Premium Connection Product Line Validation and Extrapolation
Connection Brief

Industry Standard Connection Qualification Testing and Evaluation

API RP 5C5:2017 4th ed. Annex F

Hunting Energy Services

Connection Technology Division

www.hunting-intl.com

January 2019

The evaluation of connection performance is a vital part of a reliable casing or tubing well design for the oil and natural gas industry. Tubing and casing connections are subject to loads that include internal pressure, external pressure, axial tension, axial compression, bending, torsion, transverse forces, and temperature change. The magnitude and combination of these loads will result in various pipe body and connection failure modes. Experimental testing and analytical evaluation of these loads are essential to validating a connection performance envelope.

Hunting has standardized on API RP 5C5 Fourth Edition, January 2017 for the experimental testing and validation of casing and tubing connection performance. API RP 5C5 defines tests to determine the galling tendency, sealing performance and structural integrity of threaded casing and tubing connections. API RP 5C5 considers a range of performance parameters and applies test and limit loads under conditions targeting the extremes of those parameters. Testing of the extremes of the performance parameters ensures that production meets or exceeds the performance of the tested connections.

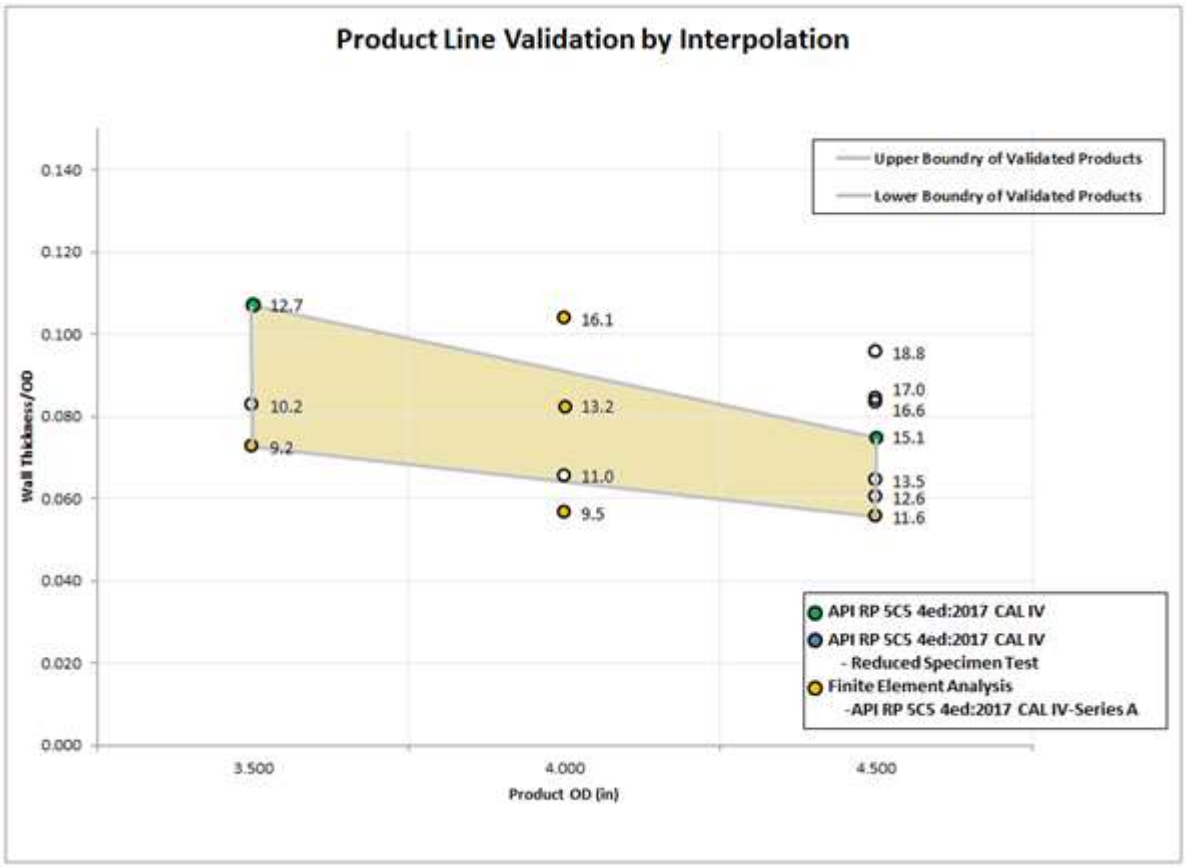
As experimental testing in accordance with API RP 5C5 is costly and time consuming, product line validation and extrapolation/interpolation of connection designs fully tested have significant benefits. API recognizes that full-scale physical testing on every diameter, mass, and grade within a product line is not practical and not necessary to define connection performance. API RP 5C5 Annex F provides a framework for product line validation and extrapolation/interpolation of connection designs.

Hunting Energy Service Connection Technology Division has established guidelines for product line validation through the interpolation and extrapolation of completed full scale physical connection testing compliant with API RP 5C5 Annex F.

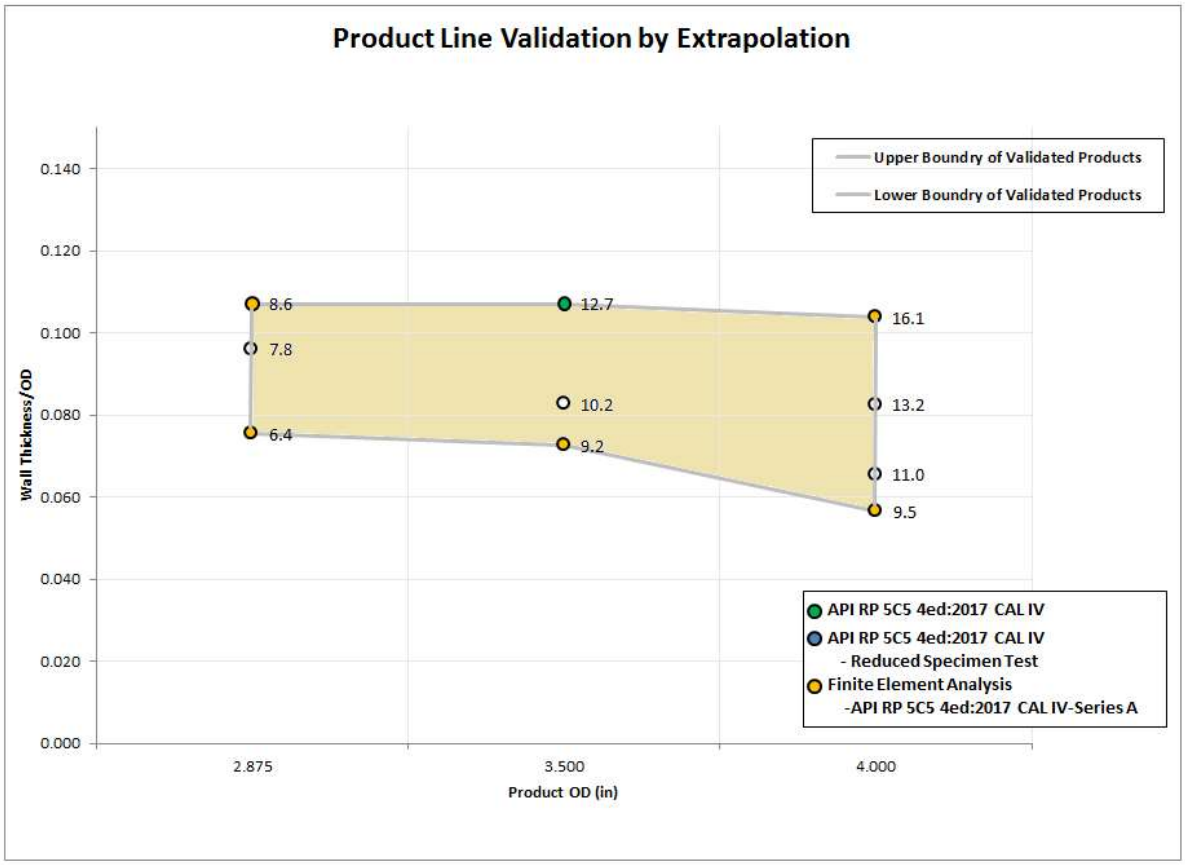
Interpolation: The results from the fully tested connections can be interpolated to different size and weight combinations provided the interpolation regions are bound by full-scale testing at the highest t/D ratio connections and by reduced specimen testing or analytical (FEA) analysis at the lower t/D connections. The Interpolated region shall be bound by straight lines connecting the interpolated region. Refer to Product Line Validated by Interpolated Testing results.

Extrapolation: The results from the fully tested connections can be extrapolated to different size and weight combinations within one API OD (above and below), provided the t/D ratio is not greater than the tested connection and not lower than 50% of the original tested connection. Testing results can also be extrapolated to interchangeable connections, regardless of t/D ratio. Refer to Product Line Validated by Extrapolated Testing results.

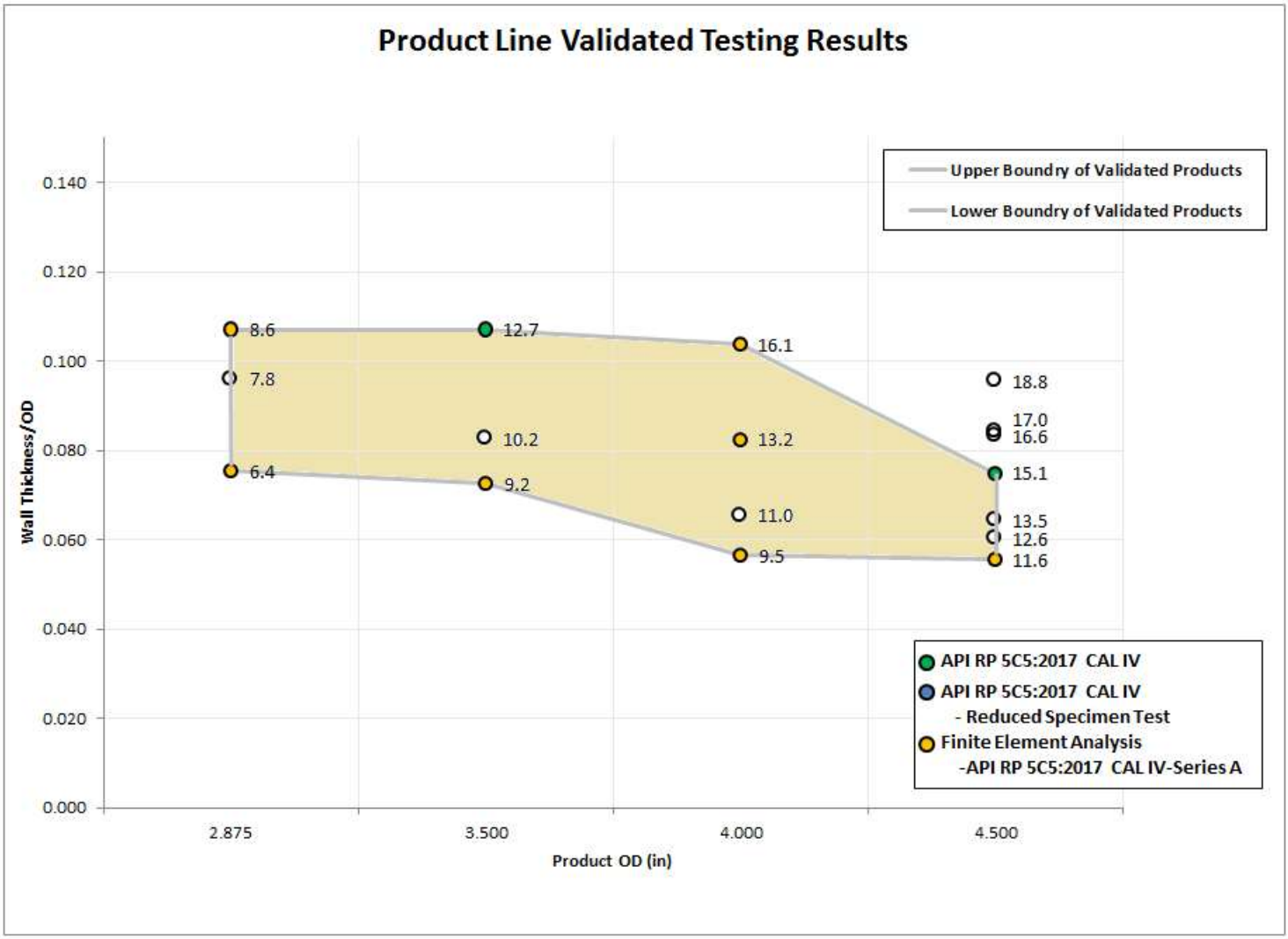
The extrapolated and/or interpolated connection's validated performance envelope shall be limited to the lowest percent Pipe VME/ CEE for the tested connection, and/or API 5C3 collapse. The pressure ratings and the CAL test of those size/weight combinations extended by extrapolation shall not be greater than that successfully demonstrated during full-scale testing. A minimum two specimen test relative to the original full CAL test is needed to increase the maximum service pressure due to either increased material grade or wall thickness. Extrapolation and Interpolation guidelines can be applied from the reduced specimen testing. Both Interpolation and Extrapolation of full-scale tested connections may be used in conjunction for Product Line Validation. Refer to Product Line Validated Testing results.



Product Line Validation by Interpolated Testing Results



Product Line Validation by Extrapolated Testing Results



In this example, full-scale CAL IV testing was completed on the 3.500 12.70 ppf (t/D = .107) and the 4.500 15.10 ppf (t/D = .0749) API P110 Grade connections. The Product Line Validation from Interpolation includes 3.500 12.7ppf down to 9.2ppf and across to 4.500 15.10 ppf down to 11.60 ppf when the Finite Element Analysis on the lighter weight connections were completed. Note that Interpolation did not include 4.000" 16.10 ppf or 9.50 ppf as well as 4.500 18.80 ppf through 16.60 ppf as they are outside the bounded area. Product Line Validation from Extrapolation of the 3.500 12.70 ppf CAL IV testing includes 2.875 8.60 ppf (t/D = .107) and 4.000 16.10 ppf (t/D = .104). Extrapolation includes through the interchangeable weights of 2.875 6.40 ppf (t/D = .0755) and 4.000 9.50 ppf (t/D = .0565). Finite Element Analysis was completed on the Extrapolated sizes and subsequent lowest interchangeable weight to confirm the galling tendency, sealing performance, and structural integrity were similar to the full-scale tested connection. Combining the Interpolated and Extrapolated sizes produces the final Product Line Validated CAL IV Testing Results for P110 material and below.

Note that 4.500 18.80 ppf though 16.60 ppf are not considered validated as they are outside the limits of Interpolation and extrapolation. A reduced 2 specimen CAL IV Test on 4.500 18.80 P110 or 4.000 16.10 ppf P110 must be completed to extend the Product Line Validation to include these sizes.