBI

Example of a typical PSV RBI matrix:

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

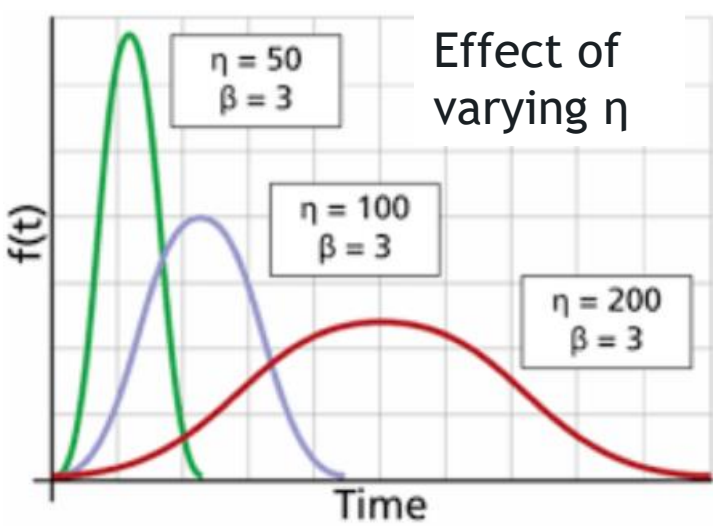
Consequence score	Maximum recommended interval between inspections (months)			
	Grade 0	Grade 1	Grade 2	Grade 3
1	6	12	24	48
2	12	24	36	48
3	12	24	48	60
4	24	36	48	60
5	36	48	60	72

Downsides to this approach

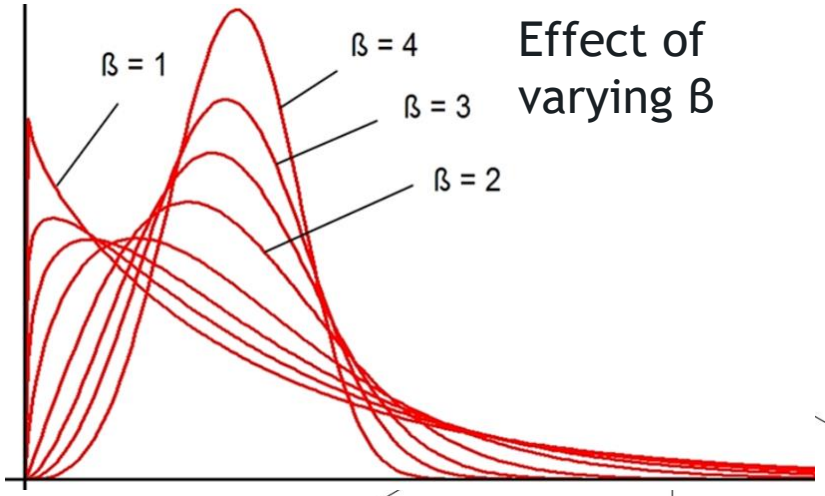
- Criticality assessment is based on semi-quantitative data and qualitative questions
    - Different users may come up with different answers
    - Arbitrary final selection
- PSVs operate as part of a designed safety system
    - The SIL assessment is where the complete safety loop is captured
    - 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 (ß and η)



Effect of varying η

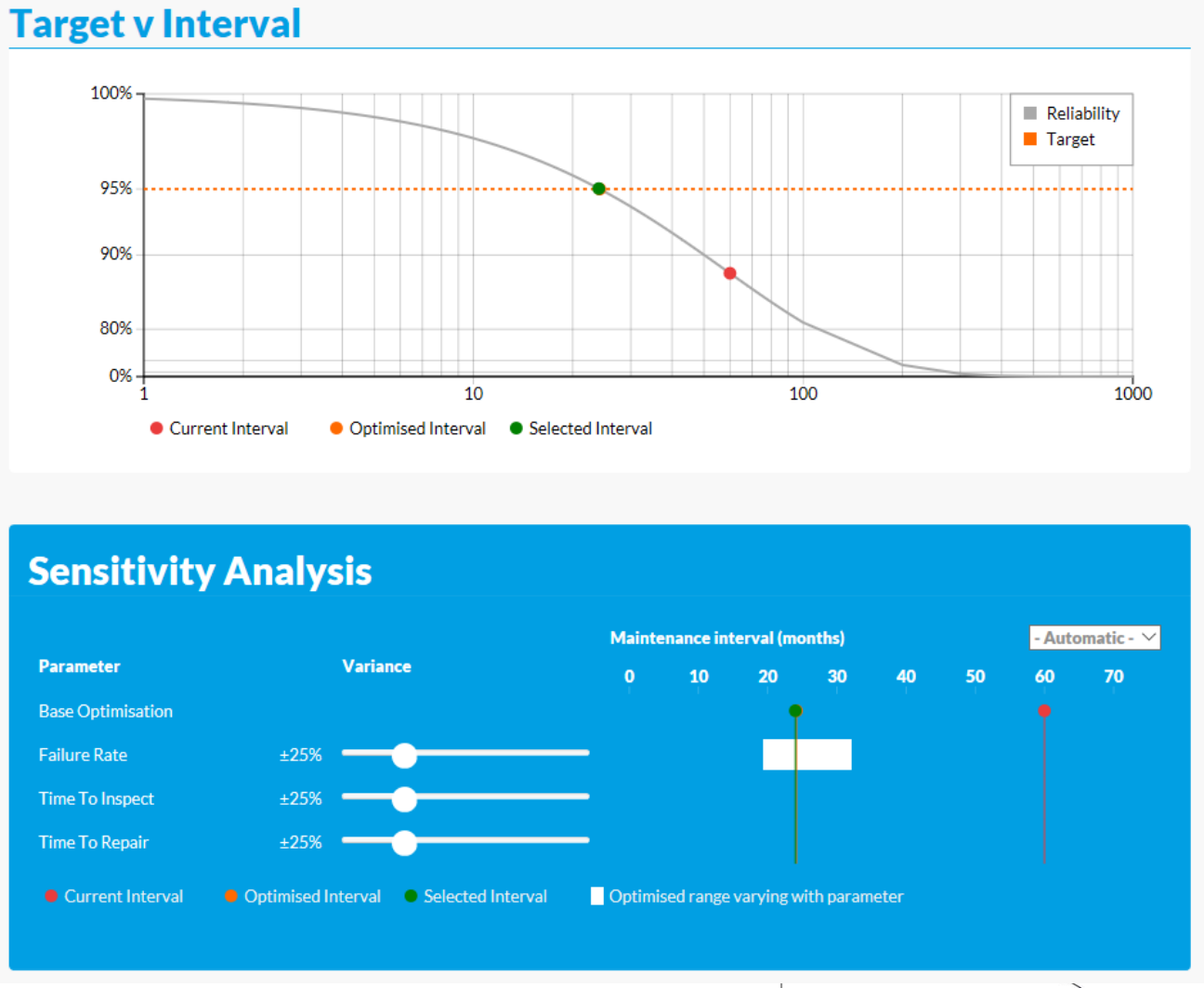


Effect of varying ß

- 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:



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

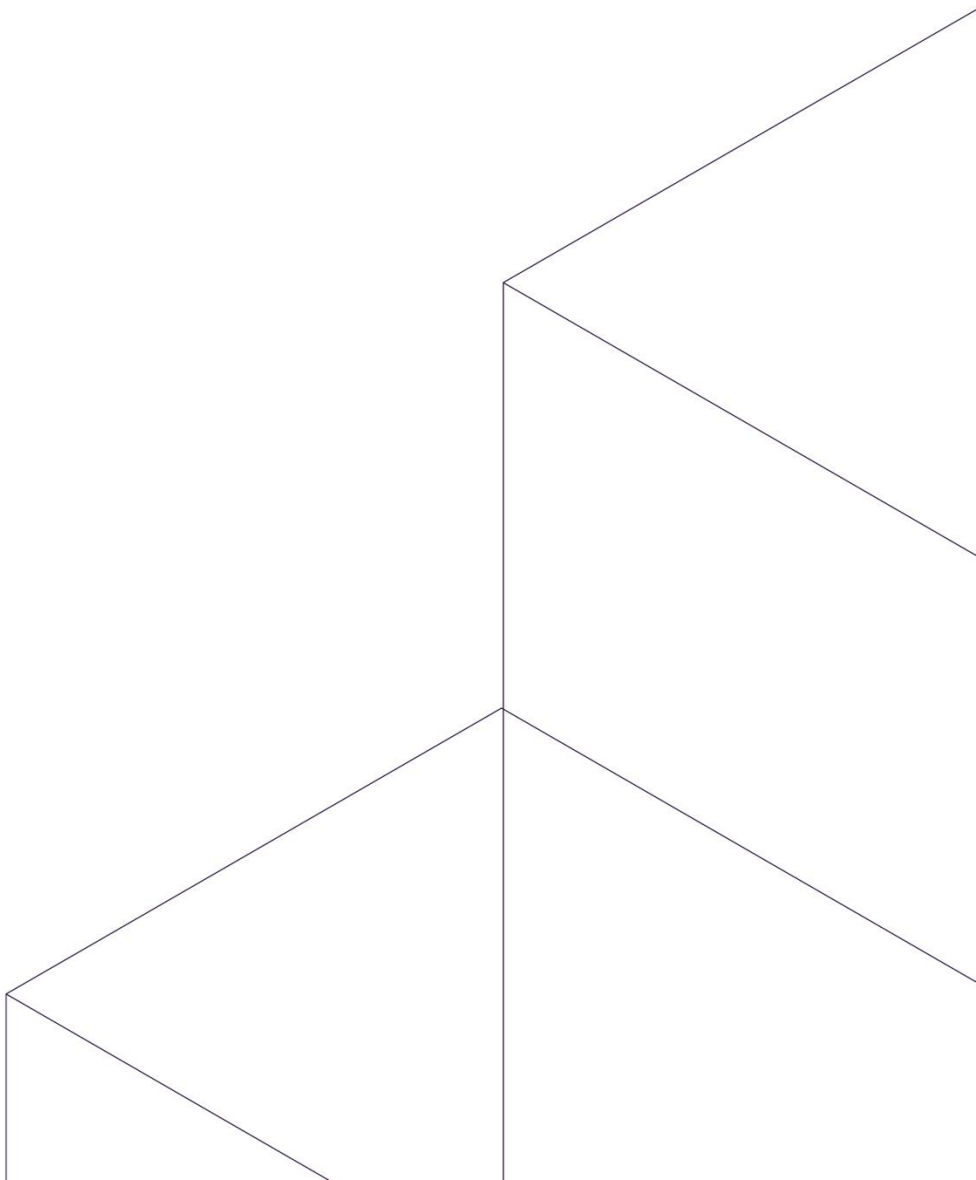
Disadvantages of this approach?

- 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



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