

*“A Study of FRP Failures, Root Causes and Lessons Learned to Maximize Reliability”*



Presented by:

**Jeff Eisenman, P.E.**

President  
Maverick Applied Science, Inc  
[jeisenman@mas-mss.com](mailto:jeisenman@mas-mss.com)  
Cell: (941) 224-6650

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# General Outline

- Priorities
- Scope of the Study
- Data Collection and Industries
- Overview of FRP Failures
- FRP Equipment Failures
- FRP Piping Failures
- Examples and Discussion
- Summary



# Priorities

- Operate Safely
- Operate Reliably
- Minimize Loss Production



Fixing Pipes should not have to be your Priority!

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# Scope of the Study

- Sample Size: 79 Incidents
- Time Span: 1999 to Present
- Nonmetallic Materials:
  - FRP
  - Dual Laminates
  - Thermoplastics



# Scope of Study

## Equipment

- Piping
- Storage Tanks
- Process Vessels
- Scrubbers
- Stacks
- Chimney Liners



# Data Collection

## Our Projects

- Our Clients
- Failure Investigations
- Plant Failures
- Corrective Measures



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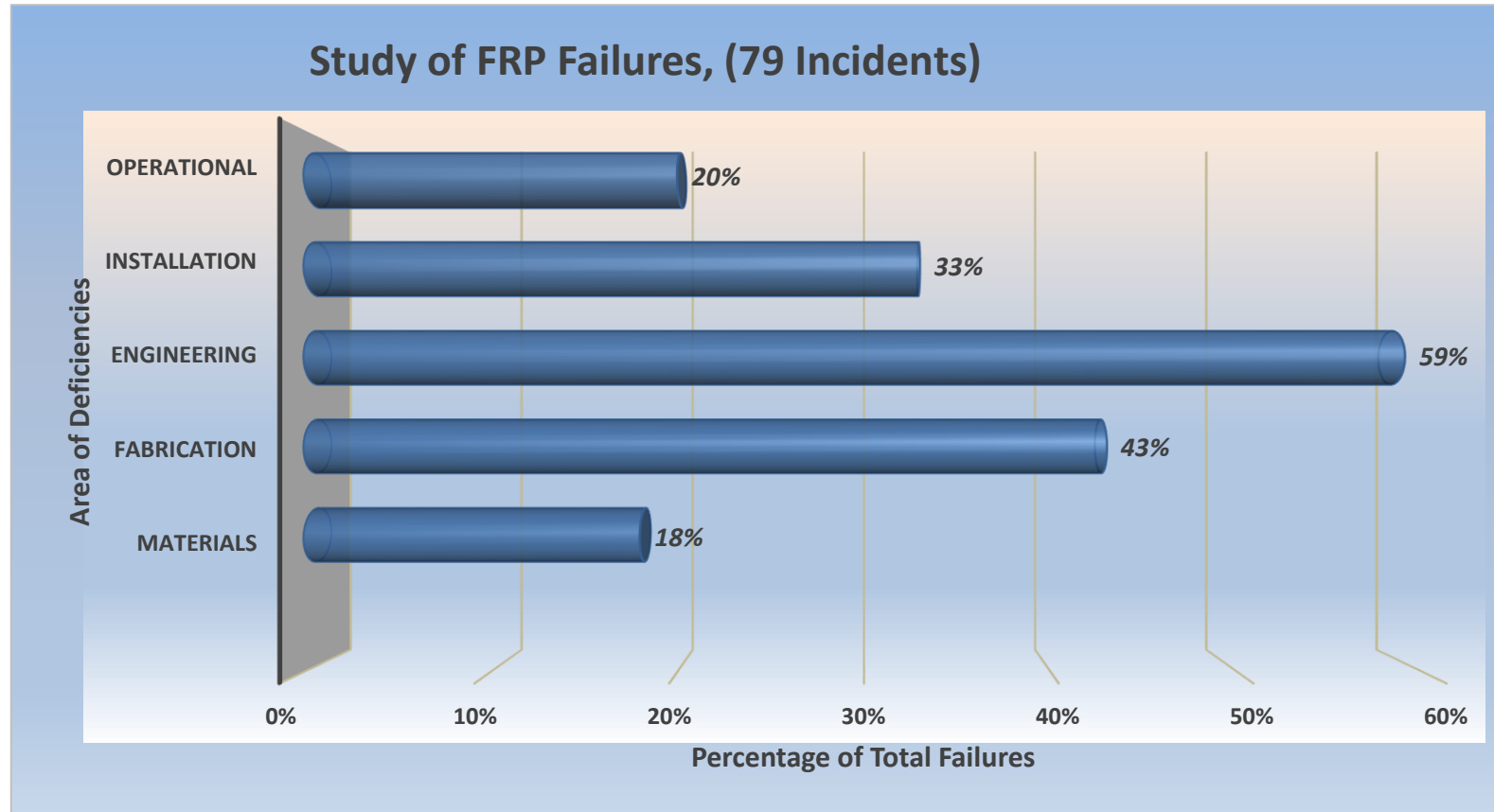
# Industries

- Power
- Pulp & Paper
- Mineral Processing
- Chemical Process
- Desalination
- Water/Wastewater Treatment
- Metal Processing



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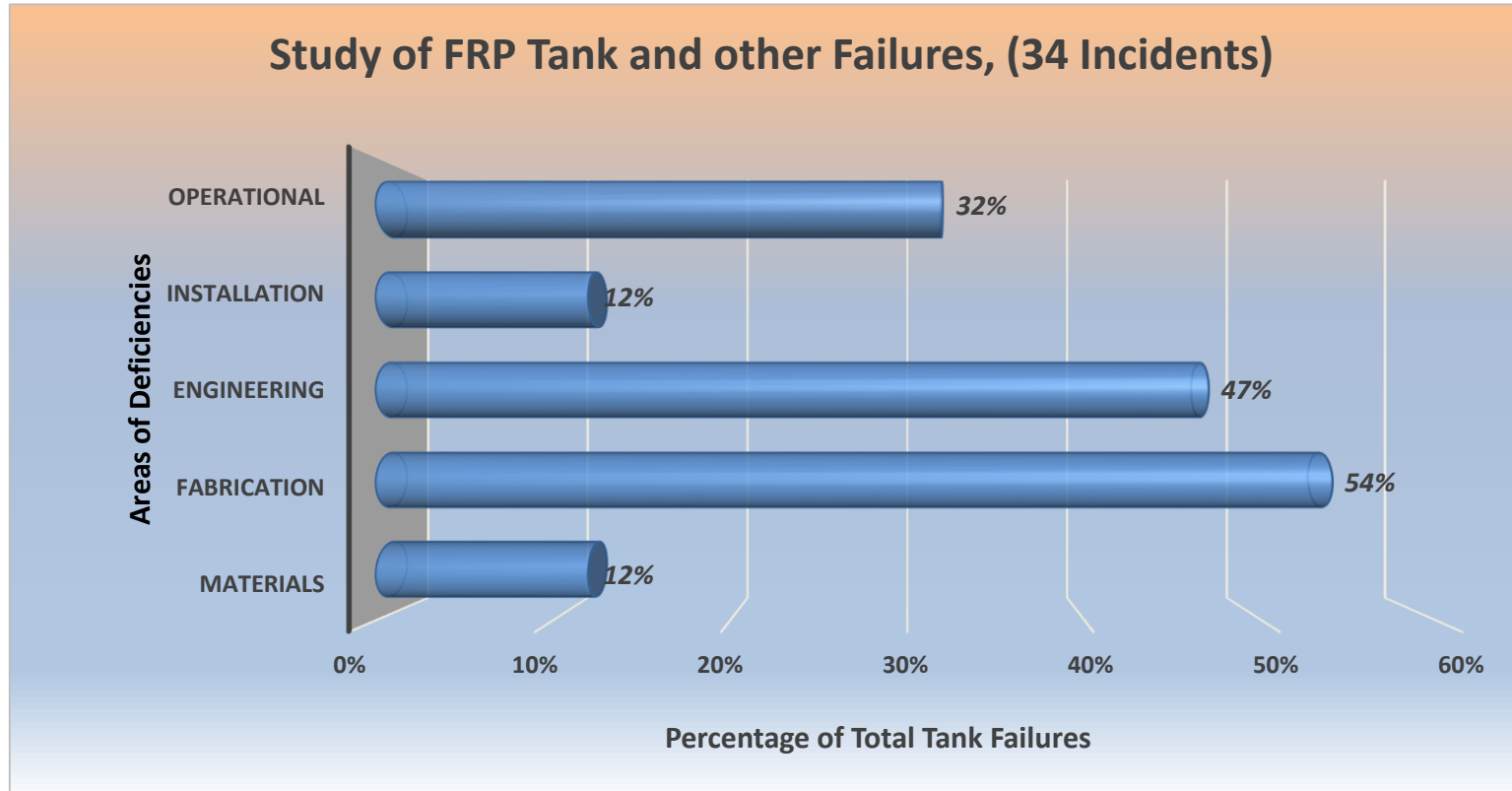
# Overview of Documented FRP Failures



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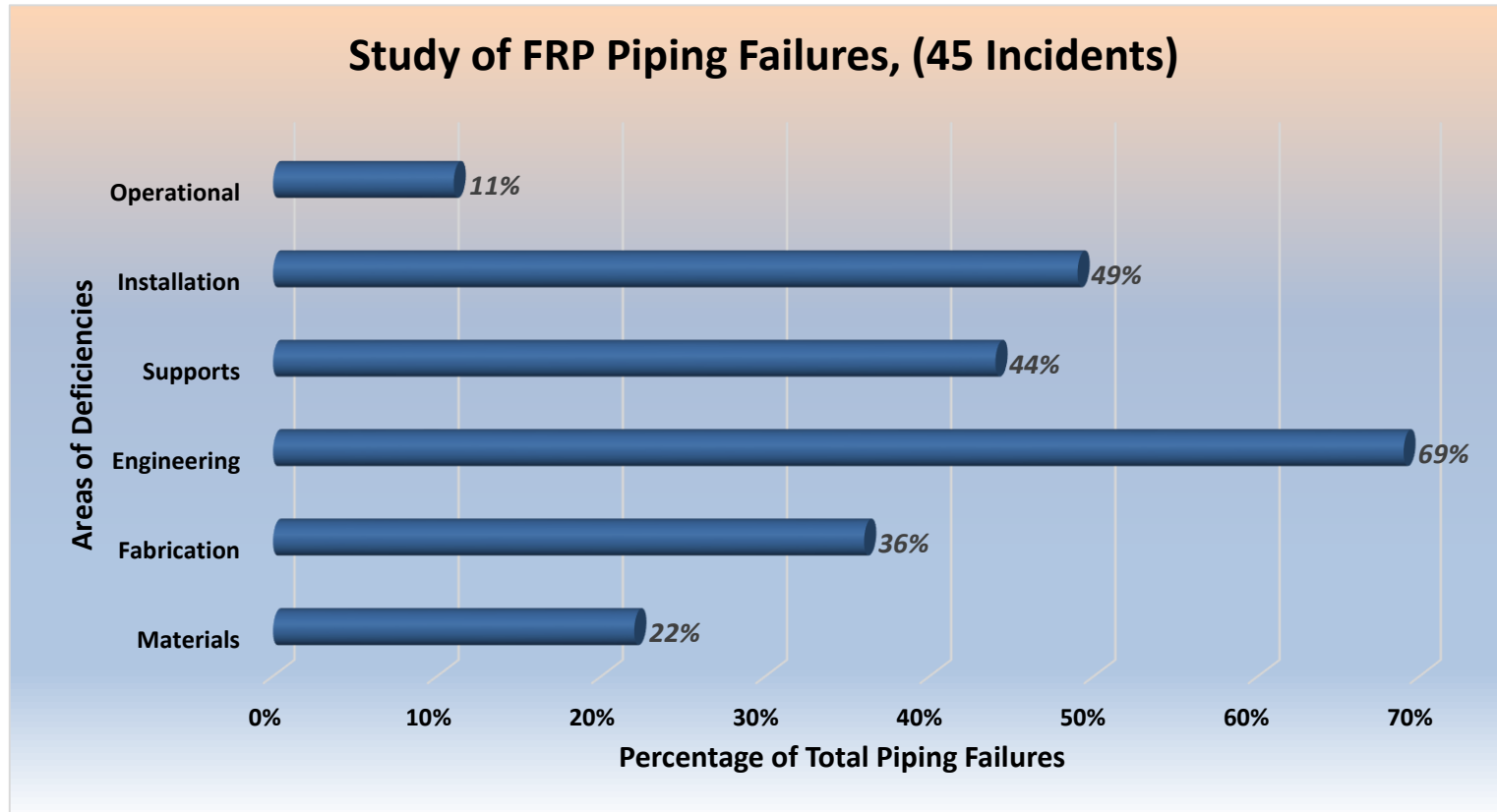
# Examination of FRP Equipment Failures



More than 50% of Failures have 2 or more Contributors.

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# Examination of FRP Piping Failures



More than 50% of Failures have 2 or more Contributors.

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# Examples of Flange Failures



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# Examples of Flange Failures



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# Examples of Poor Installation



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# Examples of Poor Fabrication



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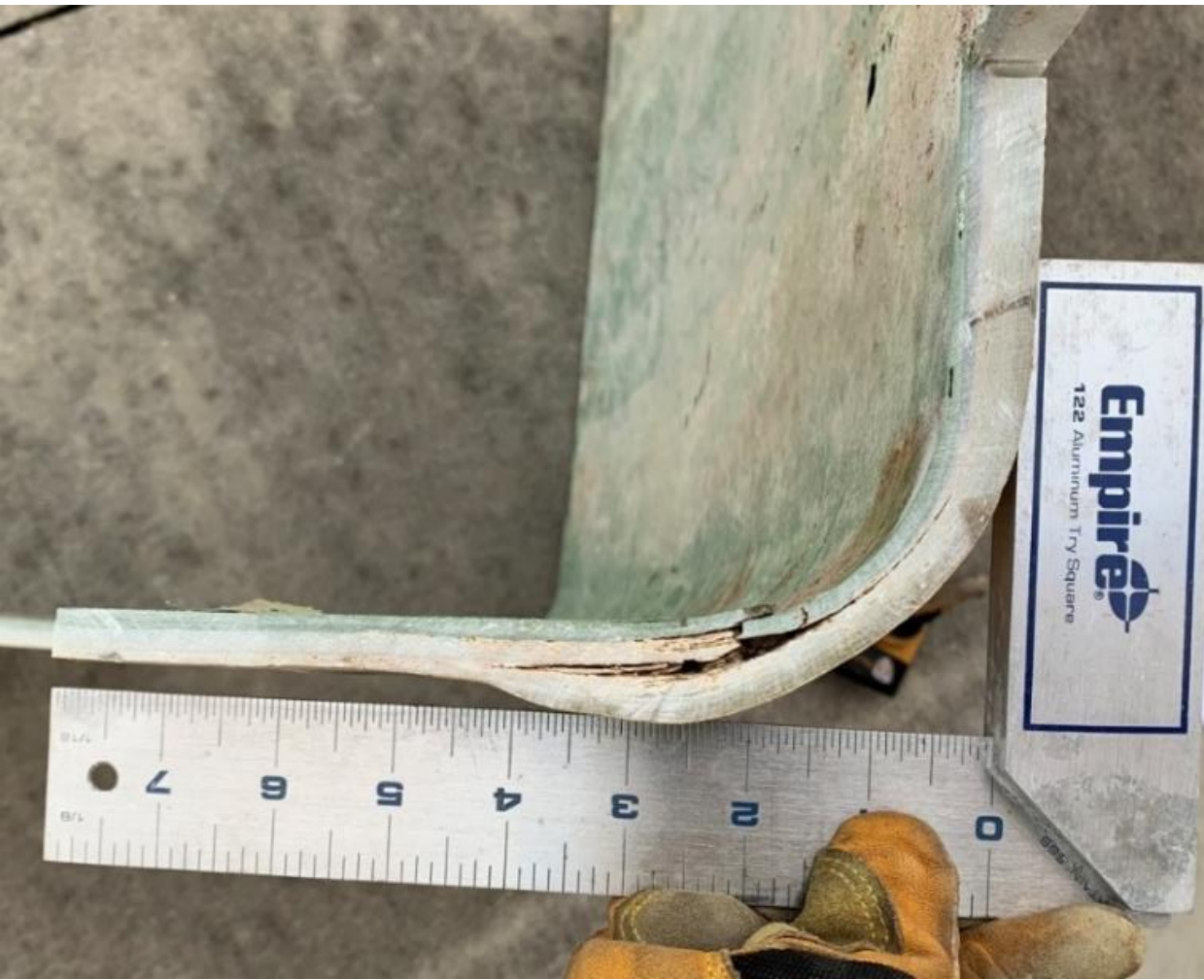


# Examples of Poor Fabrication



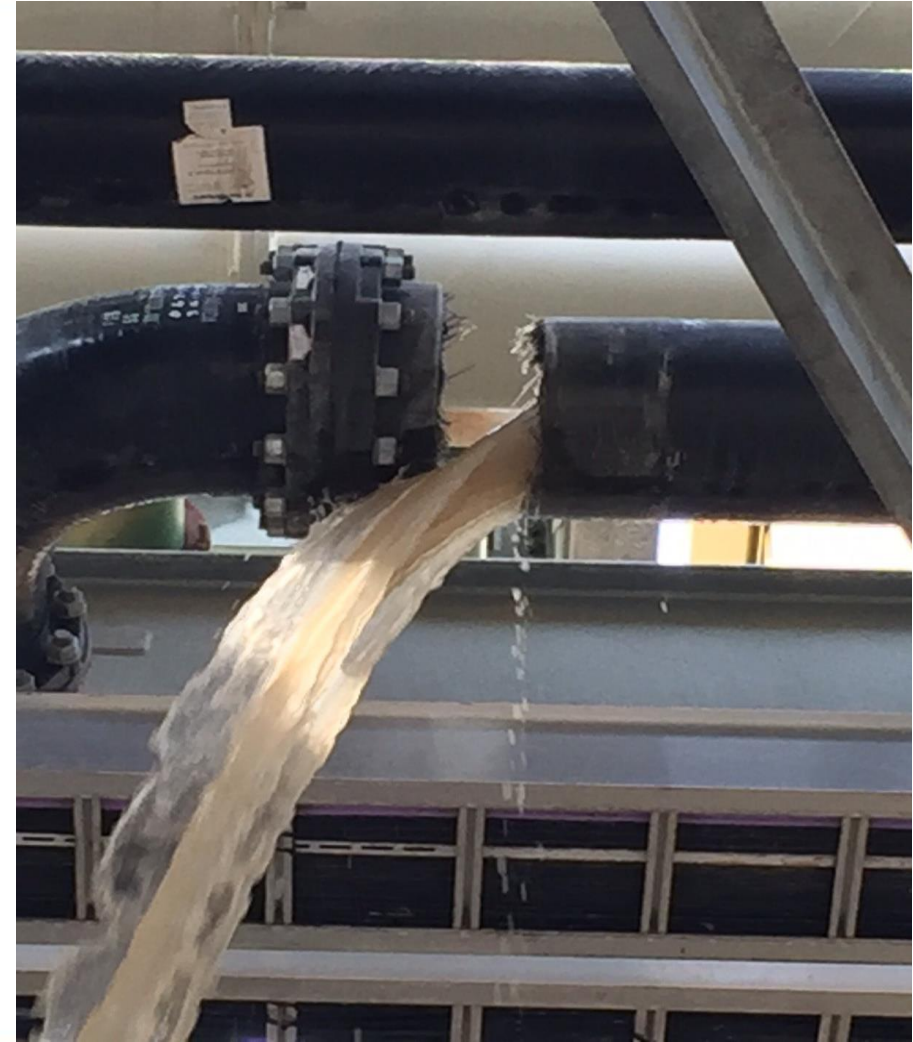
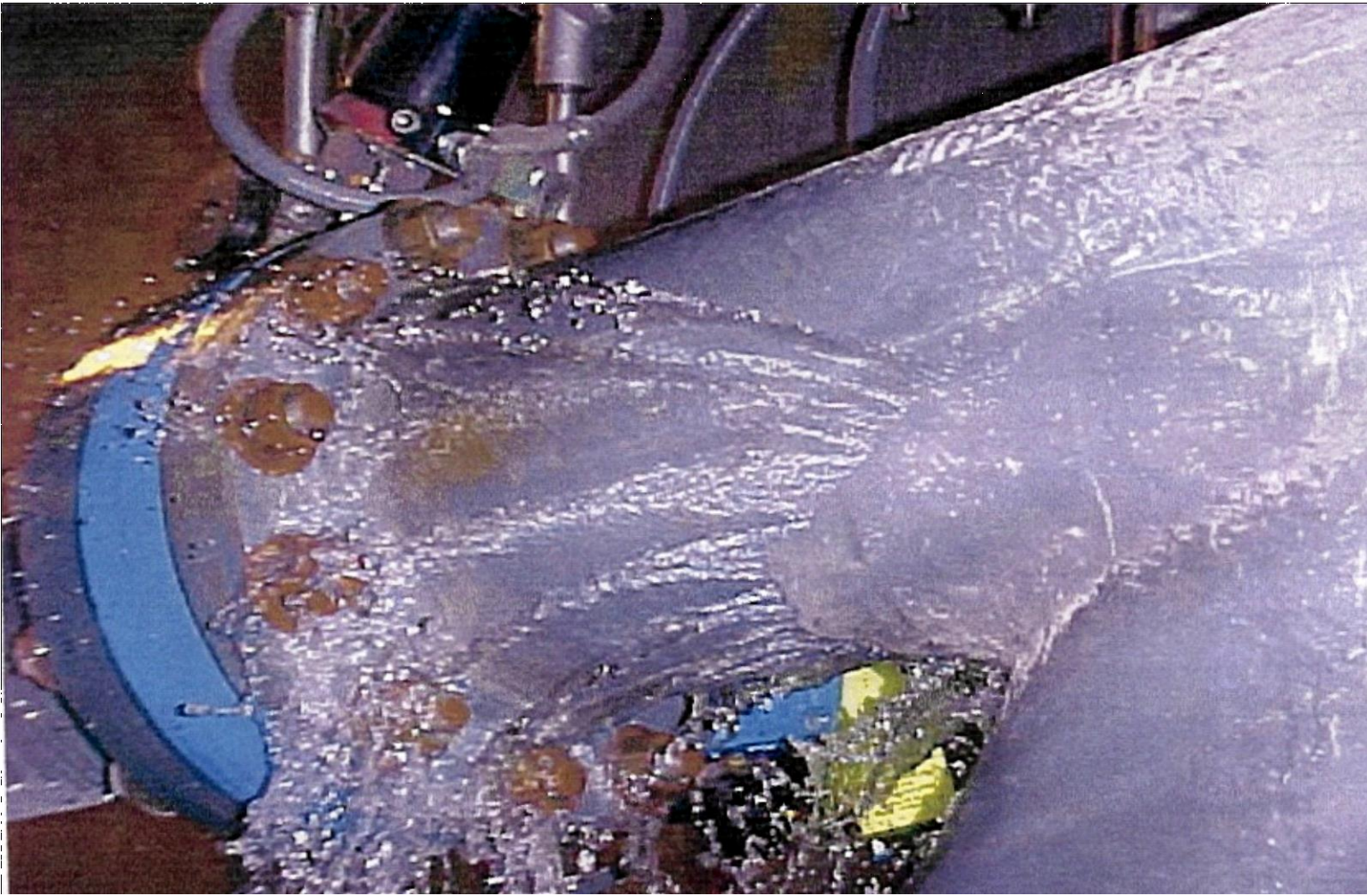
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# Examples of Poor Fabrication



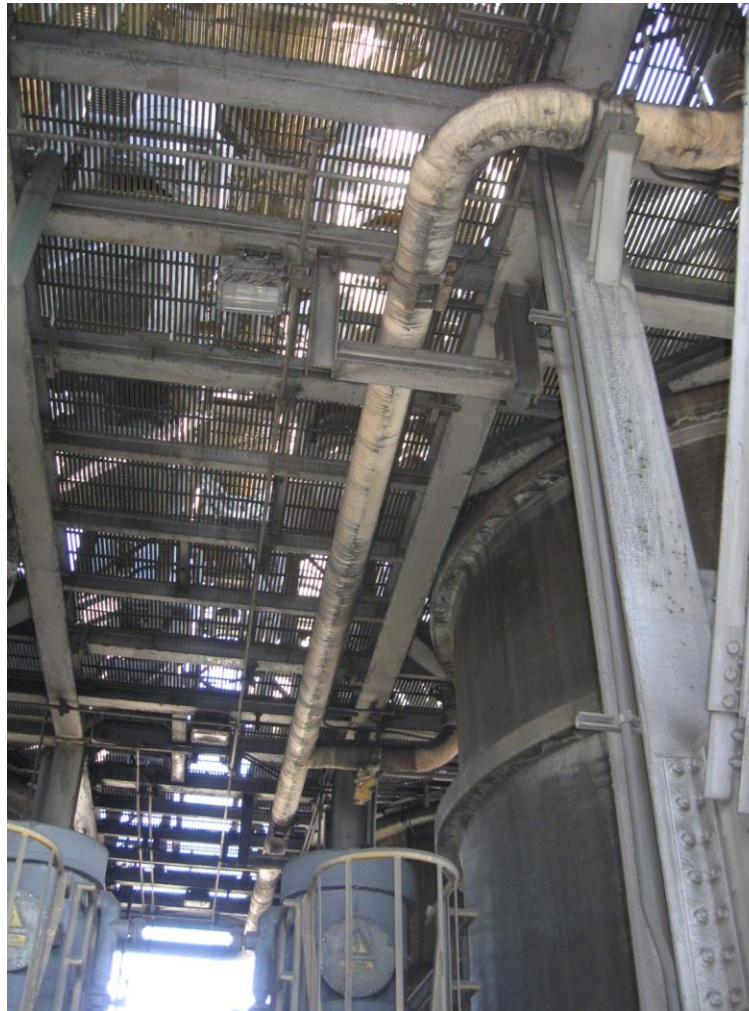
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# Examples of Engineering Deficiencies



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# Examples of Engineering Deficiencies



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# Examples of Poor Supports



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## No. 1 Deficiency – FRP Engineering

- Most FRP process piping should be formally analyzed
- Analyzing FRP piping is not just changing material properties
- Design conditions and load cases need to be reviewed to ensure they cover the full extent of operating expectations
- This extends to other nonmetallics as well
- Vessel internal components need to be closely evaluated

## Material Selection Deficiencies

- Thermoplastics Pressure Pipe is over specified in some areas
- Dual laminate materials are a common challenge
- Materials should be hard spec'd to the Manufacturer and Material No.
- Inspections eliminate opportunities for substitutions and outdated materials
- Vinyl Esters offer better material properties and durability over polyester resins

# Assessments and Summary

## Fabrication Concerns

- Due the complexity, Fabrication is a bigger issue with tanks than piping, although piping cannot be ignored
- Laminators should be certified per ASME RTP-1 or other standard
- Flange Installation tolerances and squareness
- Inadequate tank bottom flatness and knuckle radius create stress risers
- Proper joint surface preparation and quality control
- Poor flange construction



## **Installation Concerns**

- Proper Bolt Torquing of Flanges
- Raised face flanges
- Valves should be independently supported
- Certified Laminators are needed in the field as well
- Misalignment of joints, laminated and bolted
- Monitor environmental conditions

## Additional Concerns to Think About?

- For Piping installation Deficient Contractor Training has been involved in 18% of FRP piping failures.
- Lack of Timely Inspection has been a contributor to 14% of failures.
- Entry points and isolation of buried lines need to be preplanned for future inspections.
- Poor pipe supports has contributed to a number of tank nozzle failures.

# Conclusions

## Takeaways

- Take Ownership of the Process!
- Identify your Best Resources for Success!
- Trust and verify!
- Monitor and be involved in every step.
- Don't Assume.

**Keep the Big Picture in Mind.**  
**Project Savings can quickly disappear with Lost Production!**

***“Failures have many Contributors.  
Attention to Details at every phase of the  
Project is Essential for Reliability.”***

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