Engineering Resolution of Production Choke Vibration for South American FPSO

Background

Severn supplied an Oil & Gas producing FPSO off the east coast of South America with over 100 choke valves.

To manage high-pressure multiphase well media, the facility uses a suite of Severn-engineered choke valves across varying sizes and pressure classes.

Among the 105 choke valves supplied, 15 valves serve as the main production chokes, configured as:

- Size: 16" × 18"
- Rating: ASME 2500
- Trim: CCD & CC Vari stage trim
- Materials: F51 body and F51 + Tungsten Carbide trim
- Rangeability: Significantly less than 1% due to tortuous path design (CCD Trim) for the lower portion of the travel, while utilising a concentric cage design to meet maximum production requirements.
- Customised trim characteristics

These production chokes were designed and delivered strictly on the process conditions contained in the process datasheets.

The issue: Severe Vibration Under New Process Conditions

Initial Field Observation

The facility operations team reported the following:

- Severe vibration when the choke opened beyond 20% travel
- Unstable control, including hunting around the 20% travel
- Production had to be stopped at 20% due to heavy vibration

A review of the Choke valves performance revealed:

- The valve's actual travel fluctuated significantly when commanded above 20% travel
- Pressure transmitters P1 & P2 exhibited unstable profiles
- The instability consistently aligned with the transition region between the stages of the Vari-stage trim.

Severn concluded that a technical investigation and critical root cause analysis was needed before significant production loss was caused and increased chances of potential safety issues.

It was identified that actual well flow rate and pressure conditions had diverged dramatically from the original design data provided at the engineering stage, specifically:

- Liquid flow rate doubled
- Vapour fraction increased substantially
- Actual pressure drop was approximately 100 bar, far above the 76 bar second-case condition defined in the datasheet
- Significant increase in capacity due to modified production requirements

Why Vibration Occurred:

The original CCD trim was designed on the process data sheet for:

- High ΔP, low flow (startup conditions)
- Up to 20% travel, where multi-stage pressure letdown controlling high velocity, thus preventing cavitation phenomenon

However, under the new conditions:

- The choke was forced beyond 20% travel despite still experiencing high ΔP (approximately 100 bar)
- This pushed the flow into the proportion of Vari-stage trim with lower stages, which is intended for low ΔP, high-flow operation

- Severn's unique power factor calculations increase to far above the acceptable range
- This mismatch caused severe vibration and oscillation

Due to these new conditions, the operator later acknowledged that the FPSO could not increase production rates as needed.

Severn's Engineering Response

Severn collaborated with the operator over multiple engineering reviews, covering:

- Verification of original sizing methodology
- Reassessment of well fluid properties
- Evaluation of multiphase power-factor impacts
- Redesign of choke internals to cope with new operating parameters

Key findings included:

- The transition zone (20–30% travel) was unstable under new well conditions, leading to potential unsafe operations due to severe vibration,
- Cage trim operation at high ΔP (>70 bar) is not permissible
- Sustained operation above 20% under high ΔP would likely result in catastrophic trim erosion or complete choke failure leading to possible unplanned downtime and significant loss of production

Severn's Engineering Solution

It was identified that the change in process conditions meant a new custom engineered solution was needed, specifically a bespoke designed an upgraded Vari-stage trim.

This new custom engineered trim solution needed to:

- Provide more multi-stage pressure letdown for higher ΔP, high flow conditions
- Maintains stability throughout the valve travel
- Fits within the existing 16" × 18" choke body design
- Minimise downtime, increase production rates and reduce total ownership costs

Final Design Delivered

Severn supplied a full CCD Vari-trim upgrade, offering:

- Rated Cv to achieve maximum capacity in existing valve body with high ΔP conditions
- Extended multi-stage pressure-letdown capability, providing:
  - Lower trim exit velocity
  - To handle the physical complexities of a three-phased media
  - Trim guard: protection of the solid tungsten carbide trim against large solids contained within the media
  - Erosion resistant materials: To protect against sand entrained within the flowing media
  - Dramatic vibration reduction
  - Power factor reduction
  - Customised trim characteristics to meet extremely wide-ranging controllability requirements

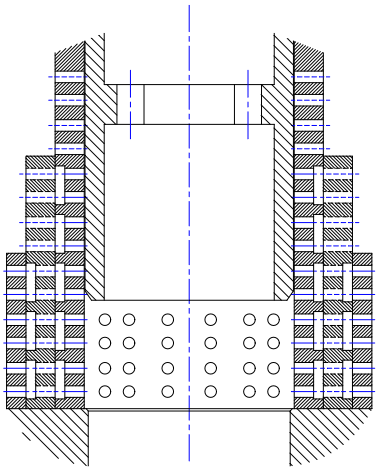

Fig 1: CCD Vari-trim

Due to the complex requirements as stated above, multiple options were provided by Severn to the FPSO operator. Through extensive discussion and collaboration between Severn and the FPSO operator, the desired solution with the full CCD Vari-trim design was chosen due to it being the most effective in terms of reliability, performance and cost effectiveness and therefore the optimal solution for the operator to meet all process and commercial requirements.

The operator's preference was to retain the existing valve bodies to minimise capital cost and downtime, making the CCD Vari-trim solution optimal given the site constraints.

Results: Increased, Stable Production & Proven Field Success

The FPSO operator issued formal positive feedback:

''Following in-depth discussions on the spurious actuations and high vibrations affecting three choke valves on the FPSO in question, we are happy to share excellent news.

Thanks to Severn's outstanding support and engineering design, the new trim solution has been implemented across all required valves.

The valves are now operating flawlessly—vibrations have been completely eliminated, the client is satisfied, and operations are running safely and reliably at full capacity.

This is a special thank you for your commitment to an application that required significant effort: Addressing numerous client clarifications, meeting stringent high-pressure multiphase fluid design requirements, selecting suitable materials for a corrosive environment, and delivering all of this within the shortest possible lead time."

Quantifiable Choke Valve Performance Benefits:

- Zero vibration across all upgraded valves for the complete travel
- No more hunting evidenced/witnessed
- Restored production control stability
- Increased production capacity
- Risk of unplanned shutdown removed
- Existing choke bodies retained (major capex savings)
- Extended trim life under severe multiphase service
- Safer operation of the wellhead

Conclusion:

This project shows Severn's advanced choke design and engineering capability in extreme multiphase conditions. Despite receiving process data that diverged significantly from actual well behaviour, Severn rapidly diagnosed the issue, engineered a tailored trim solution, and supported the FPSO operator **with significant collaboration** through every stage of review, redesign, and commissioning.

The outcome:

- Full operational stability restored
- Increased production rate substantially
- Equipment integrity protected
- Substantial cost avoidance realised
- Strong trust built between customer/operator and Severn

This technical success demonstrates Severn's ability to solve the most extreme and challenging severe service applications in modern deepwater production environments.