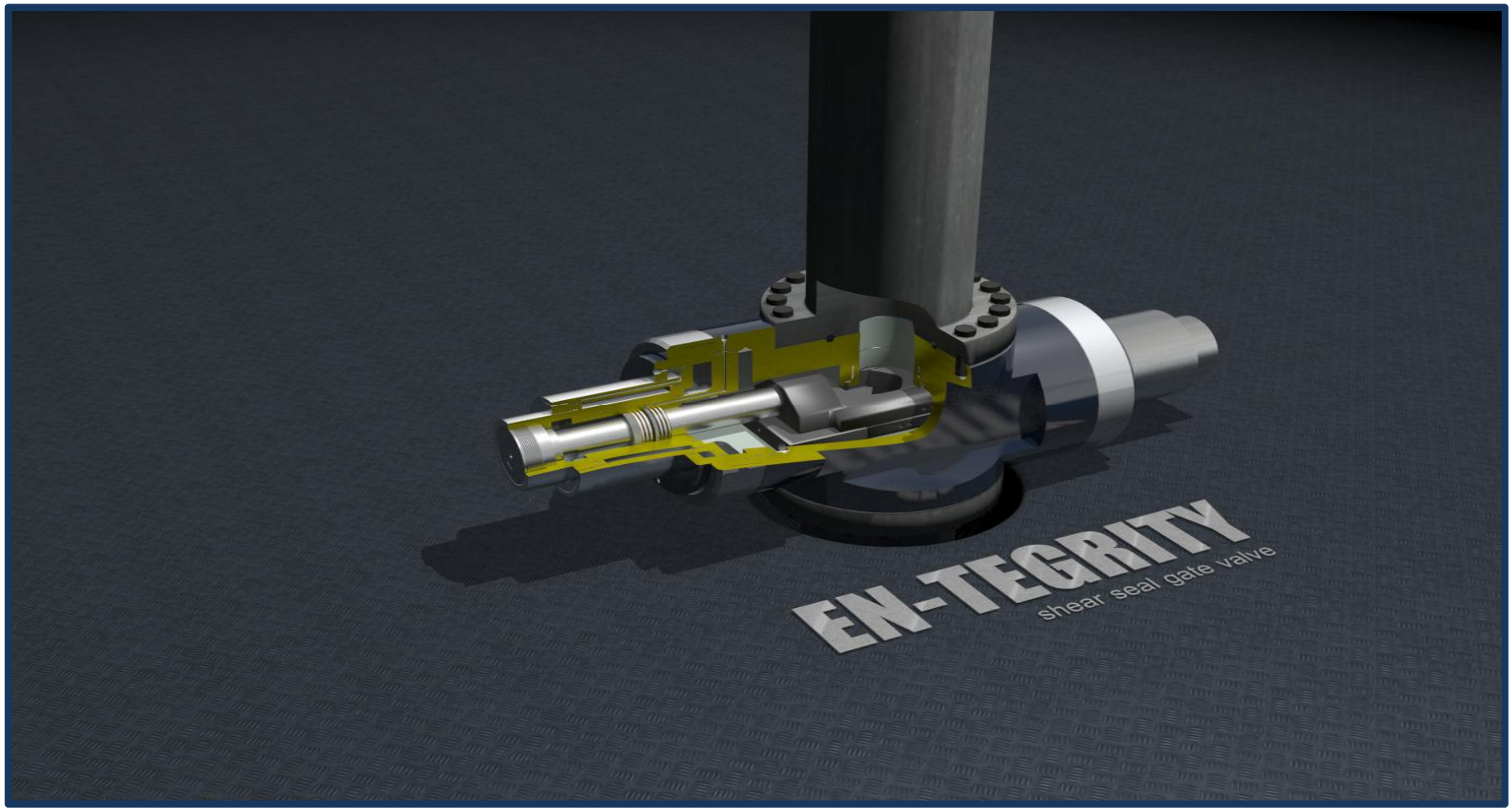
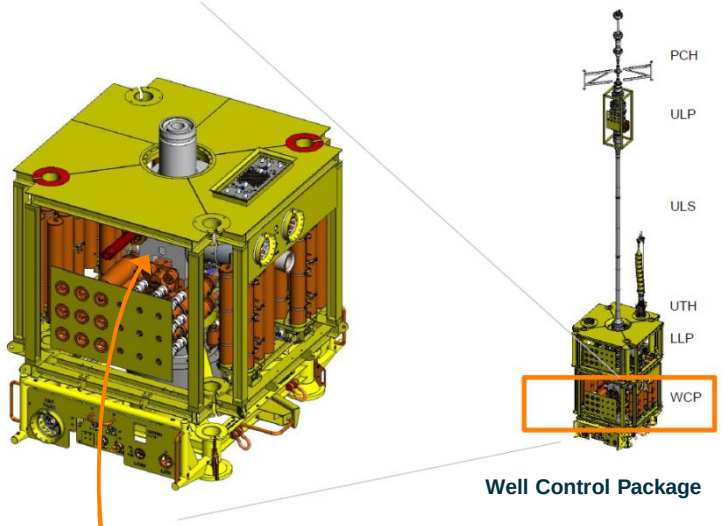


En-Tegrity

A step change in subsea well control safety

Product Overview

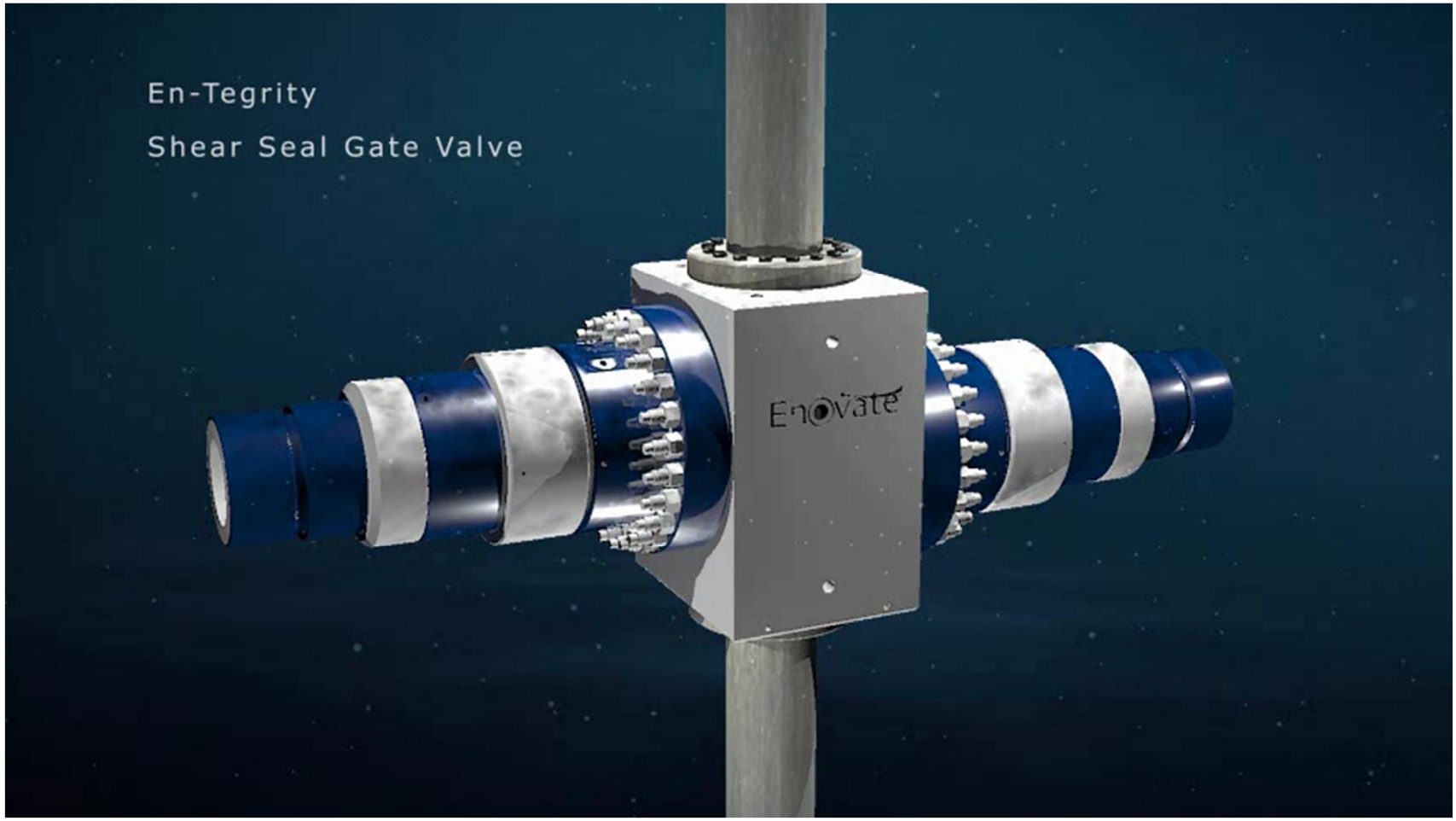
- 7-3/8”, 10,000psi, Shear & Seal Gate Valve
- Main Well Barrier in Intervention Well Control Package (WCP)
- Features
  - Bi-Directional Sealing
  - Metal-to-Metal sealing (from below)
  - >1,000,000 lb Shear Force
  - Designed to shear all media as per Norsok D-002 (2000), Annex B
  - Capable of shearing 3.5”, 15.5 lb/ft, S-135, Drill Pipe Connection
  - ‘Pull to close’ - bore pressure assists valve closure, unlike a conventional ‘push-to-close’ ram.
  - Ability to open under full pressure differential
- Intended Applications
  - Safety Head (SH)
  - Working Valve (PIV and RV)



Well Control Package

7-3/8” En-Tegrity Safety Head

Product Overview



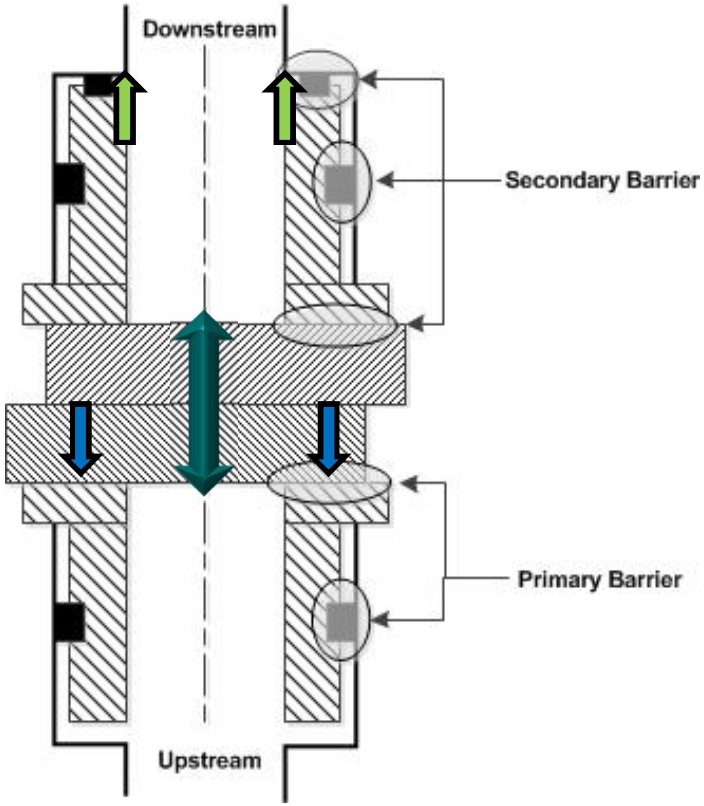
Barrier Philosophy

- **Dual Independent Barriers from Below**

- Primary well barrier comprises
  - M2M seal between lower seat and seal plate
  - Thermoplastic seal between lower lip seal on the lower seat & seat pocket
- Secondary well barrier comprises
  - M2M seal between upper seat and seal plate
  - Thermoplastic seal between lower lip seal on the upper seat & seat pocket

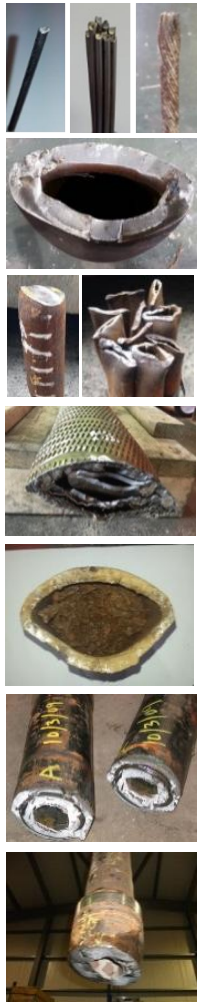
- **Single Barrier from Above**

- Barrier comprises
  - M2M seal between upper seat and seal plate
  - Thermoplastic seal between upper lip seal on the upper seat & seat pocket



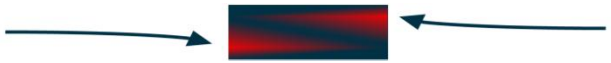
Shear & Seal Capability

- Delivers ca. 1,000,000 lb Shear Force
- Designed to shear all media as per Norsok D-002 (2000), Annex B and 3.5”, 15.5 lb/ft, S-135, Drill Pipe Connection
- Default cut behaviour is to shear blade to blade
- Potential secondary shear against the upper seat for media in neutral tension or against both seats when media is in compression
- Prototype 7” and 13-5/8” En-Tegrity assemblies completed extensive shear testing evaluation:
  - 7” Prototype shearing up to a 3.5”, 15.5 lb/ft, S-135 Drill Pipe Connection
  - 13-5/8” Prototype shearing up to a 6-5/8”, 34.0 lb/ft, S-135 Drill Pipe Connection

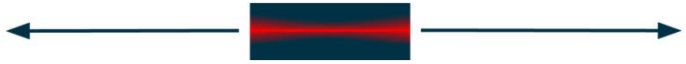


Shearing Method

- Conventional ‘push to close’ Rams
  - Rods in compression, deflection of blades



- En-Tegrity ‘pull to close’ arrangement
  - Rods in tension, self-alignment of blades



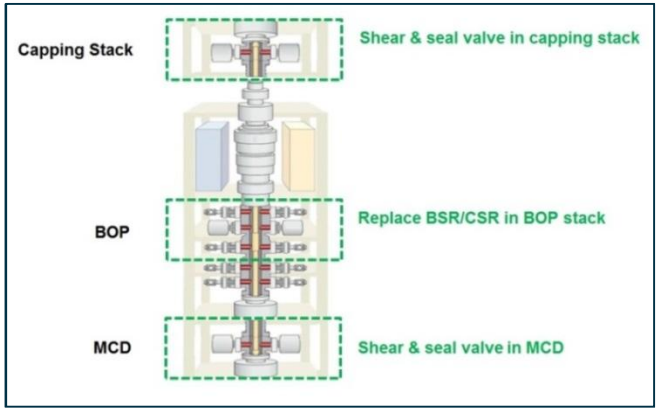
- Blade profile centralises media during shearing process

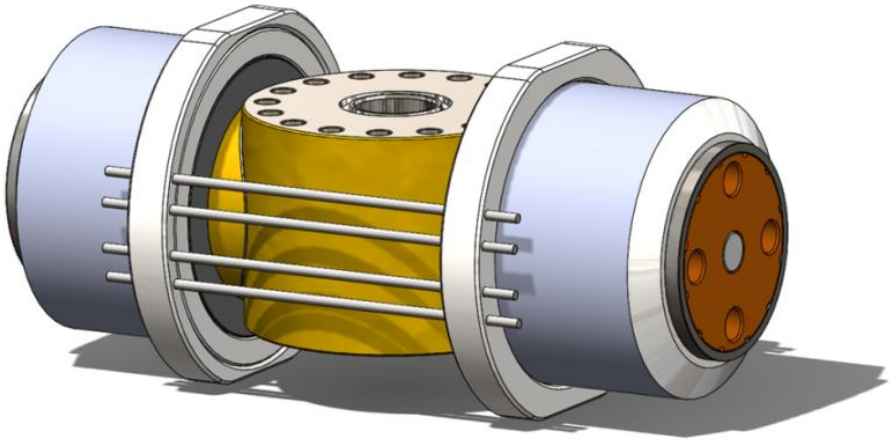
Qualification Overview

- API 6A, Annex F, PR2 Tested
  - Valve (-18°C to +121°C), Actuators (-4°C to +65°C)
  - 200 x MWP Differential Breakouts from Below
- API 17D, Annex L, Hyperbaric Tested
  - 3,000m Water Depth
  - 200 Open / Close Cycles under Hyperbaric Conditions
- API 6A, Annex I, Class II Flow Tested
  - 50hr, 2% sand flow period
  - 500 open/close cycles under 2% sand flow conditions
- API 6A, Annex F.1.13.5.3 Seal Fixture Testing
  - Well wetted non-metallic seals (-18°C to +121°C)
  - Material Class DD/EE (5% CO_2)
- Norsok D-002, Annex B, Shear Tested
  - Incl. Tension & Compression Cuts
- API 16A (ISO 13533), Annex C.2.3 Shear Tested

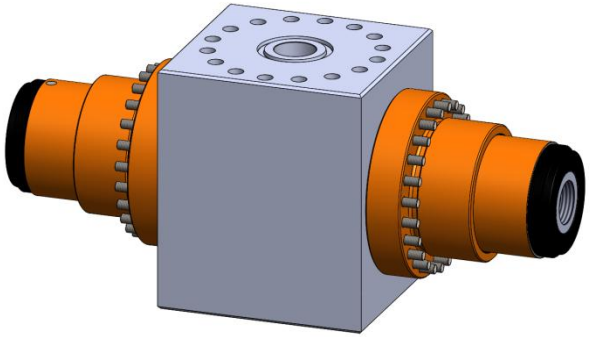
Future Developments

- An 18-3/4” version of En-Tegrity, delivering 3,500,000lbf, has been developed to TRL2 for use in:
  - a BOP stack as a replacement to CSR/BSR
  - mudline closure device
  - capping stack





- A 5 inch version, delivering 300,000lbf, has been developed to TRL 2 for use in vessel lightweight intervention systems
  - A 20K version is also in development



Summary

- The 7-3/8” En-Tegrity has been qualified as a Safety Head able to run all NORSOK D-002 media at temperatures from -18°C to +121°C, in a class II, DD/EE sour environment at a depth of 3,000m
- Qualification ongoing for working valve (PIV & RV) applications
- Other applications of En-Tegrity technology are under development