

Report title:	Integral Iso-Tool Analysis and Validation	Det Norske Veritas (U.S.A.)
Customer:	Integral Pipeline Technologies	North America Oil & Gas
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Det Norske Veritas (U.S.A.), Inc. (DNV GL) was retained by Integral Pipeline Technologies (Integral) to conduct analyses to support and validate the testing of Integral’s 24-inch Iso-Tool pipeline isolation device. The conclusions for each phase are summarized below, and detailed results are provided in the attached report:

**Theoretical Calculations**

A range of configurations were analyzed based on the information provided:

- The maximum pressure capacity ranged from 254 psi to 575 psi, based on the grip force ranges analyzed.
- The maximum predicted hoop stress based on the various grip contact areas, wall thickness, and applied grip force ranged from 10,402 psi to 128,881 psi. The maximum allowable stress limit will be dependent on the specific pipe grade used in operation.
- The pressure holding capacity is expected to be stress limited by the point at which the hoop stress from the outward grip force exceeds defined limit.

**Numerical Modeling**

- The maximum strain calculated during the tool setting simulation at the grip teeth was approximately 256 µε, which is below the estimated yield strain of approximately 2,000 µε for the x52 pipe steel analyzed.
- Based on the design and test configurations modeled, the axial contact length for the seal is approximately 6.1 inches, and the total seal contact area is approximately 257.6 in<sup>2</sup>.
- The corresponding calculated maximum pressure capacity of the seal, based on the seal contact area, seal friction, and outward force is significantly greater than the expected operating pressure, reported as 300 psi for the 24 inch tool.
- The pressure holding capacity is expected to be stress limited by the point at which the hoop stress from the outward grip force exceeds defined limit, typically the yield stress, or some allowable percentage thereof.

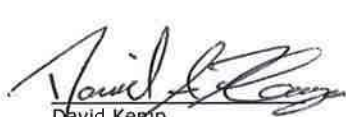
**Field Testing – 3rd Party Verification:**

- Validation of numerical model results with the field measured strains show good agreement of strain at the locations monitored.
- The maximum measured strain at the set position, for conditions similar to the numerical model, was approximately 250 µε, compared to the 256 µε calculated.
- The 24 in. Iso-Tool was shown to function reliably at pressure differentials up to 800 psig, with the pipe supported by the external clamp.
- No visual damage to the tool or the pipe was observed after testing at up to 500 psig.
- No residual strain was present after any tests at up to 400 psig, suggesting that plastic deformation is not expected from use of the Iso-tool at these pressures without any pipe clamp or reinforcement required.

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Reference to part of this report which may lead to misinterpretation is not permissible