UTComp®

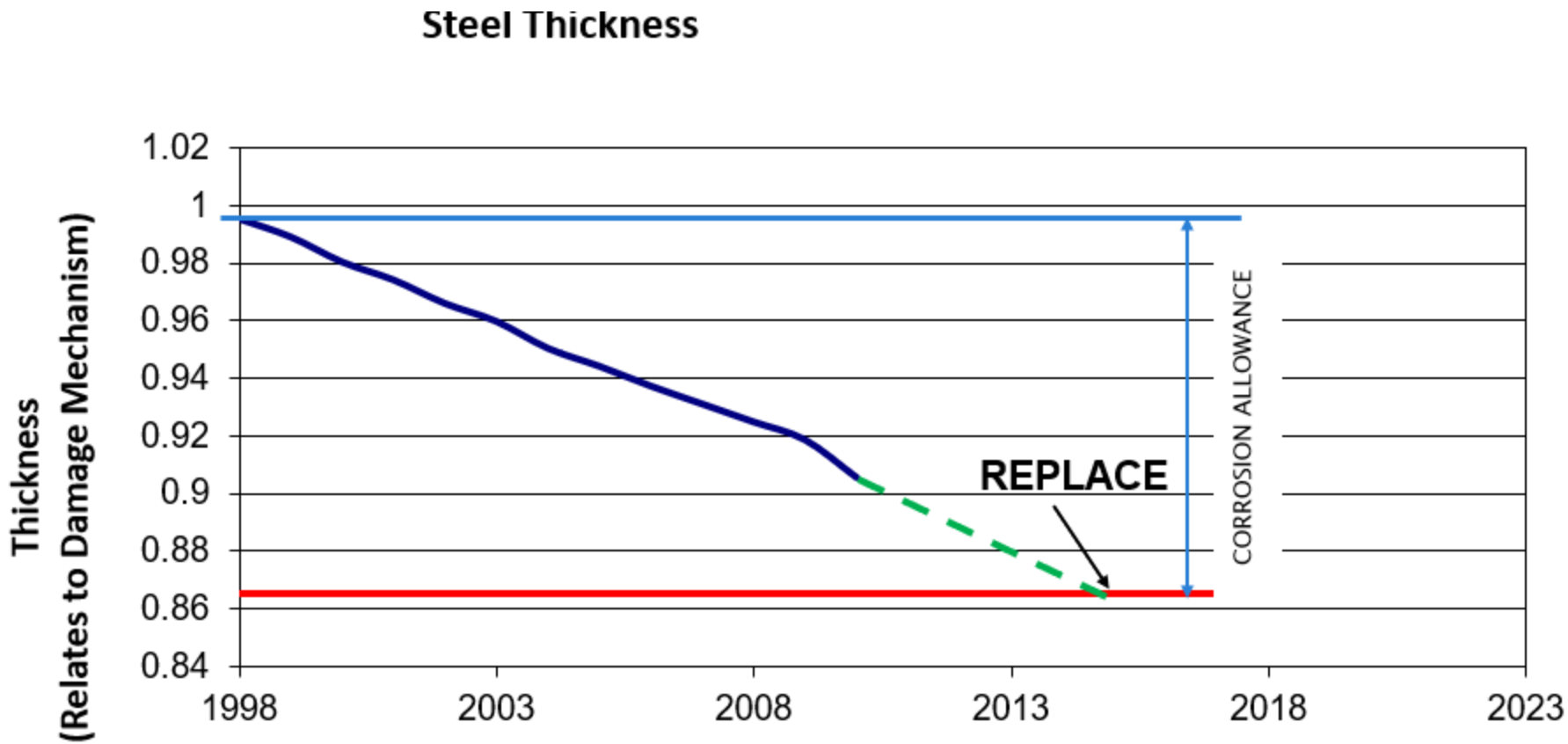
Predicting FRP Remaining Service Life: What if you could know?

Plan

Provide meaningful Fitness for Service (FFS) and condition assessment of FRP.

1. Introduction
2. FRP Damage Mechanisms
3. Measurement and Verification
4. Examples
5. Summary

Corrosion of Steel – Vessel or Pipe



Corrosion of Steel – Vessel or Pipe

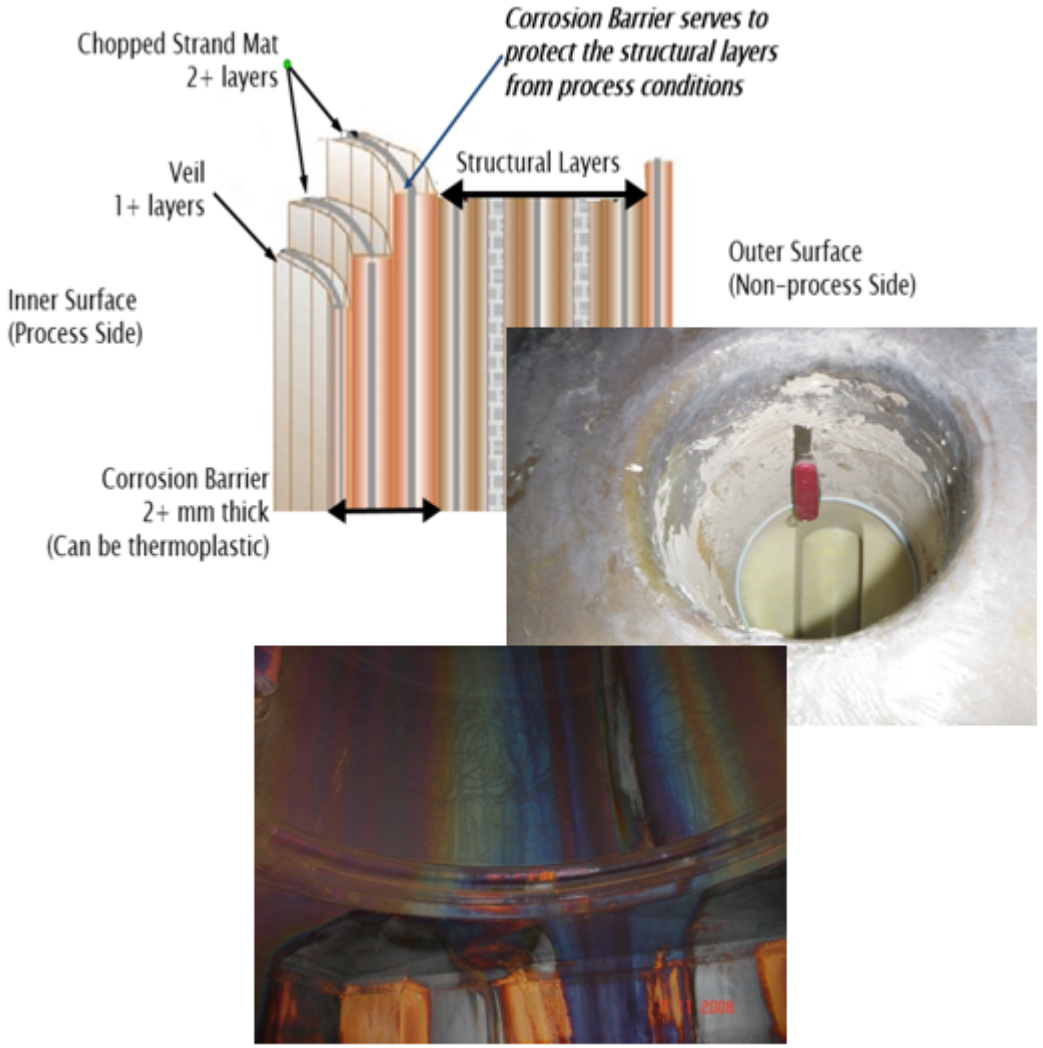
- For Steel:
  - Fitness for Service is related to structural capacity
  - Inspection methods and technology is focused on structural capacity
- Reliable assessment and prediction of remaining life.

Mechanical Integrity and Fitness for Service

- **Requires:**
  - **Non-Destructive Methods**
    - Repeatable and reliable
    - Current condition of a component
    - Can it continue functioning?
  - **Objective criteria for evaluation**
    - Based on DATA
- **Desires:**
  - **Non-Intrusive Methods**
    - Facility operating during inspection
    - Maximize safety of personnel

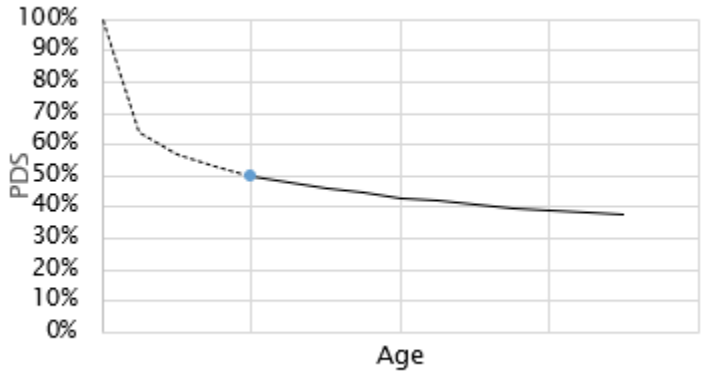
Conventional FRP FFS Inspection

- **Internal**
  - *100% INTRUSIVE*
  - Visual assessment of Corrosion Barrier
  - Assess internal bonds and structures
  - Not usually possible for pipe
  - No ASTM, API, ASME, NACE standards
  - Some materials available from TAPPI, MTI, Swerea KIMAB, Reichhold



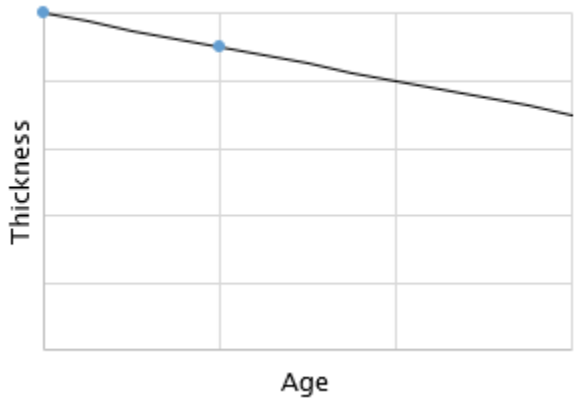
FRP Damage Mechanisms

- **Creep:** Loss of structural capacity



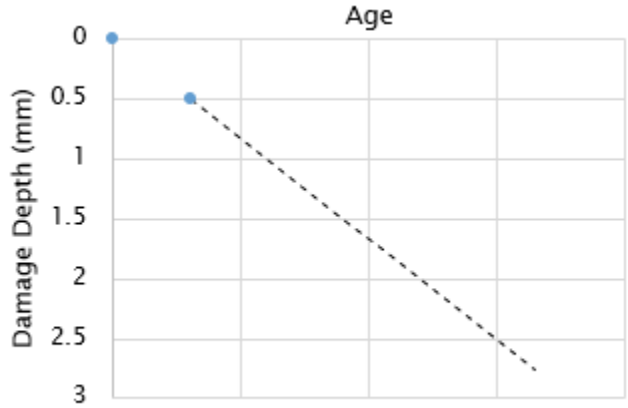
- Dominant for structural designs
- Causes safety factors of 4 to 12.
- Parameter: PDS

- **Thickness Loss:** Abrasion & oxidation



- Chlorine, pulping, slurries
- Unit: mm

- **Corrosion Barrier Damage Depth**



- Hardness reduction
- Loss of Tg
- Blisters, absorption
- Common in corrosion
- Unit: mm

History and Science

- Ultrasonic testing has been used on FRP since 1960's – mostly airplanes
- UT is *MOST COMMON NDT* used on FRP
- Commonly used for Thickness
- 50 years of studies by NASA & universities has clearly shown that UT can be used to detect Creep
- Recent discoveries have shown Corrosion Barrier Damage

Calibration

Conventional

- Constant sonic velocity
- Focussed on flaw and discontinuity detection and classification

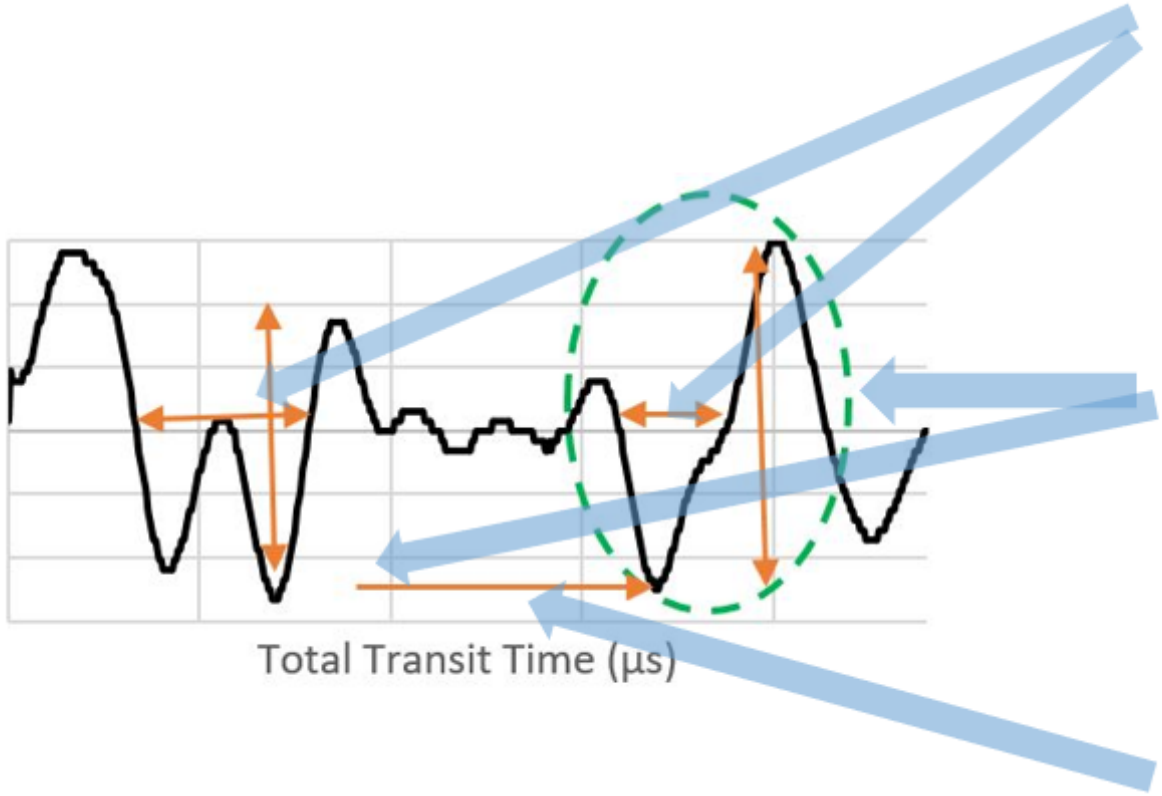
FRP Advanced Ultrasound

- Sonic velocity not constant
  - 15% variation can occur within millimeters
- Conventional calibration methods do not provide relevant data.

Inspection

- Uses off-the-shelf UT hardware
- Proprietary software
- Off-site analysis
- Non-destructive
- Non-intrusive
- Creep, Thickness and CB Damage Depth come from A-Scan.

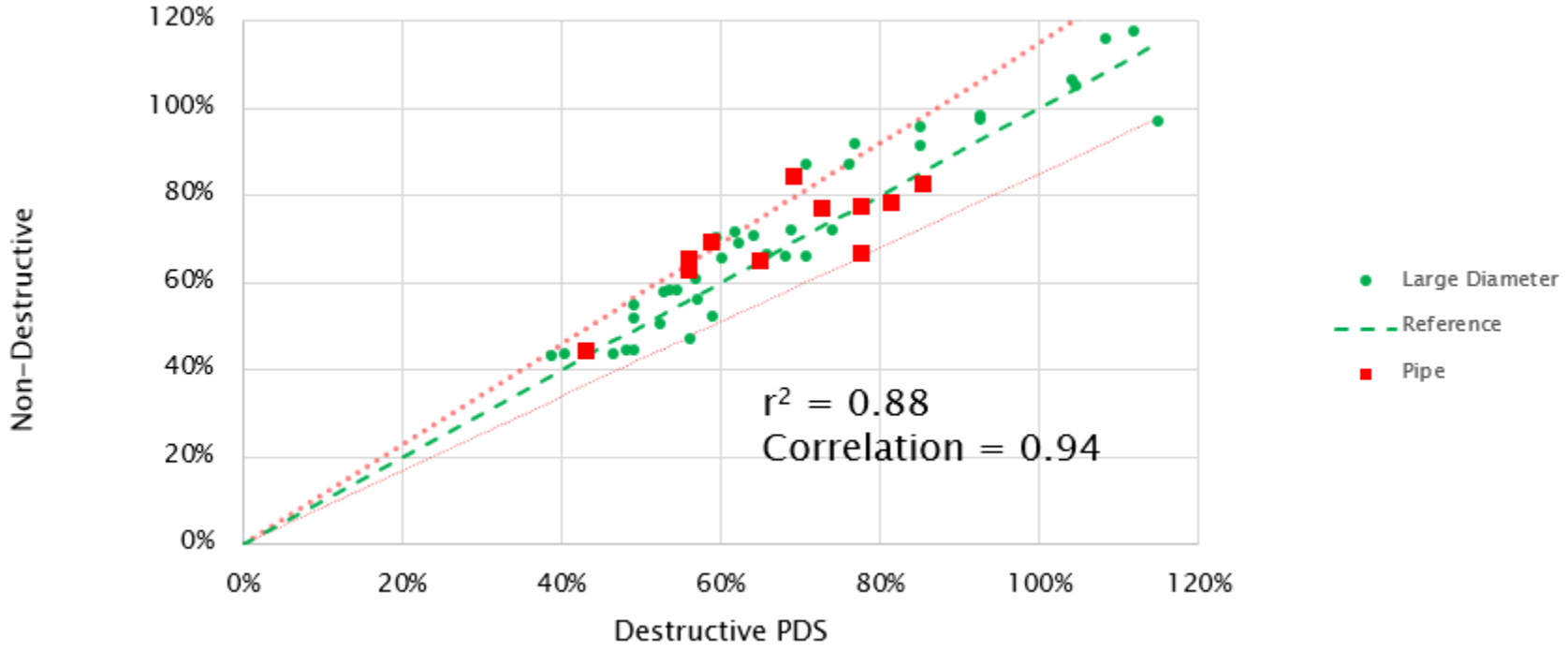
Analysis



- Must be done off-site at this time

Verification

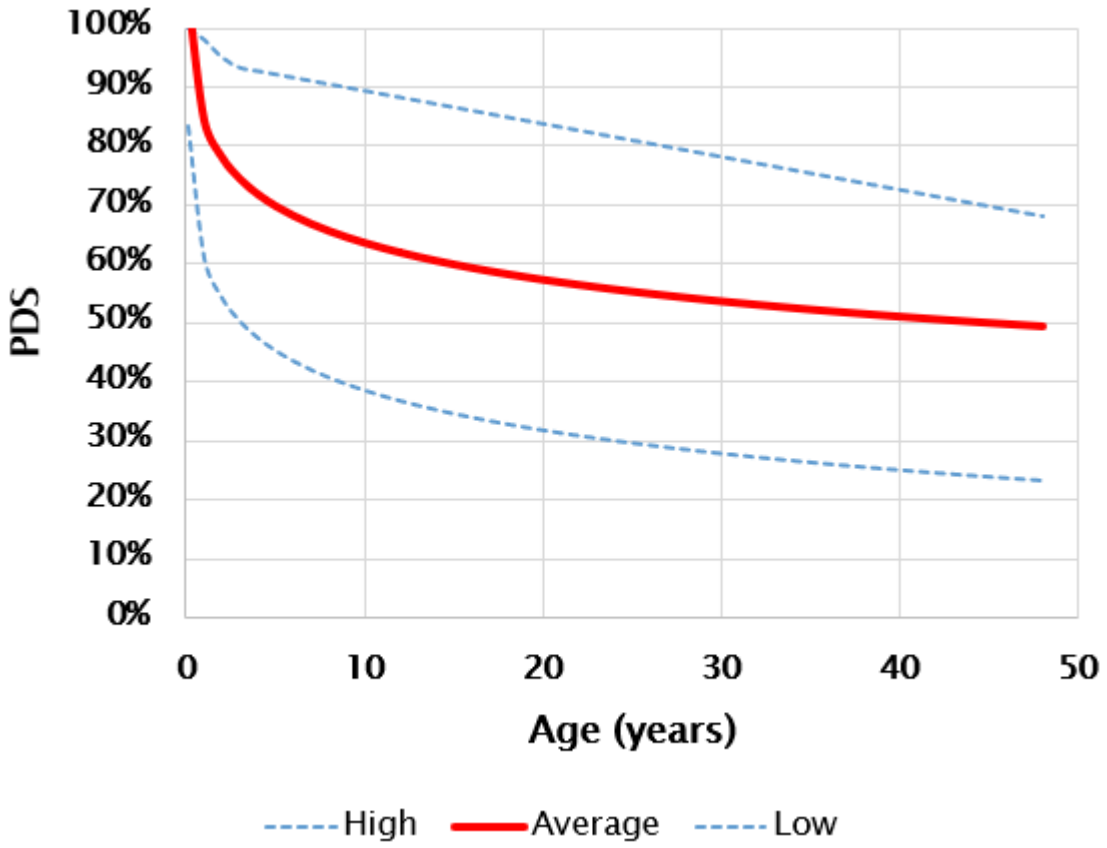
- Testing creep results against destructive testing



Data from 800+ Inspections

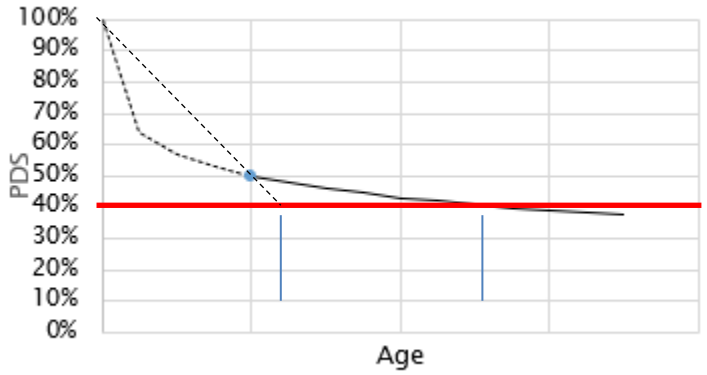
- 800 inspections with multi-year data
- FRP Age from 0 to 48 years
- Corresponds to long-term creep testing

- Experience and data show:
  - 40% or less – attention required
  - 60% or more – no action req'd



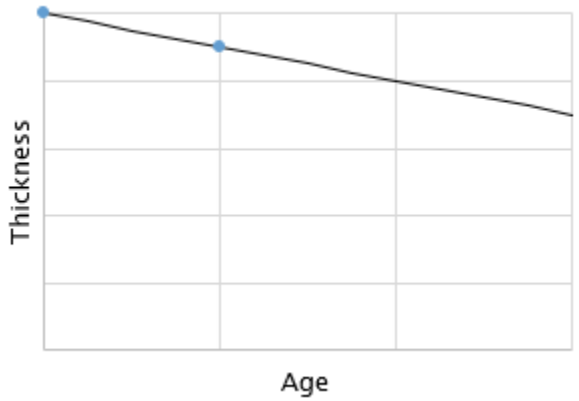
Predicting Remaining Service Life

- **Creep:**



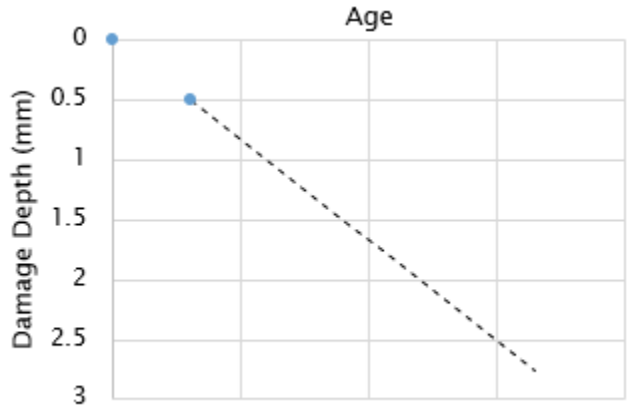
- 40% – Action required
- Several points required to establish the correct slope.

- **Thickness Loss:**



- Limit calculated based on design.
- Usually NOT the fastest rate

- **Corrosion Barrier Damage Depth**



- Some customers prefer this
- Can be related to experimental work on aging of CB

Limitations

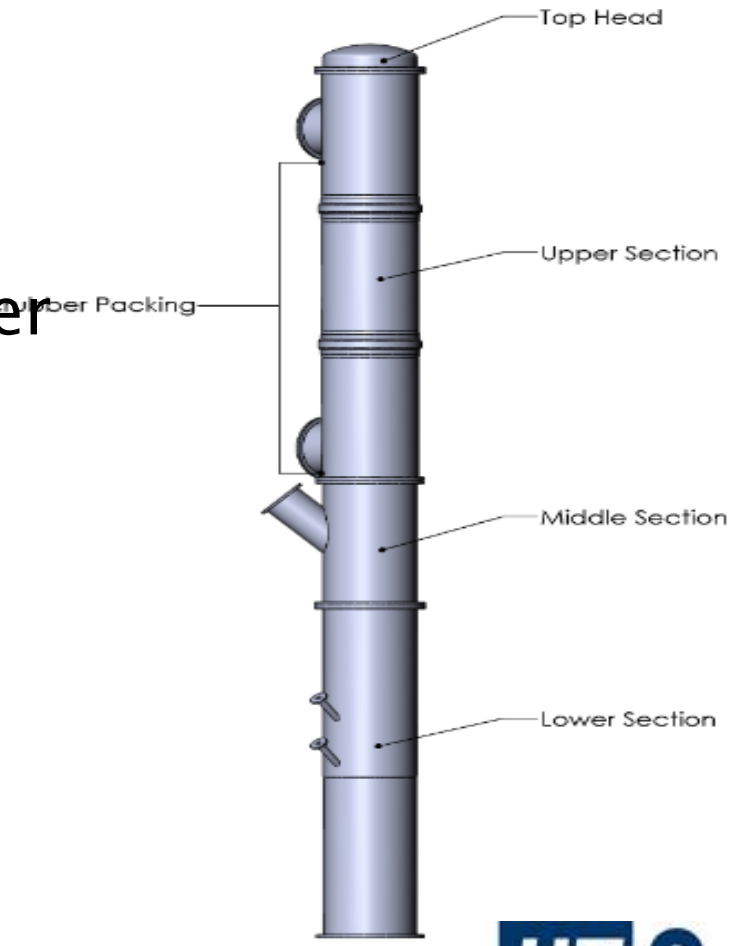
- Operates best at temperatures >50°F or 10°C
- Not useable with foam cores
- Not useable with balsa core >3inch or 7.5cm
- No verification for pipe <5cm (2inch) outside diameter
- High Magnetic fields disrupt instruments
- Transducer must be in contact with FRP surface
- Accurate interpretation in the field is not available
- Scanning method has not been developed

Case Study

Examples where this has been used to predict remaining service life.

Case Study – FRP Scrubbing Column

- Function: Scrub vapors of aHCl, aHF and organics with sodium hydroxide
- Hand lay-up with 2N 4M corrosion barrier
- Bisphenol-A vinyl ester resin with BPO/DMA cure
- Removed from service by the plant operations in 2015 based on internal visual inspection of corrosion barrier



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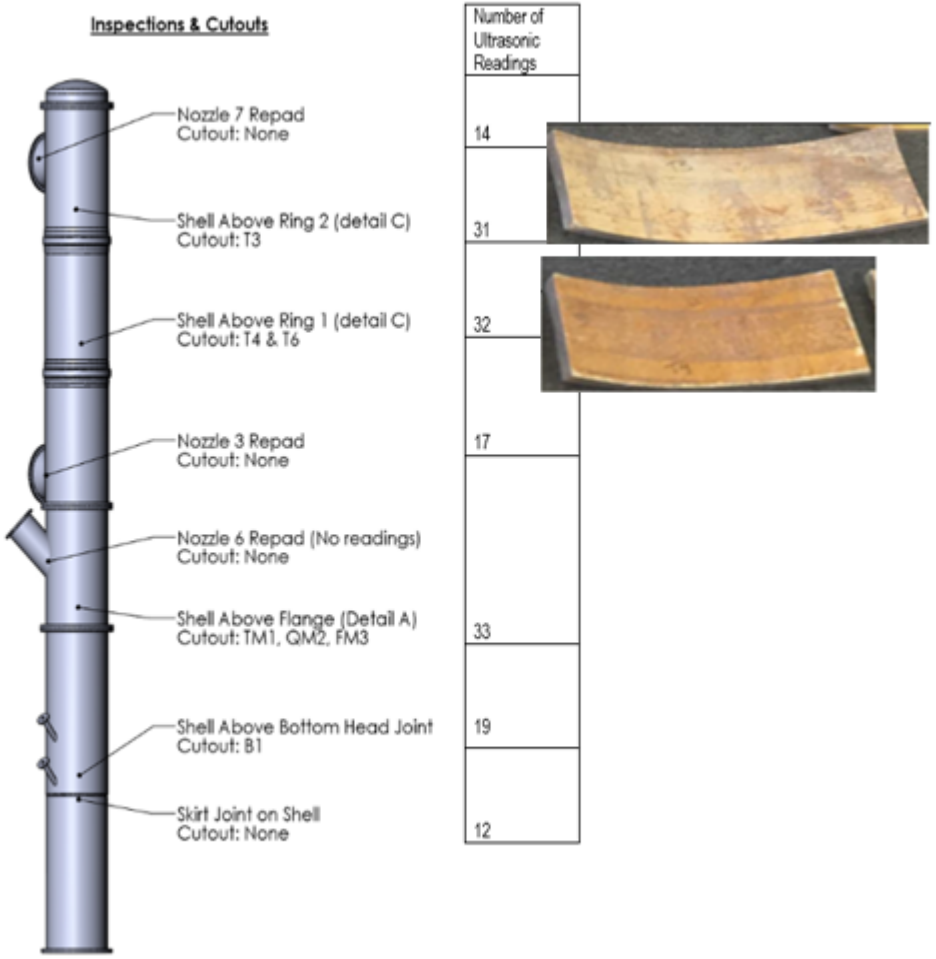
ENGINEERING – INSPECTION – CONFIDENCE

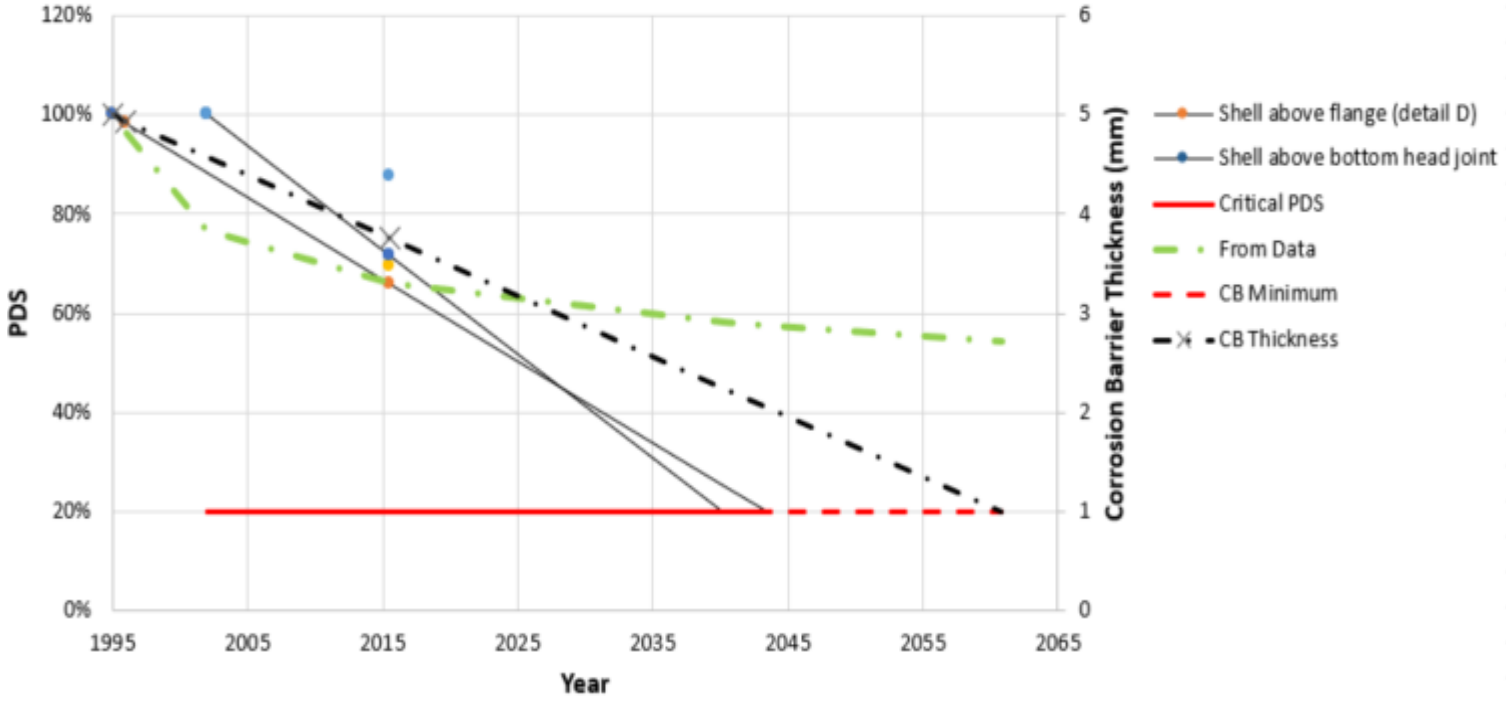
Case Study – FRP Scrubbing Column

- No access to any of the inner surface.
- Simulated non-intrusive inspection while operating.
- After NDT, cut-outs were removed for verifications.
- Destructive Stiffness values were within 14% of UltraAnalytix values
- Corrosion Barrier damage – same for UltraAnalytix and cutout sections



Case Study – FRP Scrubbing Column

- Based on PDS, straight-line prediction of remaining Structural life : 25 to 27 years
- Based on Corrosion Barrier damage Remaining Service Life: Approx. 45 years



Case Study – Vacuum Vessel

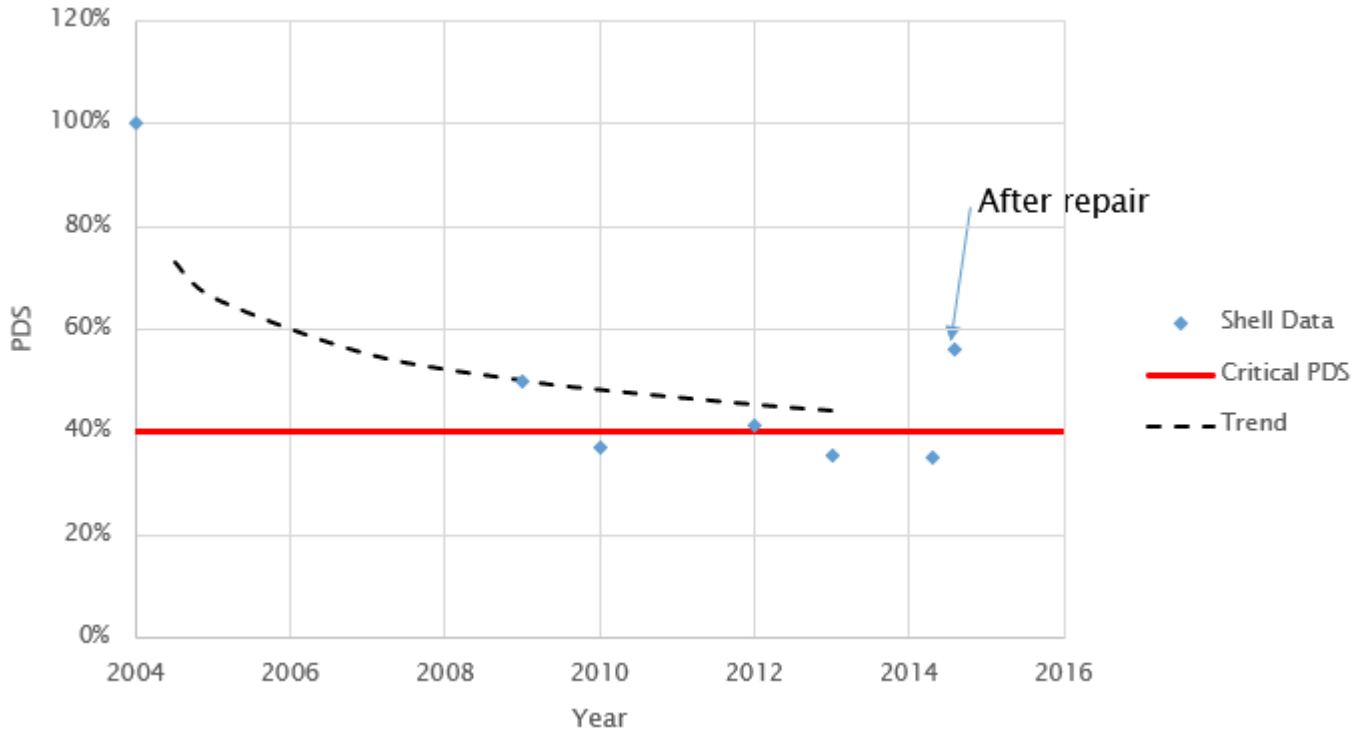
- First inspection in 2009.
- In 2010 creep was noted.
- 2011 engineering analysis and repair recommended.

Case Study – Vacuum Vessel

- March 2014: Design of repairs complete and planned for May

Case Study – Vacuum Vessel

- Inspection History



Case Study – Vacuum Vessel

- Results;
  - Timely identification of need for repair.
  - Life prediction was re-started after repairs were completed.

Summary

- Remaining Life can be predicted based on Creep, Thickness Loss and CB damage using Non-destructive, non-intrusive technique.
- Fastest rate will define it.
- Several inspections are required to establish the rate.
- Early predictions will be conservative

Questions?

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UTComp 2008-2018 10th ANNIVERSARY

CELEBRATING 10 YEARS OF FRP RELIABILITY INNOVATION

ULTRA Analytix