Enhance Casing Collapse Ratings through Testing and Dimensional Measurements

Prepared for: AADE Houston Chapter Deepwater and Emerging Technologies Group

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Prepared by: Lisa M. Ely, PE

Taking on your toughest technical challenges.

STRESS ENGINEERING SERVICES INC.

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What kind of collapse are we talking about?

Why does collapse happen?

- Anytime the external pressure minus the internal pressure exceeds the collapse resistance of the pipe.
  - Subsea Pipelines
    - Potential Loss of Miles of Pipeline
    - Loss of Production
  - Downhole Tubing and Casing
    - Potential Loss of Entire Well
    - Loss of Production

Why Collapse Test?

- Why Test?
  - To confirm the collapse values for actual pipe meet specifications.
  - API 5C3, API 1111, and BS 8010 contain collapse prediction equations.

Factors that Affect the Collapse Pressure

Collapse is an instability event affected by:

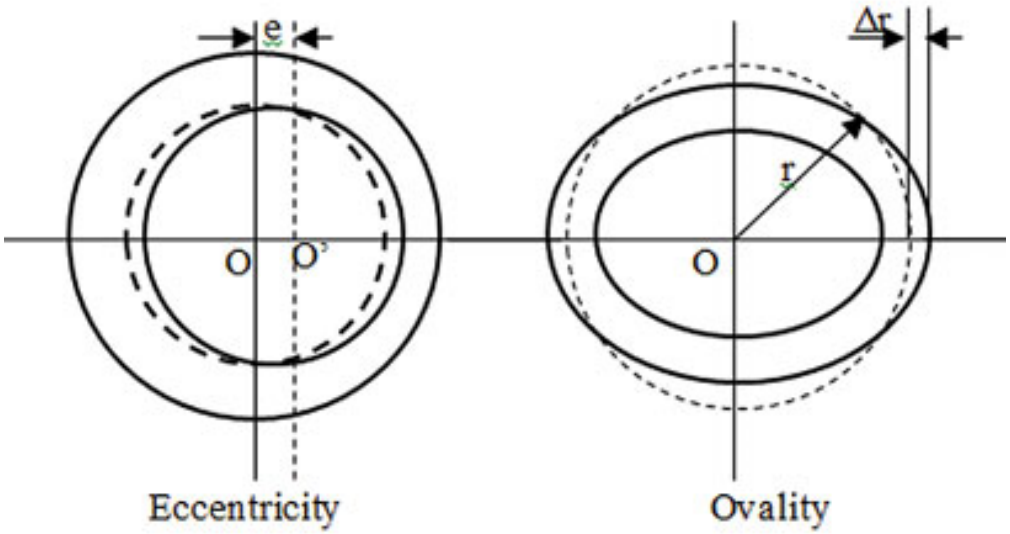
- Ovality / Eccentricity
- Residual Stress
- Axial Tension/Compression (must be zero for API-compliant testing)
- Internal Pressure
- Yield Strength/Modulus of Elasticity

- It's difficult to calculate the collapse pressure of pipe because the initiation of collapse is looking for "the weak link."

Weak Links – Eccentricity and Ovality

Eccentricity – how centered is the bore?

Ovality – how round is the pipe?



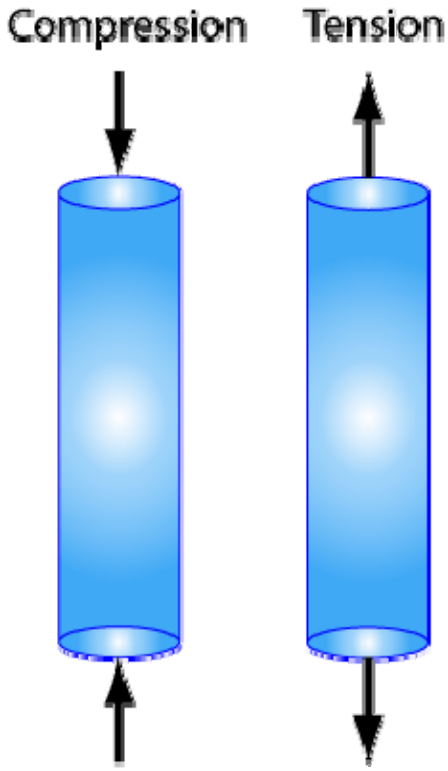
Weak Link – Residual Stress

- The pipe is under stress prior to testing from the straightening processes used in the mills or welding of the seam.
- 2D length tested at ambient temperature in accordance with ASTM E1928.

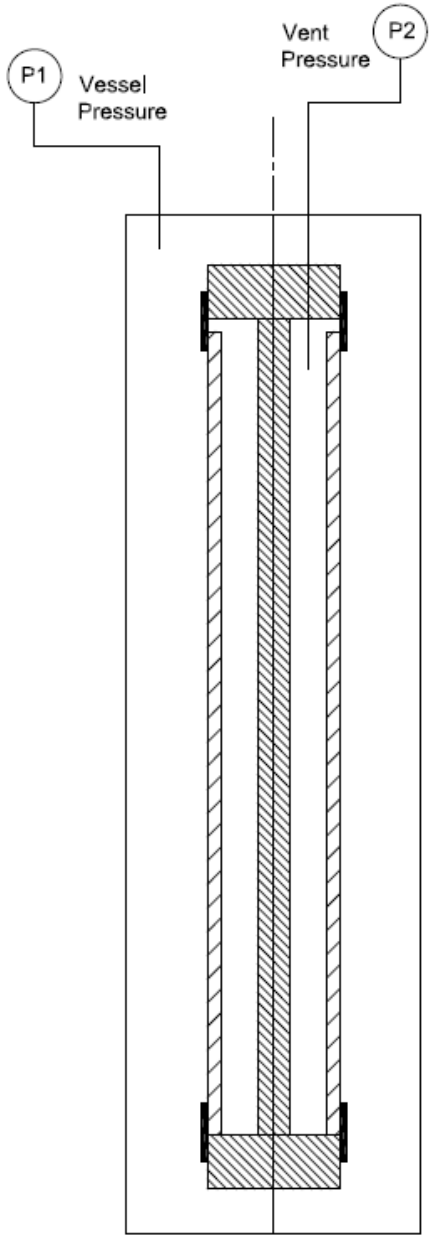
Weak Link – Axial Load

For Testing:

- The sample must be free to collapse anywhere along the sample length
- Axial load will affect the collapse rating of a sample:
  - Compression will increase the collapse value
  - Tension will decrease the collapse value



API 5C3, Annex I

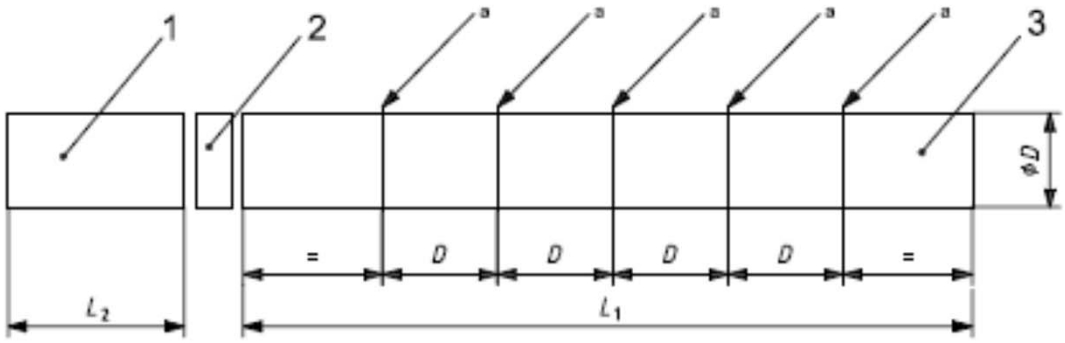


SES's testing is fully compliant with API 5C3, Annex I:

- Collapse sample length of:
  - 8D for 9-5/8" OD and less
  - 7D for larger than 9-5/8" OD
- Test apparatus:
  - 4.5" to 20" OD up to 25,000 psi
  - Test pressure applied to full sample length
  - NO radial or axial restraints, either mechanically or hydraulically
  - NO pressure applied to the inside surface of the specimen.

Dimensional Mapping – API 5C3, Annex I

- Measurements performed prior to collapse testing.
- Used to calculate ovality and eccentricity of each sample.
- Outer diameter and wall thickness measurements are recommended at five equally-spaced cross-sectional locations.



Key

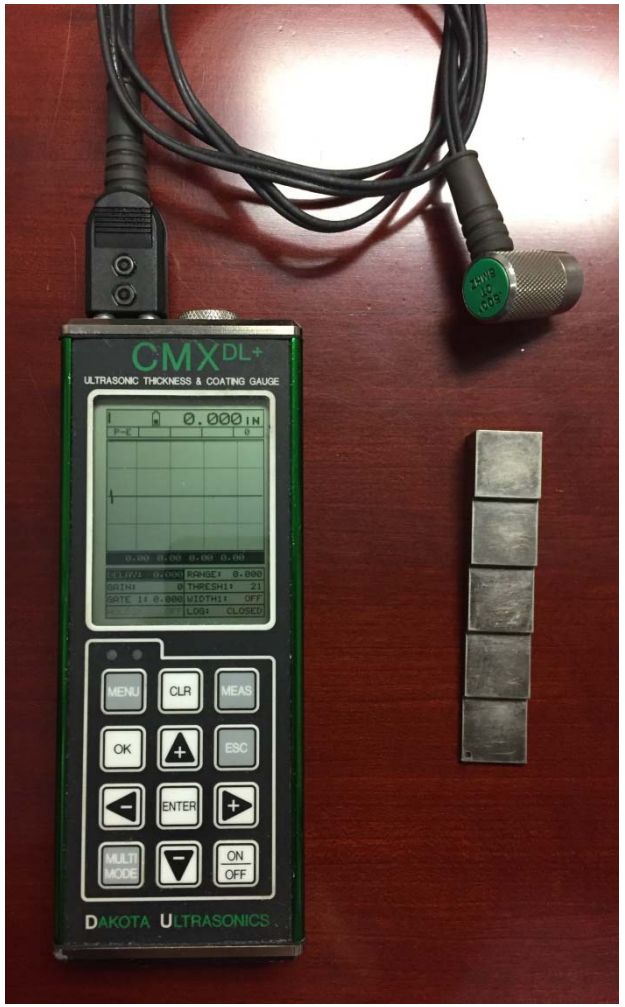
1 residual stress test specimen
2 tensile test specimen
3 collapse test specimen

Outer Diameter

- API 5C3 specified that the diameter should be measured with a pi tape at each ring and averaged.
- SES collects OD measurements at eight equally-spaced positions (45° intervals) using a wireless Mitutoyo digital micrometer.

Wall Thickness

- SES uses a digital UT meter.
- Wall thicknesses are measured at eight equally-spaced positions (45° intervals) and averaged.



Example Data Sheet

Eccentricity: $100\,\frac{t_{max} - t_{min}}{t_{avg}}$

Ovality: $100\,\frac{D_{max} - D_{min}}{D_{avg}}$

Client ID #	Nominal OD (in)	Nominal Wall (in)	Heat	Grade	Collapse Pressure (psi)
SES-01	9.625"	0.595"	Q123	HC P110	10,000

% Eccentricity:	3.98
% Ovality:	0.16

WALL THICKNESS [in]						
Position	"1"	"2"	"3"	"4"	"5"	
0°	0.604	0.608	0.609	0.599	0.592	MAX
45°	0.611	0.606	0.608	0.602	0.599	0.615
90°	0.607	0.599	0.600	0.596	0.605	MIN
135°	0.598	0.594	0.591	0.608	0.602	0.591
180°	0.598	0.601	0.596	0.601	0.610	
225°	0.599	0.607	0.601	0.595	0.605	
270°	0.597	0.609	0.606	0.603	0.611	
315°	0.607	0.614	0.615	0.605	0.600	Tot. Avg.
Average	0.603	0.605	0.603	0.601	0.603	0.603

OUTER DIAMETER (OD) [in]						
0°-180°	9.677	9.677	9.674	9.673	9.676	MAX
45°-225°	9.685	9.680	9.679	9.685	9.681	9.685
90°-270°	9.675	9.670	9.671	9.676	9.677	MIN
135°-315°	9.679	9.679	9.680	9.677	9.679	9.670
OD avg.	9.679	9.677	9.676	9.678	9.678	Tot. Avg.
						9.677

Thank You!

Lisa M. Ely
Lisa.Ely@stress.com
(281) 469-2177