SUITABILITY FOR SERVICE OF FRP

Geoffrey E. Clarkson, P.Eng.
UTComp Inc.
Cambridge, Ontario, Canada

The FRP Reliability Experts

Fibreglass Reinforced Plastics

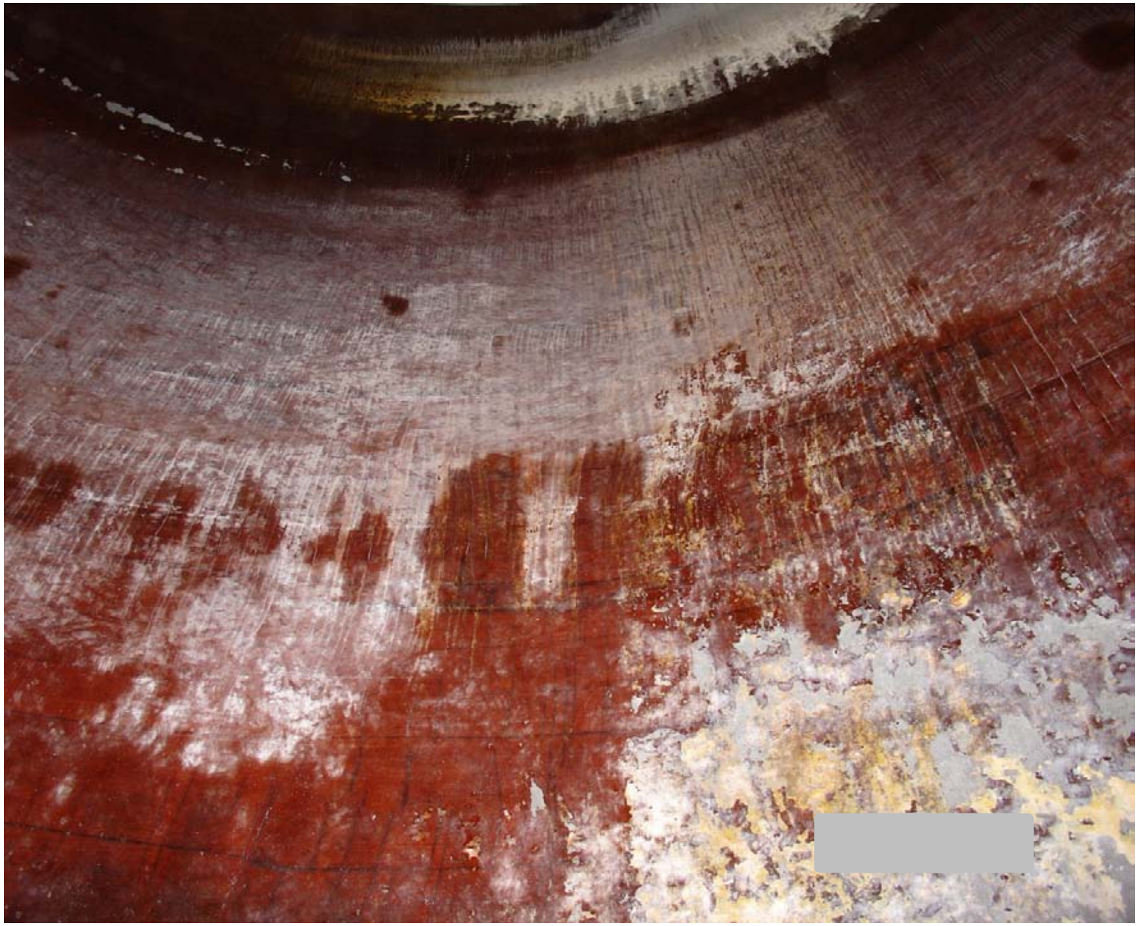
- Used widely in corrosion applications
- Tanks, Pipe, Scrubbers, etc.
- Corrosion Resistant
- Used for: Chlorine compounds, acids, wastewater, etc
- Key Ingredients: Engineering; Resin/Matrix, Reinforcement (glass); Shop Methods

Corrosion Barrier Life Cycle Inspection

New Equipment

Corrosion Barrier Life Cycle Inspection

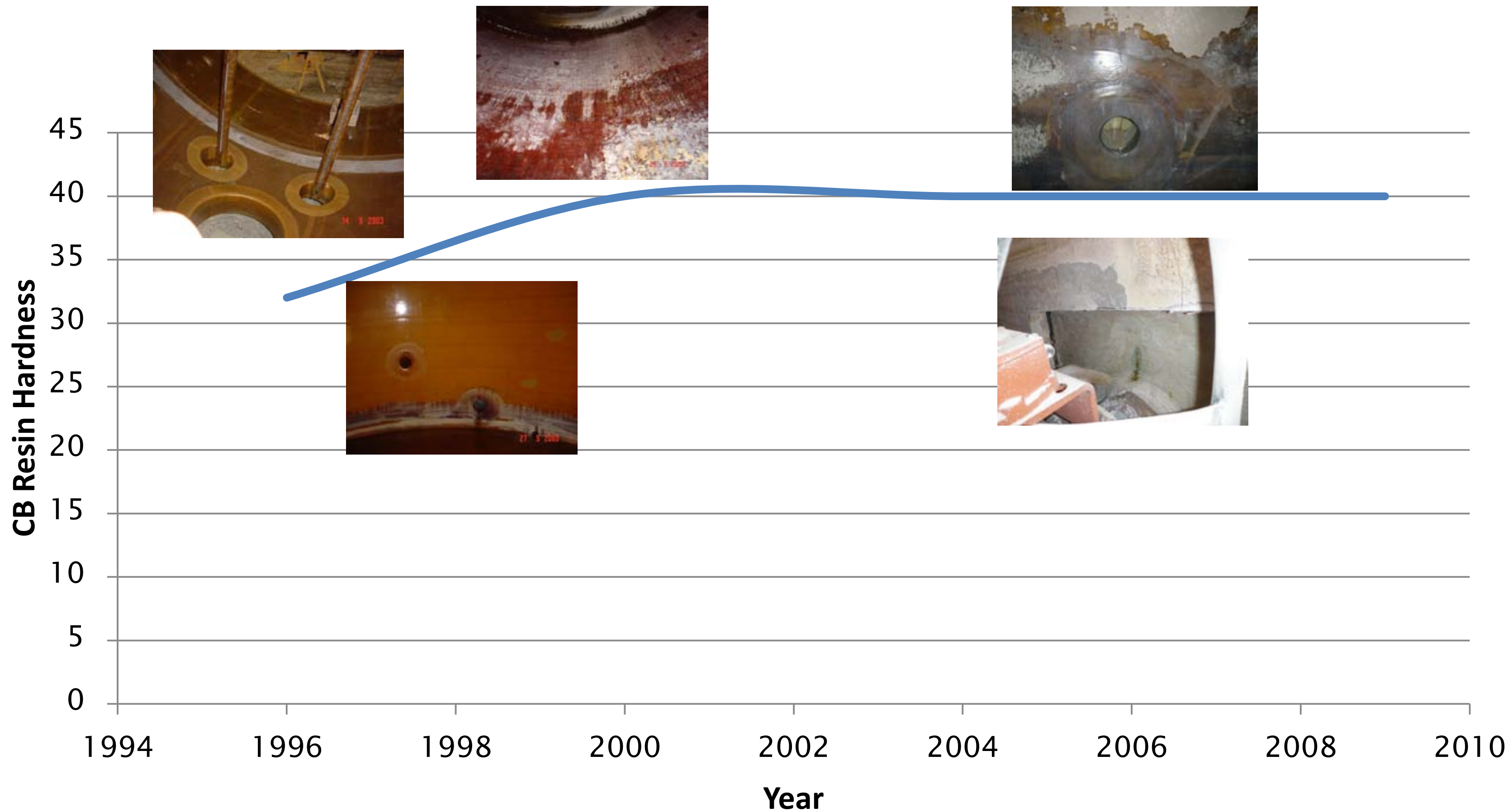
In-service Equipment



Corrosion Barrier Life Cycle Inspection

- Next….

Corrosion Barrier Life Cycle History



In the extreme.....

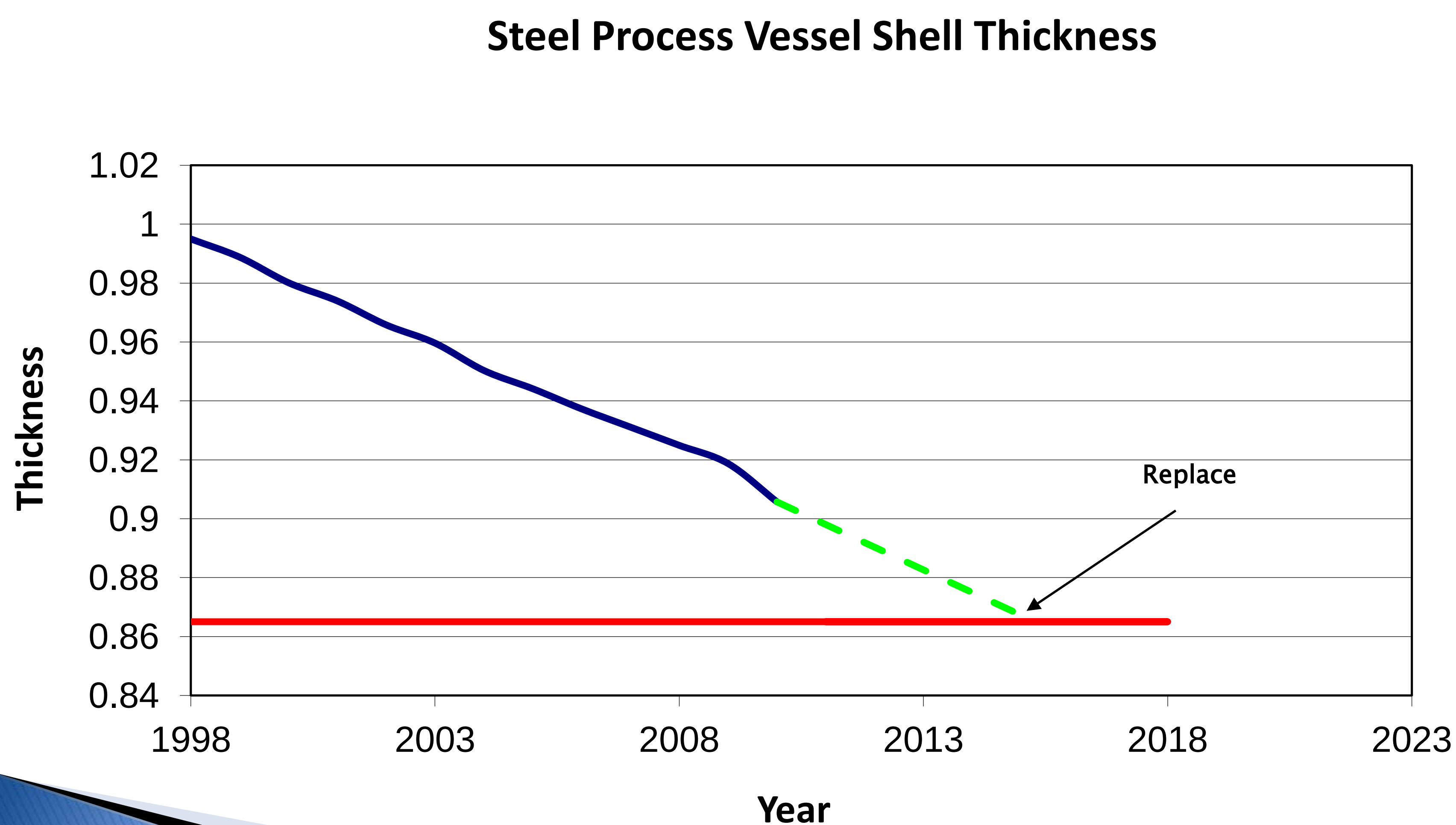
- Vessel had Corrosion Barrier inspections annually for 13 years
- Failure of structural laminate was at structural repairs made when new
- Not detectable from internal or external visual inspections.

Corrosion Barrier Life Cycle Results

In our experience……

- Little direct relationship between condition of corrosion barrier or outer surface and FRP structural condition.
- Condition of CB can be misleading about condition of the FRP as a whole

"Can we generate a curve to allow us to plan repair & replacement of FRP vessels as for metal vessels?"



Suitability for Service Calculations

- Metals :
  - Corrosion causes material loss.
  - Thickness (t) reduces.
  - Elastic modulus and strength remain constant.

- Mathematically:
  - $t \times \text{Material Strength} \geq (\text{Maximum Load})/\text{width}$

  - Or $t \times \text{Strength} \geq \text{Constant}$

Suitability for Service Calculations

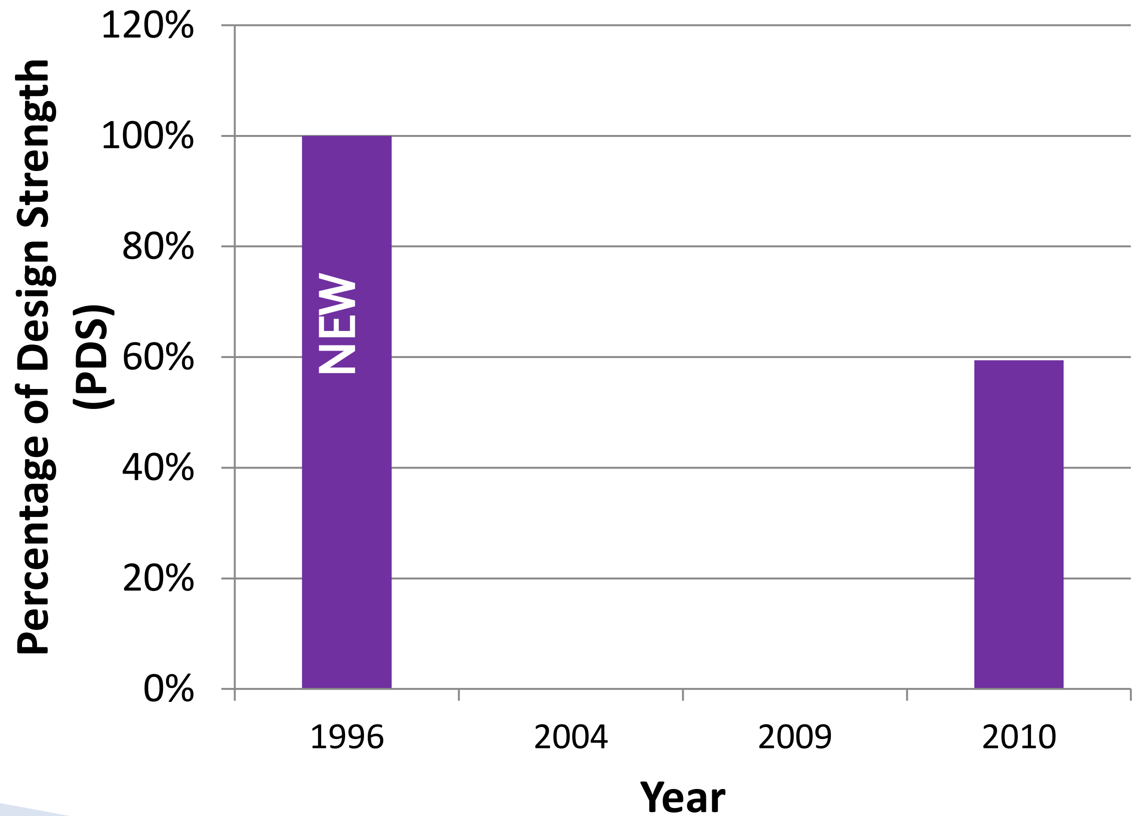
- FRP
  - Loss of strength has been observed.
  - Thickness is generally constant.

- Mathematically:
  - $t \times$ Material Strength $\geq$ (Maximum Load)/ width
  - Or $t \times$ Strength $\geq$ Constant

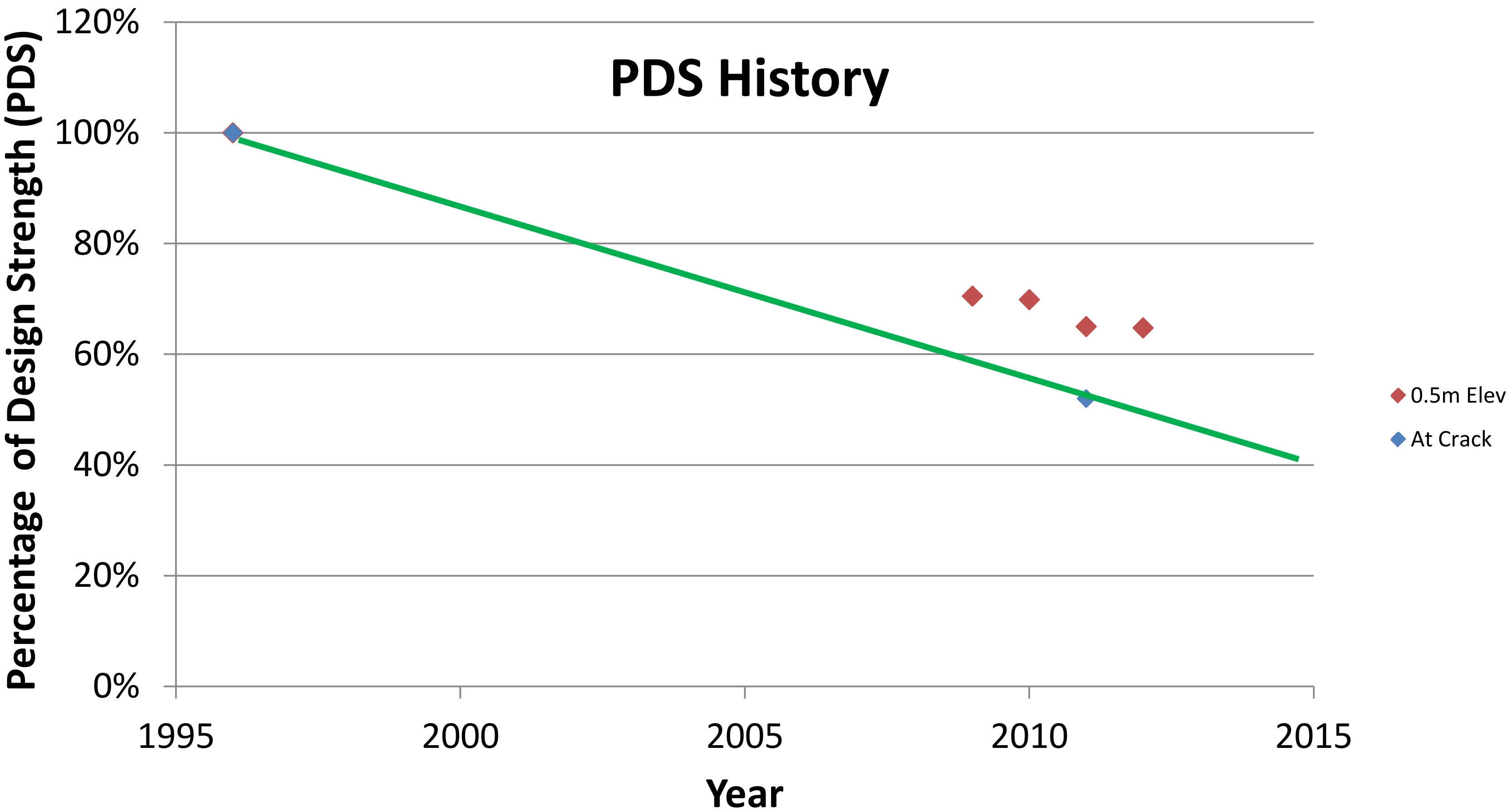
FRP Strength Change

- Destructive Test Results for the same tank as Corrosion Barrier history earlier

$$PDS = \frac{Current\ Modulus}{Design\ Modulus}$$



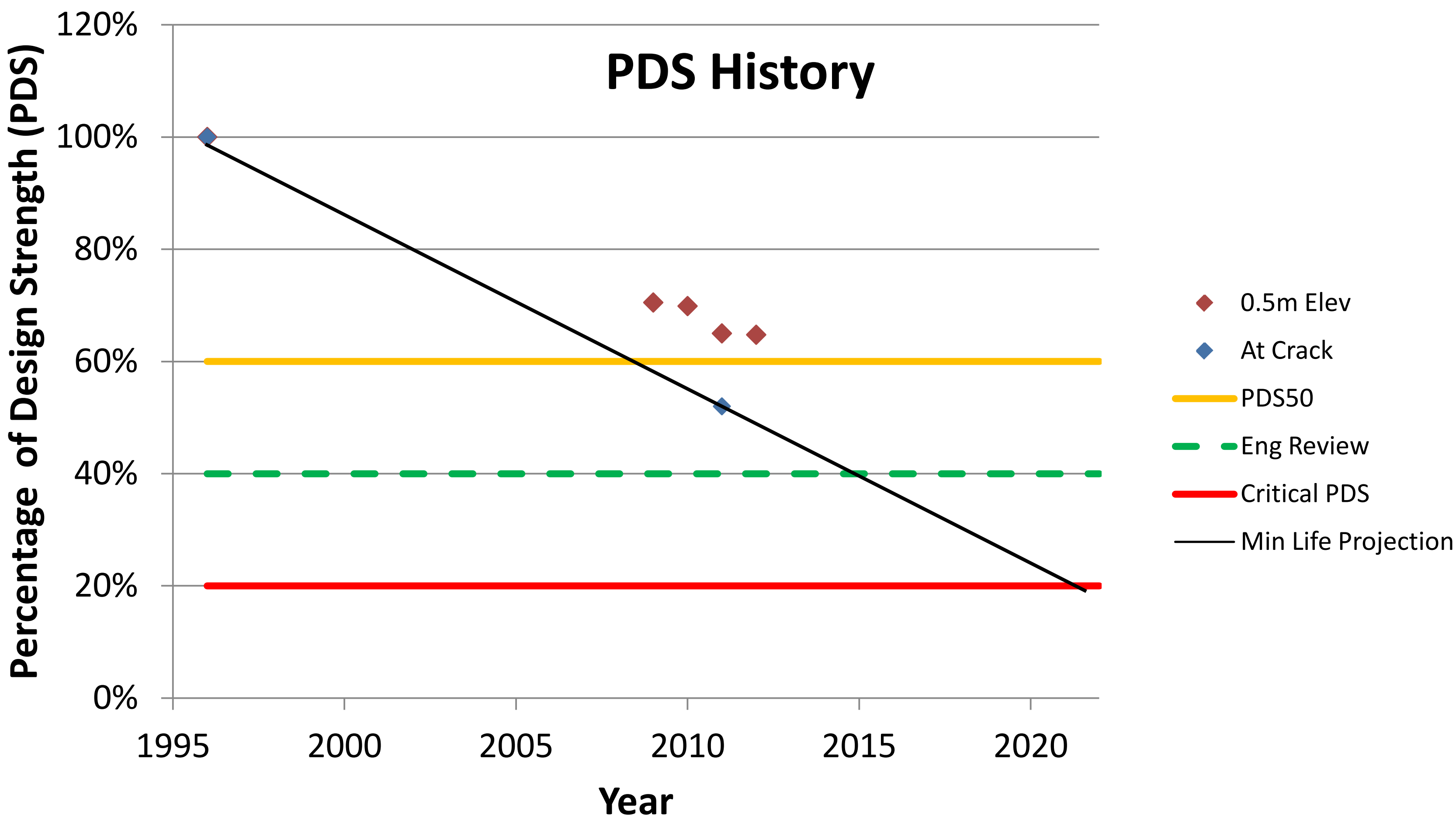
FRP Service History



Parameters

1. Critical PDS:
   - Minimum allowable value of PDS for equipment operation.
   - Intent to set where the actual current Design Factor=2
   - For new Design Factor=10, Critical PDS=20%
   - For new Design Factor =6, Critical PDS=33%
   - For new Design Factor=5, Critical PDS = 40%
2. Half Life PDS (PDS_{50})
   - Value of PDS at 50% of FRP lifespan to Critical PDS.
3. Engineering Review Recommended
   - To determine whether parameters are still valid.
   - Triggers at about ¾ of the calculated lifetime.

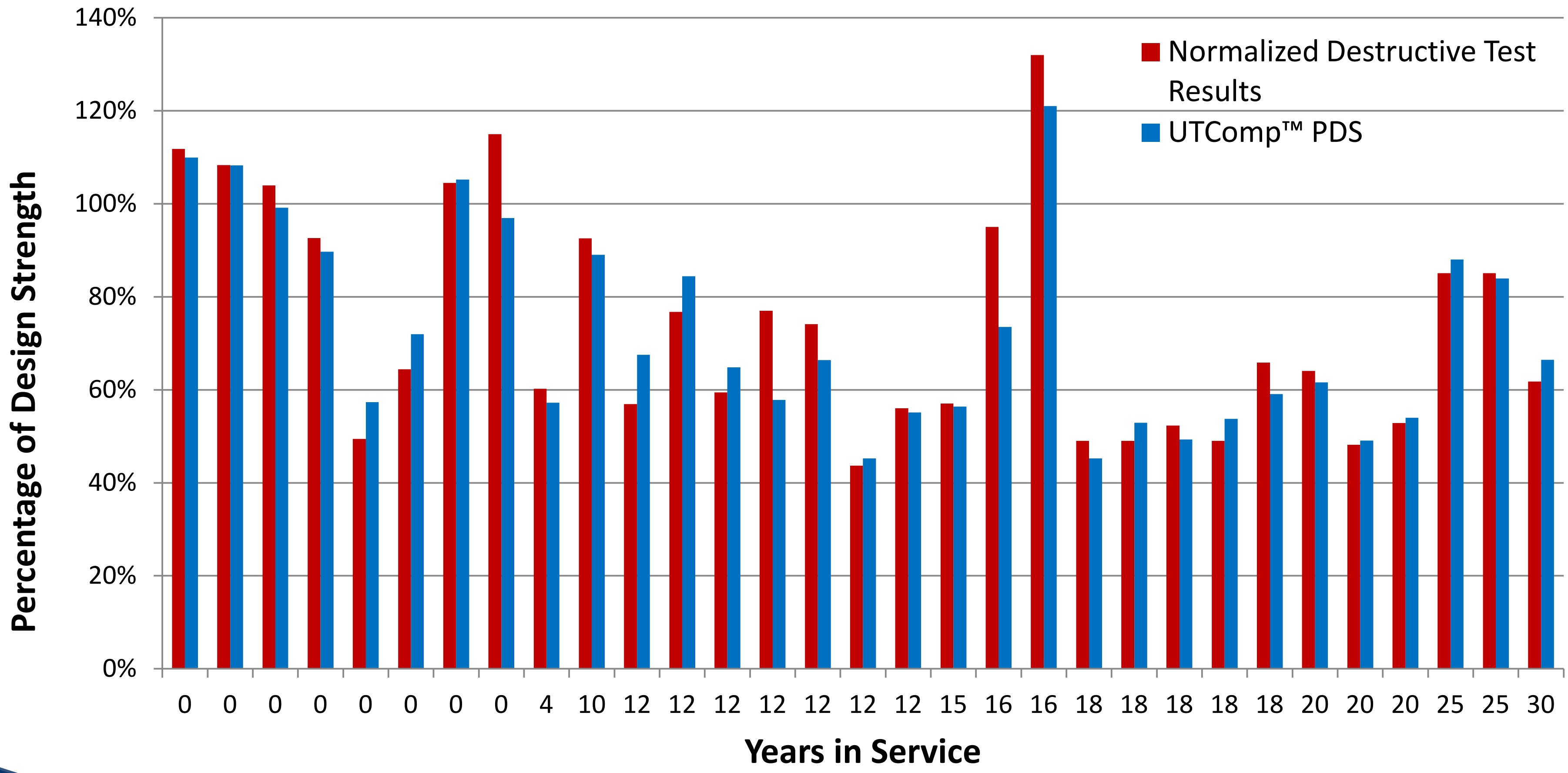
FRP Suitability for Service Curve



FRP Strength Determination

- Must be:
  - Repeatable
  - Verifiable
  - Non Destructive
- Rocket Science
  - 1960's: NASA starts investigating ultrasonic testing (UT) for flaw detection in composite aircraft parts
  - Also detected changes in strength using ultrasonic testing
  - Further work has produced a system that meets the criteria

Destructive vs. Non Destructive Results

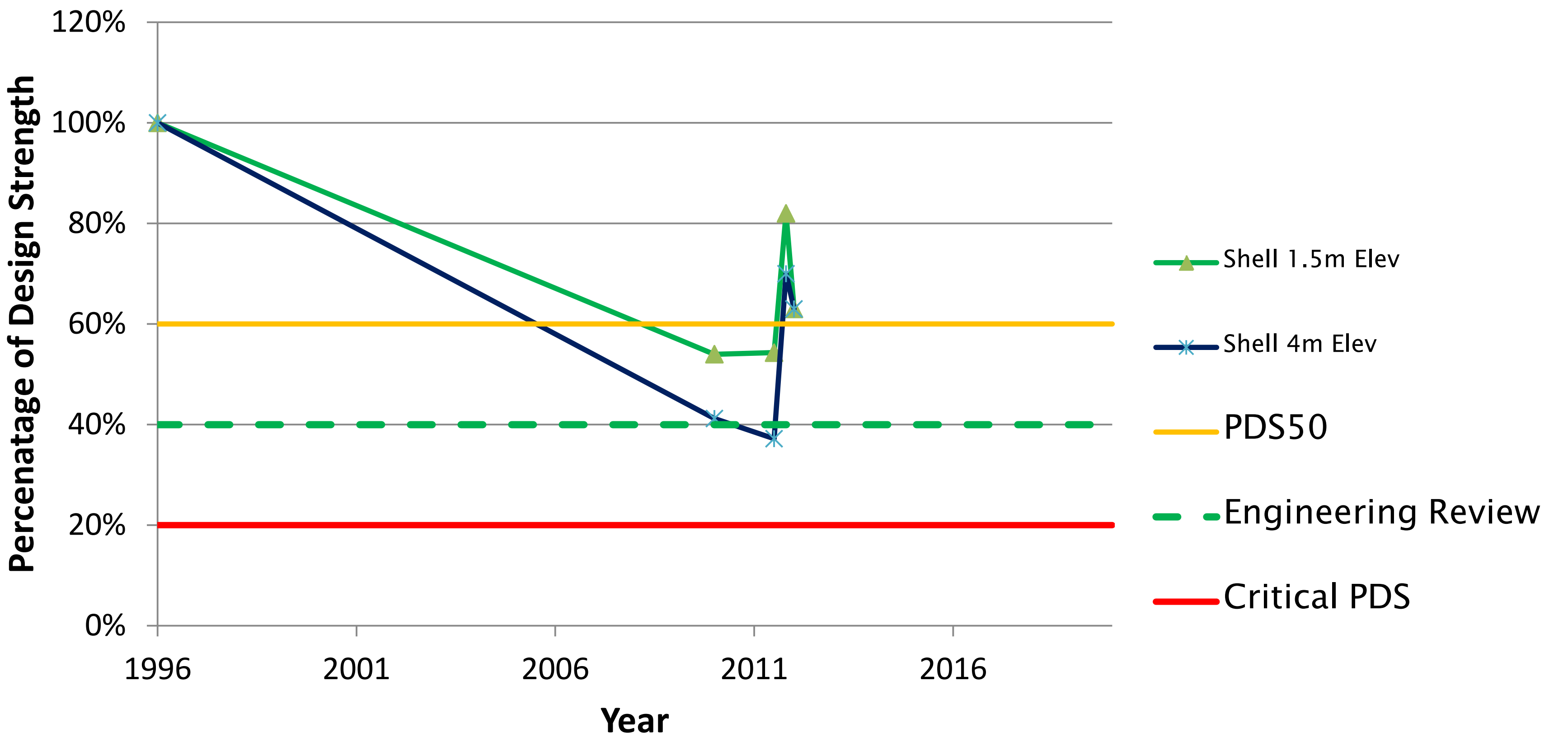


Applications

- Can be used for:
  - Vessels, Tanks, Scrubbers
  - Duct
  - Pipelines
- Principles of API 653 are generally applied.

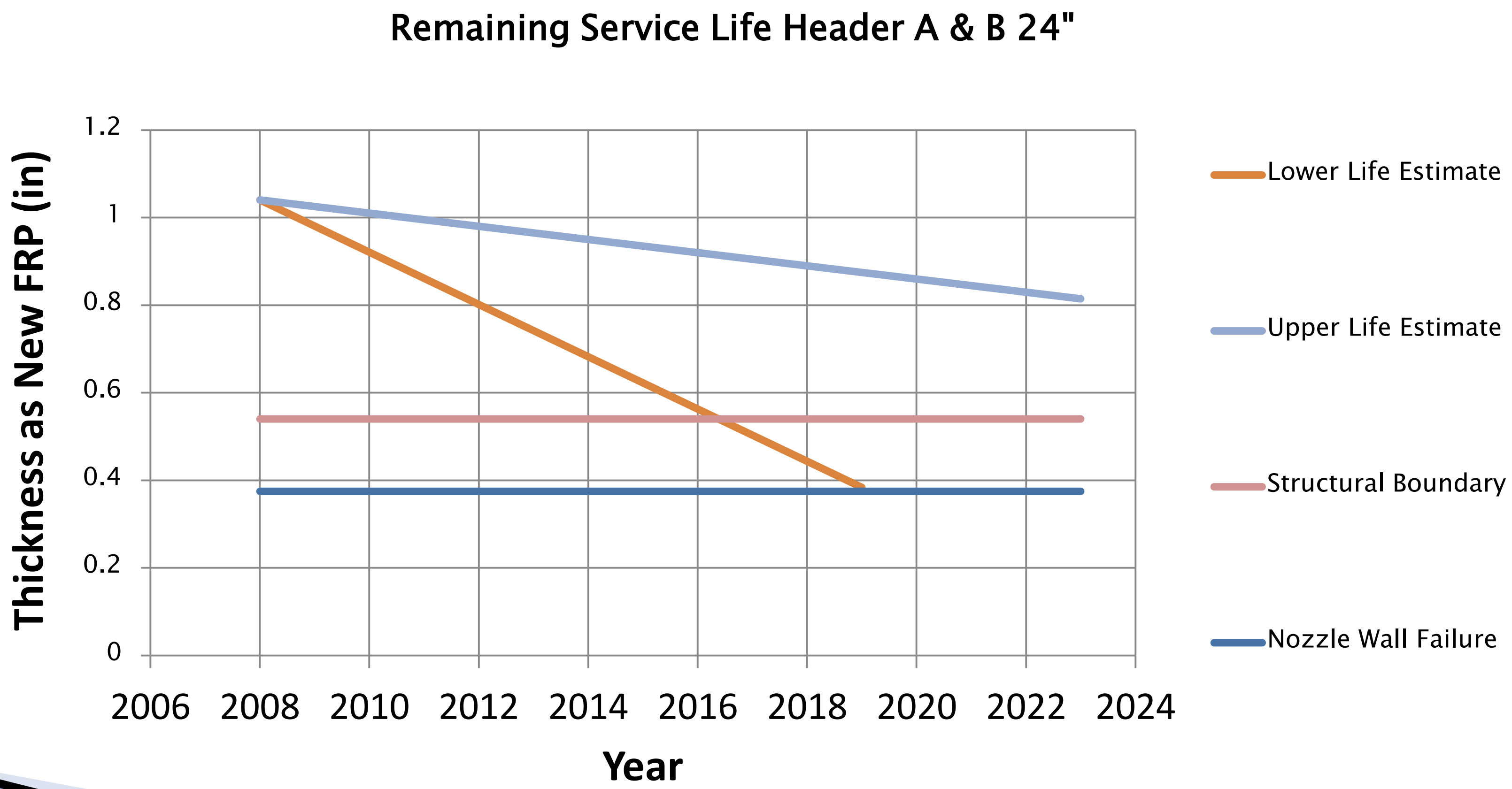
Application

- Tank with repair



Application

- Wet Chlorine Gas Headers



Conclusions

- Non Destructive Strength data for FRP can be used for Suitability for Service and Remaining Service Life reporting.

Questions?