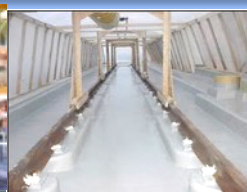


CFRP In Safety Related Piping Systems

Alternative Approaches in Design, Materials and Implementation

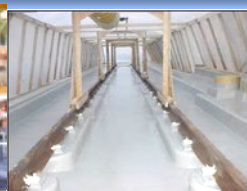
Presented by John O'Leary

Next Composite Solutions, Inc
115 Second Ave, Edwardsville, IL
618.692.1905
www.nextcomposites.com



Introductions:

- John O’Leary – President Next Composites
- Next Composite Solutions



Problem Solving Focus

Minimal
Difficulty

- **Commodity Solutions**
- **Product Driven**

Increasing
Difficulty

- **Complex Problems**
- **Solution Driven**

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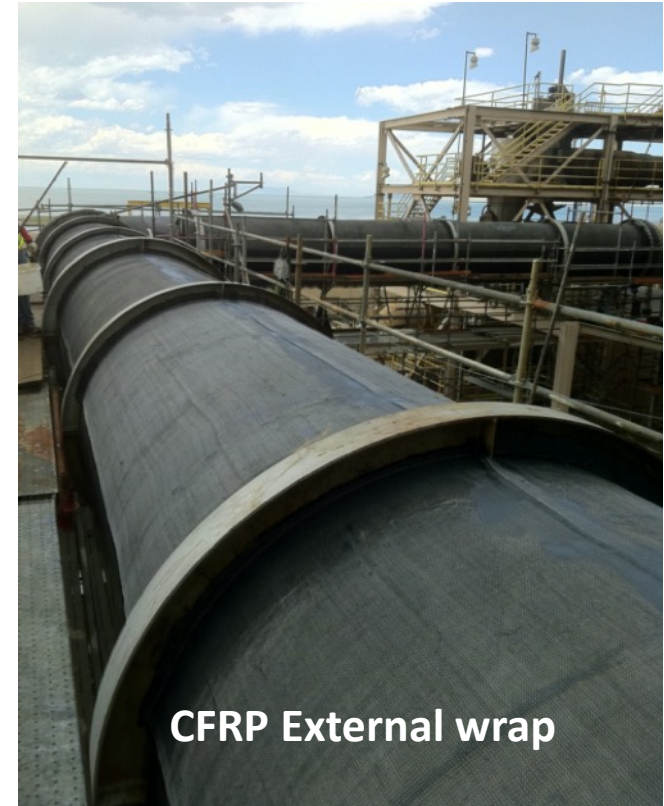
When “standard”
solutions aren’t
feasible

**3 quick examples to
illustrate this focus**

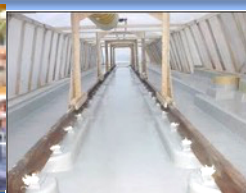


#1 - Hot gas Duct Repair

- Major internal Corrosion
- High Temp (450 to 500 F)
- Large Diameter (84" D)
- Elevated 80' above haul route

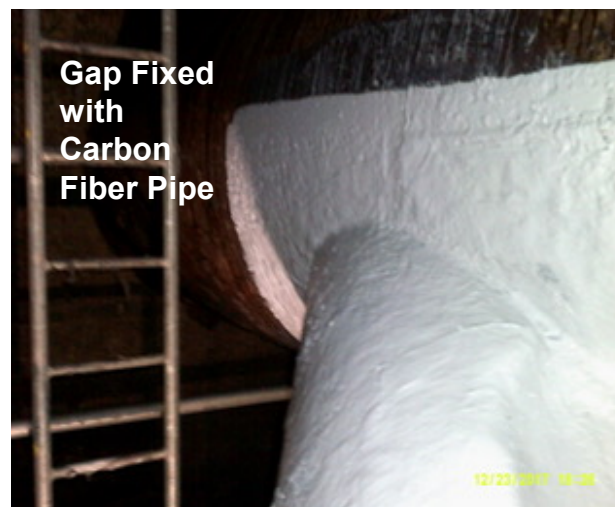
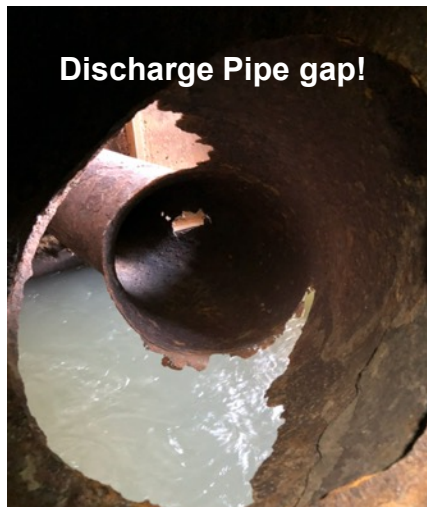


- Extensive engineering & testing
- Avoided shutdown and lost revenue
- Lowered installation costs
- No increase in structural supports

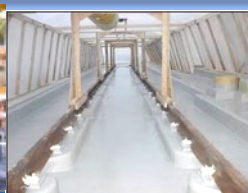


#2 - River Headworks Pipe Replacement

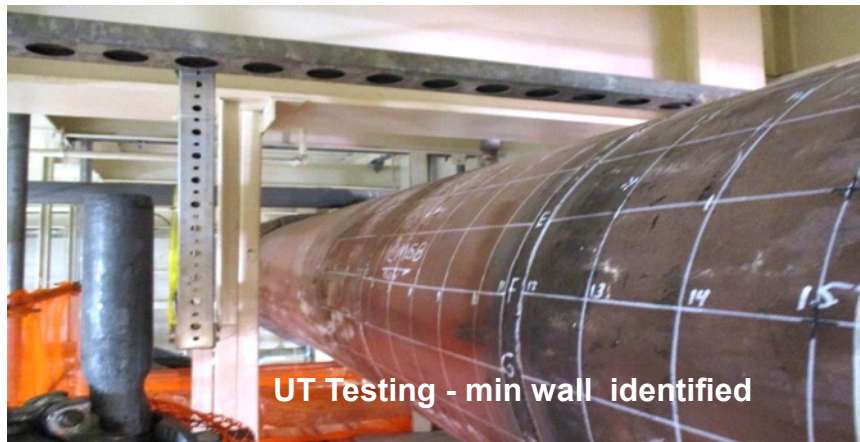
- Badly corroded warm water discharge pipe - 48" to 66" diameter
- Usually fully immersed in the river
- Large gaps in the pipe



- **Project was capitalized!** (Existing pipe was abandoned in-place)
- Much Shorter schedule (2 months vs 2 years)
- Gap fixed with Carbon Fiber Pipe



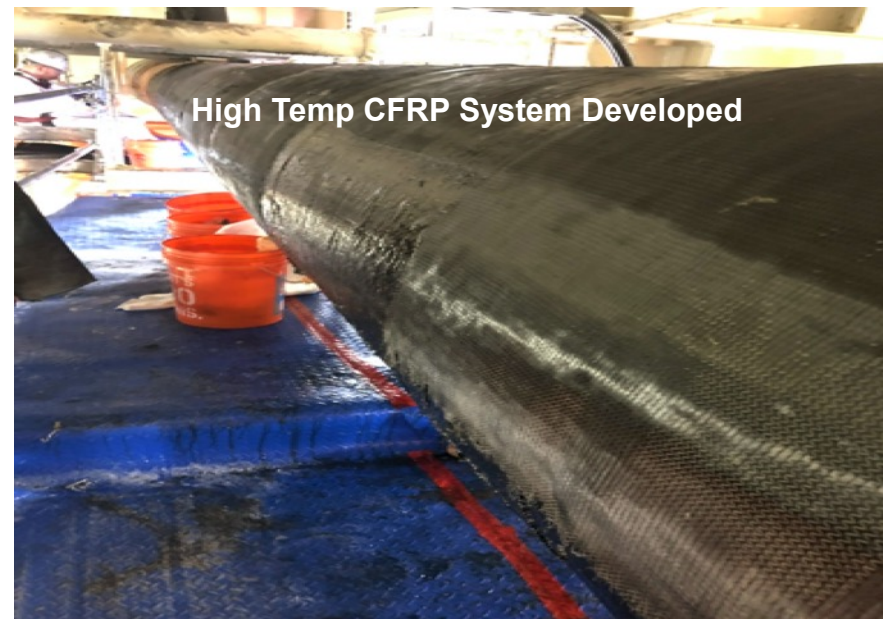
Example #3 – Nuclear Plant Condensate Pipe Repair

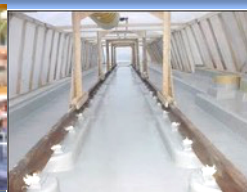


- 36" pipe, 50 LF
- High temp – 370 F
- High pressure - 670 psi with 770 psi transient
- Thin-wall discovered during outage

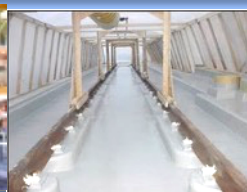
**Completed in 6 days
(within outage schedule)**

- A full design package completed in accelerated timeframe
- Over 50' of degraded pipe (thin-wall) repaired
- Full certification achieved under PCC 2 following installation under to convert from temporary to permanent





Nuclear Power Specific Innovative, Solution Driven Projects

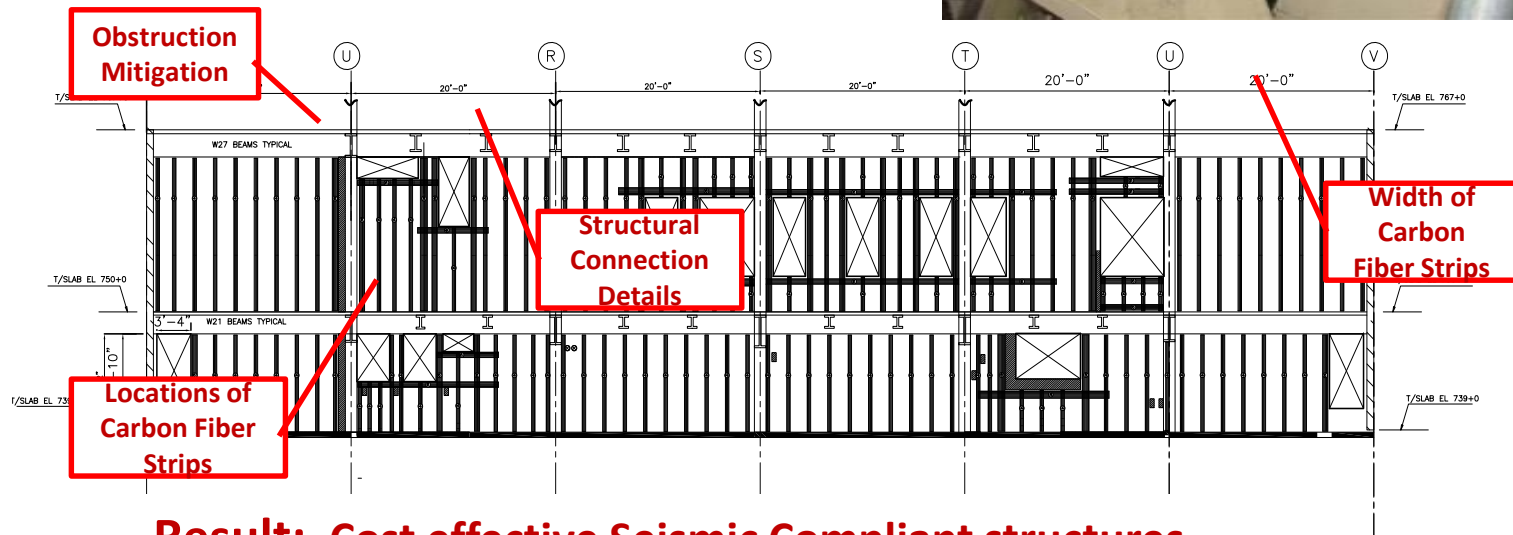
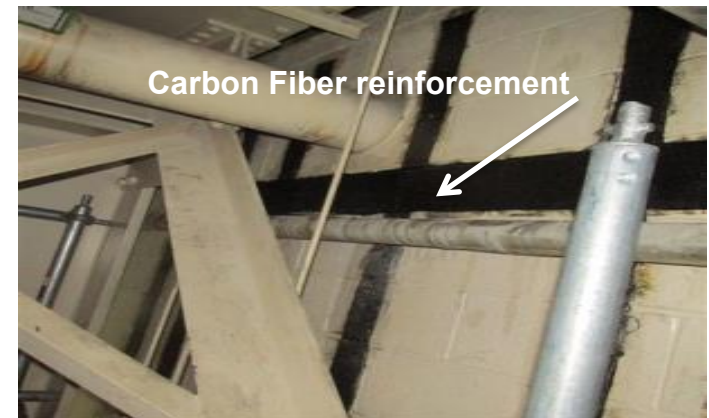


Seismic Upgrade of Block walls

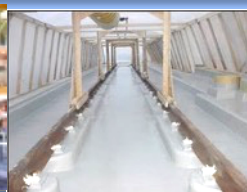
*Our CFRP Team - Single Source for
engineering and installation*

- Seismic audit identified block wall upgrades needed
- CFRP solution permitted minimal construction impacts

Nuclear Power Station

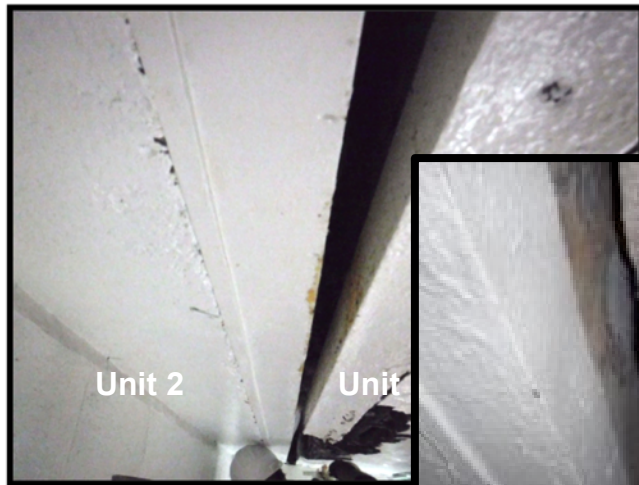


**Result: Cost effective Seismic Compliant structures
using CFRP methods and materials**

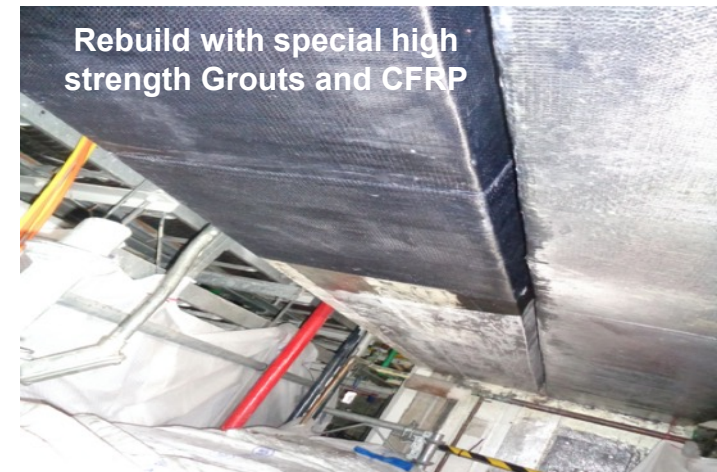


Turbine Building Girder Repair

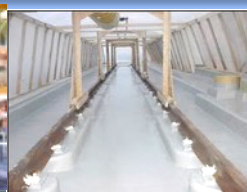
- Damaged large reinforced concrete Girders
- Significant deterioration due to exposure to run-off from heat exchangers on the floor above.



Nuclear Power Station

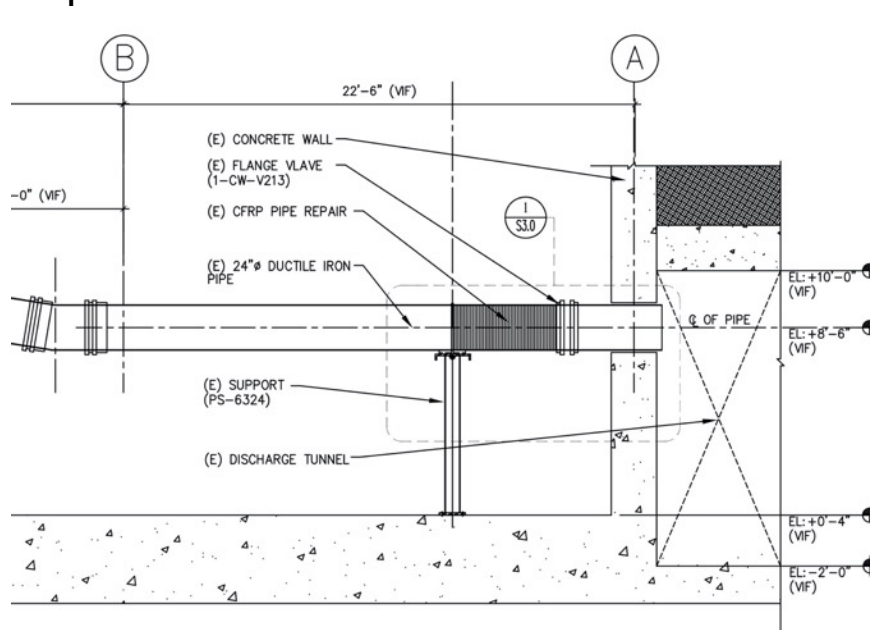


- Addressed limited access
- Met extreme loading requirements
- Offered significantly lower costs
- Minimized impact on plant operations
- Fire protection provided



Cooling Water Piping Repair

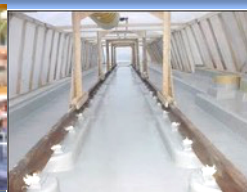
- CW Pipe - 24 Diameter
- Previously repaired leak near flange. We were requested to provide a CFRP repair alternative.
- Unable to move replacement spool into repair area.



Nuclear Power Station

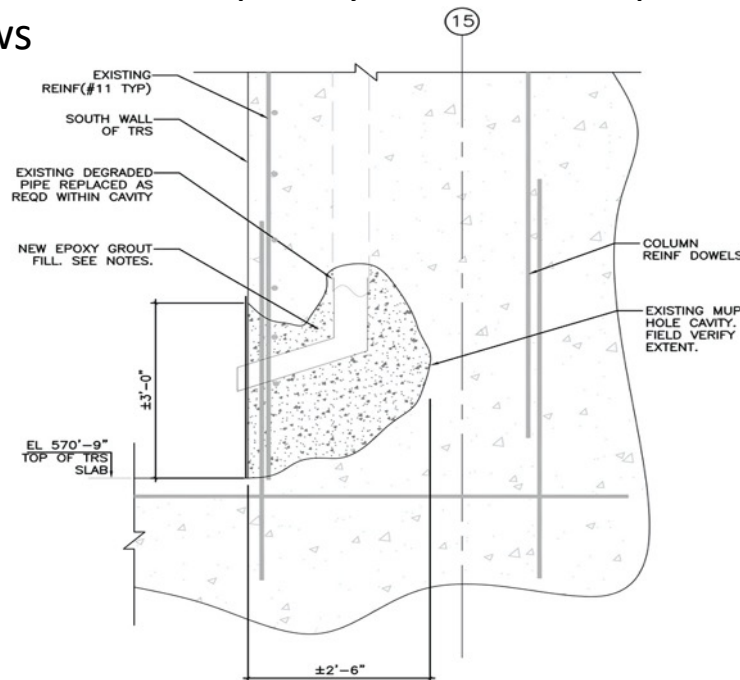


- Provided EC & CRFP Calculations
- Removed previous repair and prepared surface
- Repaired pipe with CFRP per engineering drawings
- Inspected and tested final repair
- CFRP Design, Full EC Package and Implementation Completed in 14 days



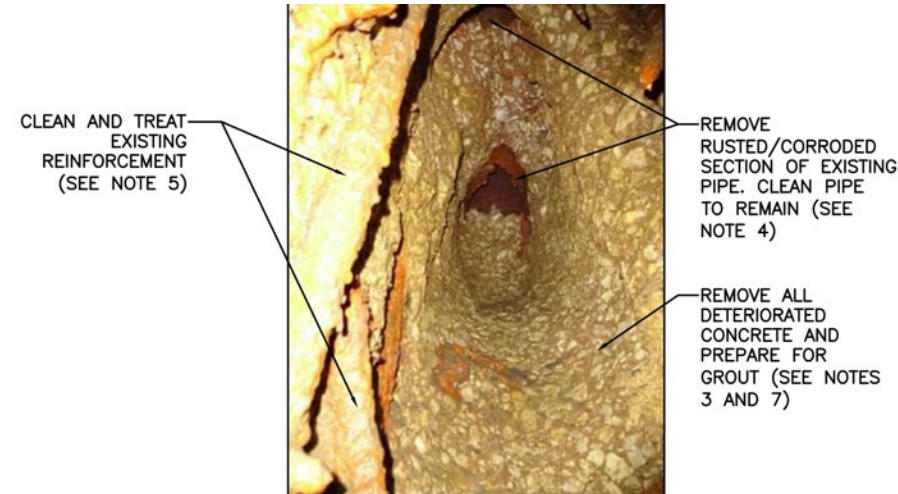
Turbine Room Sump Repair

- Corrosion threatening structural foundations
- Very limited access
- Damage approx. 3+ ' into sump wall
- No option to completely drain and stop inflows

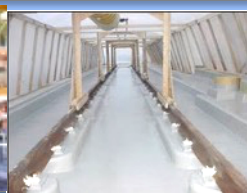


5 SECTION AT MUP HOLE
NOT TO SCALE

Nuclear Power Station



- Required extensive testing program to prove material properties and solution viability
- Installed coffer dam to isolate repair
- Preformed soundings to remove bad concrete
- Replaced damaged piping
- Repaired with specialized Grouts
- Added CFRP to repaired sump wall surface



Assembling a Solution Driven Team

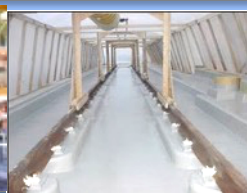
- Identifying root causes
- Listening to plant concerns
- Avoiding material or system bias
- The Lincoln Effect (competing ideas within the team)
- Each solution vetted across all relevant disciplines

For buried pipe:

Replacement options
Repair options
Alternative materials &
technologies

Next Composites Team

Kinectrics AES – Nuclear Engineering
KL Structures – Composites Experts
SAK – Tunneling & Lining Experts
Fyfe – Composite Materials
DZ – General
Construction/Logistics/Support
Audubon – Corrosion Science
Experts



Buried Pipe – A Fresh Look

- Team has been involved in nuclear buried pipe work since 2003
- Completed studies and white papers for SR piping options including CFRP beginning in 2010
- Expanded team to provide wider array of solutions to meet SR requirements
- Developed collaborative approach to developing test plans for alternative solutions with in house 400,000 sf laboratory
- Each alternative passes multi-discipline crucible before presentation to Owner
- Ultimately no single solution to SR pipe repair replacement

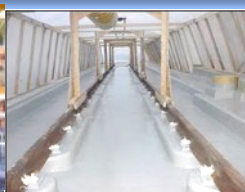


CFRP SR Code Case

Some concerns:

- One size fits all approach
- Limited temperature and size range
- Pushes entire industry to single product
- Cannot address enormous quantities of smaller diameter pipe
- Functionally limited to 30" & up Service Water Systems
- Requires "full replacement value" design. With newer UT technology full replacement is not always required
- Extremely high barriers to entry limits competition and drives up cost
- Pre & post testing often does not represent field installation
- Eliminates innovation as material and testing capabilities continue to expand

<p>ASME BPVC.CC.NC-2019</p> <p>Approval Date: December 17, 2018</p> <p><i>Code Cases will remain available for use until annulled by the applicable Standards Committee.</i></p>	<p>CASE N-871</p> <p>(19)</p>
<p>Case N-871 Repair of Buried Class 2 and 3 Piping Using Carbon Fiber-Reinforced Polymer Composite Section XI, Division 1</p> <p><i>Inquiry:</i> Under what conditions may carbon fiber-reinforced polymer composite be used for internal repair of buried ASME Class 2 and Class 3 metallic piping systems?</p> <p><i>Reply:</i> It is the opinion of the Committee that carbon fiber-reinforced polymer (CFRP) composite may be used for internal repair of buried ASME Class 2 and Class 3</p>	<p>metallic piping systems with maximum operating temperature less than or equal to 200°F (95°C) provided the following requirements are met:</p> <p>(a) The requirements of this Code Case shall apply in lieu of the requirements of IWA-4000 except as invoked herein.</p> <p>(b) The requirements of IWA-4140 through IWA-4170, IWA-4300, and Article IWA-6000 shall apply. For use with Section XI Editions and Addenda prior to the 2003 Addenda and in the 2010 Edition and later, the provisions of IWA-4180 shall also be met. For use with Section XI Editions and Addenda after the 2007 Edition, the provisions of IWA-4190 shall apply.</p>



Conclusion

- CFRP is an effective tool to address SR systems but has limits
- Approach to restoring nuclear infrastructure needs to be solution based to keep industry economically viable
- Broader view focused on all disciplines produces better results
- Team approach widens solutions and eliminates false starts

For an example of how the team approach works, we invite you to our joint presentation at the EPRI BPIG Meeting February 17-20 which will include:

- Joint presentation between Next/Kinectrics team and Major Projects Group at an active plant
- Multi-discipline review, analysis and recommendations for Buried SR Piping System
- Materials analysis, testing plans and FOAK technologies for addressing aging SR Piping