

# MERCURY MARINE 2017 WESTERN DREDGE ASSOCIATION



# Introduction

- Pete Chisholm – 37 years at Mercury
  - Product Safety Manager, Mercury Marine
  - Boating Industry Risk Management Council, Chair
  - National Boating Safety Advisory Council
  - American Boat and Yacht Council
  - SAE Marine Technical Committee
  - International Standards Organization – Technical Committee
  - International Association of Marine Investigators
- Todd Lemke – 26 years at Mercury
  - Vice President, General Counsel
  - BIRMC member
  - Litigation management





# BRUNSWICK

GENUINE INGENUITY

## Engines & Parts



## Boats



## Exercise Equipment



## Billiards



# MERCURY MARINE IS A FULLY INTEGRATED MANUFACTURER

From this ...



... to the water.

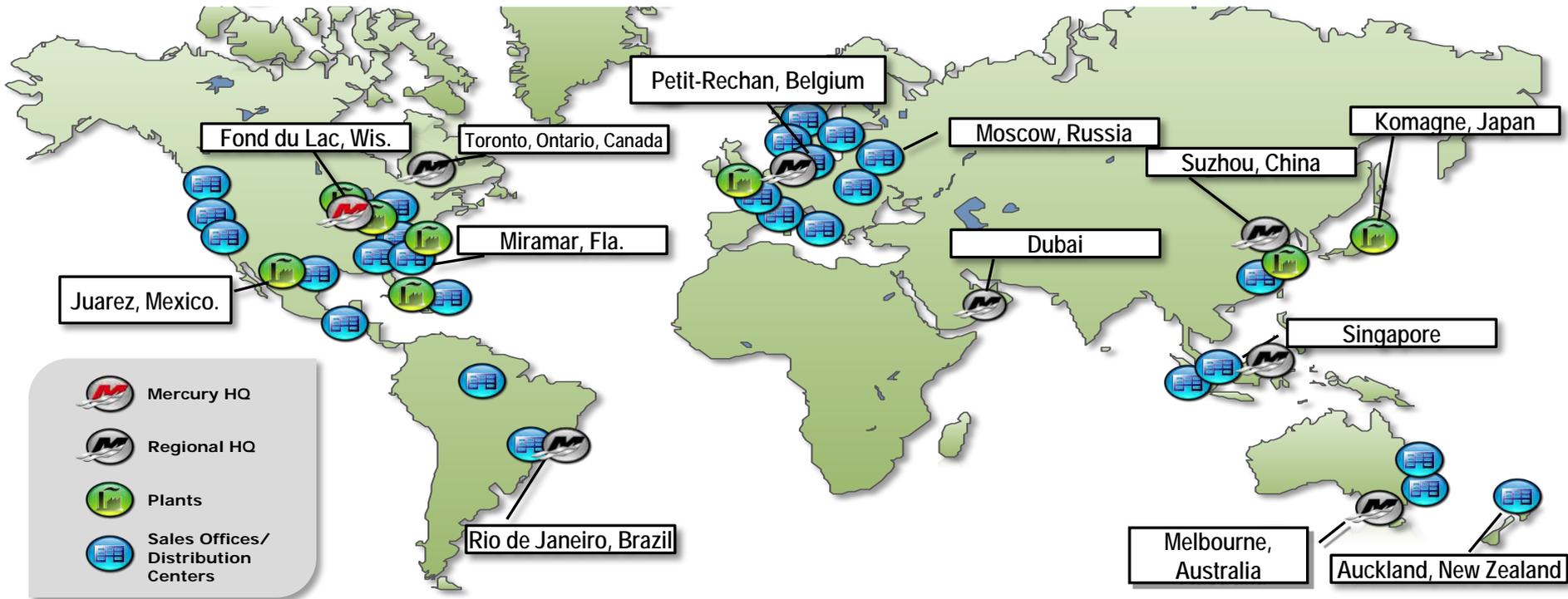
# MERCURY MARINE

## From Wisconsin to the world

- Founded in 1939 in Cedarburg, Wisconsin
- Acquired by Brunswick Corporation in 1961
  - Largest division of Brunswick Corporation, founded in 1845
- 80 facilities in 22 countries
- Industry leading developer and manufacturer of a broad range of marine propulsion systems for recreational and commercial applications
- 3,200 employees in Wisconsin & more than 6,000 worldwide



# MERCURY MARINE GLOBAL FOOTPRINT



# Prop-to-Helm Solutions

- Outboard Engines (2.5hp - 400hp)
- Sterndrive Engines (135hp - 1650hp)
- Parts and Accessories (P&A)
  - One-stop shopping for marine retailers, dealers, distributors and boat OEMs



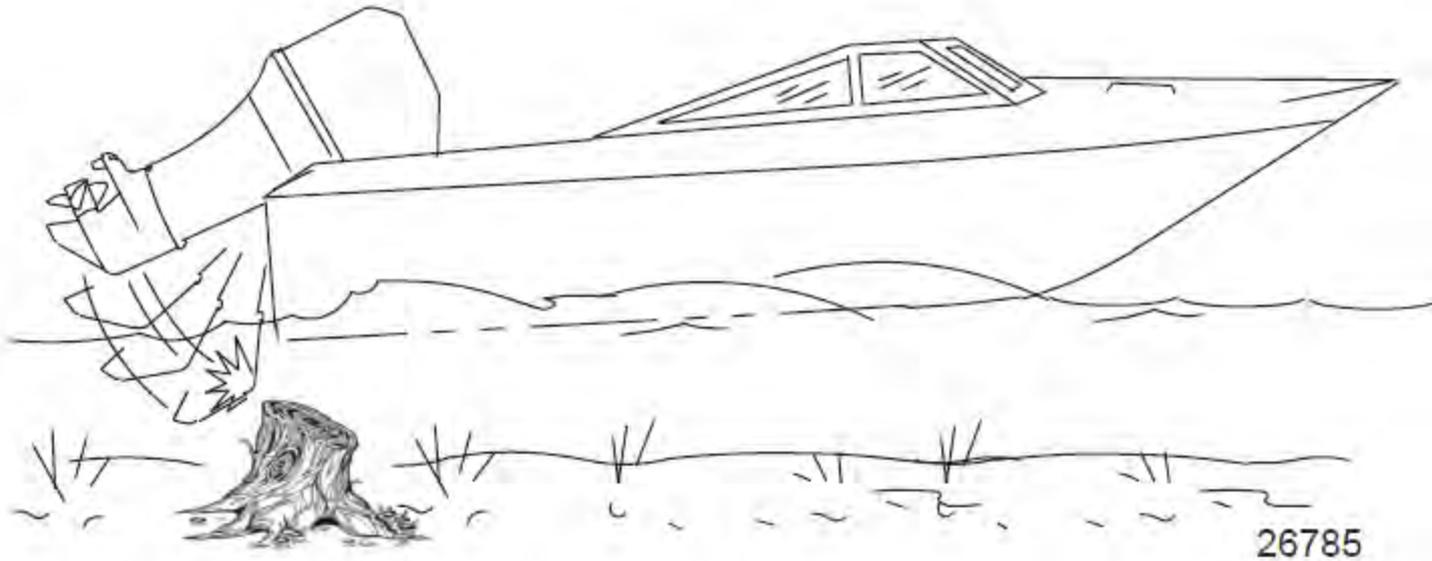
# SEA PRO FOR COMMERCIAL MARKET

- 75-115hp & 150hp SeaPro FourStroke outboard engines launched January 2015
- 40-60hp SeaPro FourStroke outboard engines launched January 2016
- First dedicated commercial 4-Stroke engines in the industry
- Tailored specifically for commercial applications
  - ✓ Designed & tested to 3x engine life vs. recreational outboards

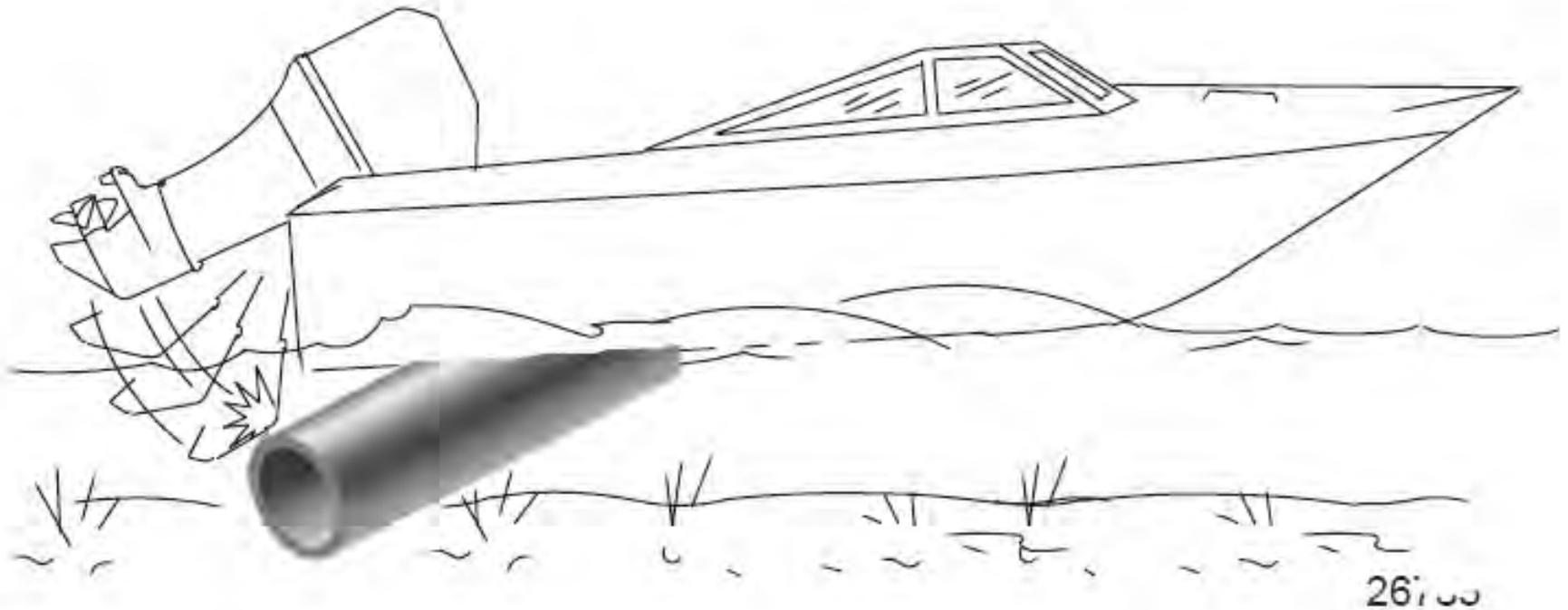


“The engines never faltered once despite the many gallons of sea water that washed over them, and when power was needed to navigate the huge seas, it was quick and positive.” Rob Naysmith, South Africa Sport fishing Charter Captain.

# Underwater impacts are anticipated



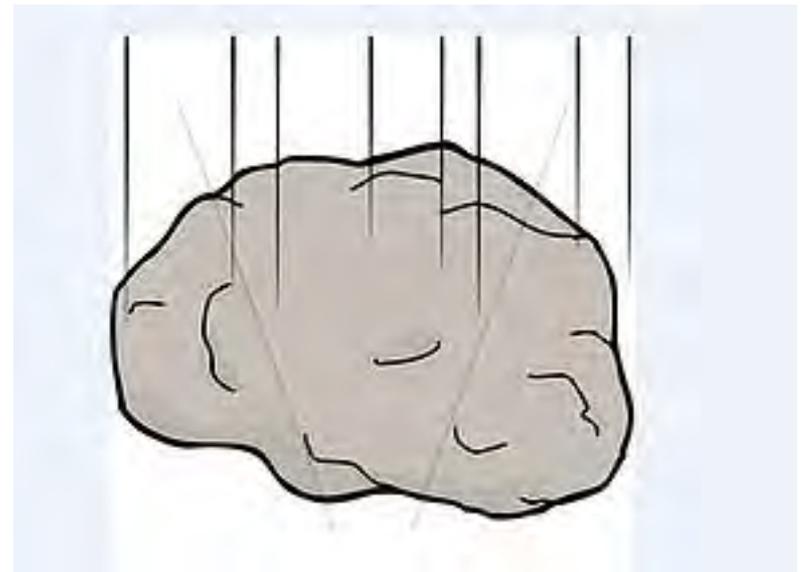
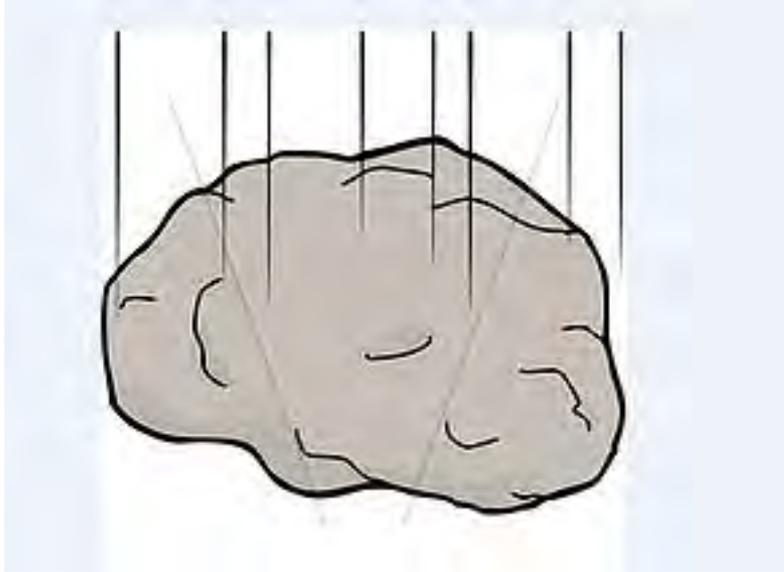
# Not all impacts are the same!



# Engineering 101

- Law of Conservation of Energy
  - Energy can not be created or destroyed
  - Energy may change form but the total energy remains the same
  
- Complex collision between engine and object
  1. Immediate energy transfer
  2. Engine rotation
  3. Engine clears obstruction
  4. Engine continues to rotate due to energy transfer

# Law of Conservation of Energy



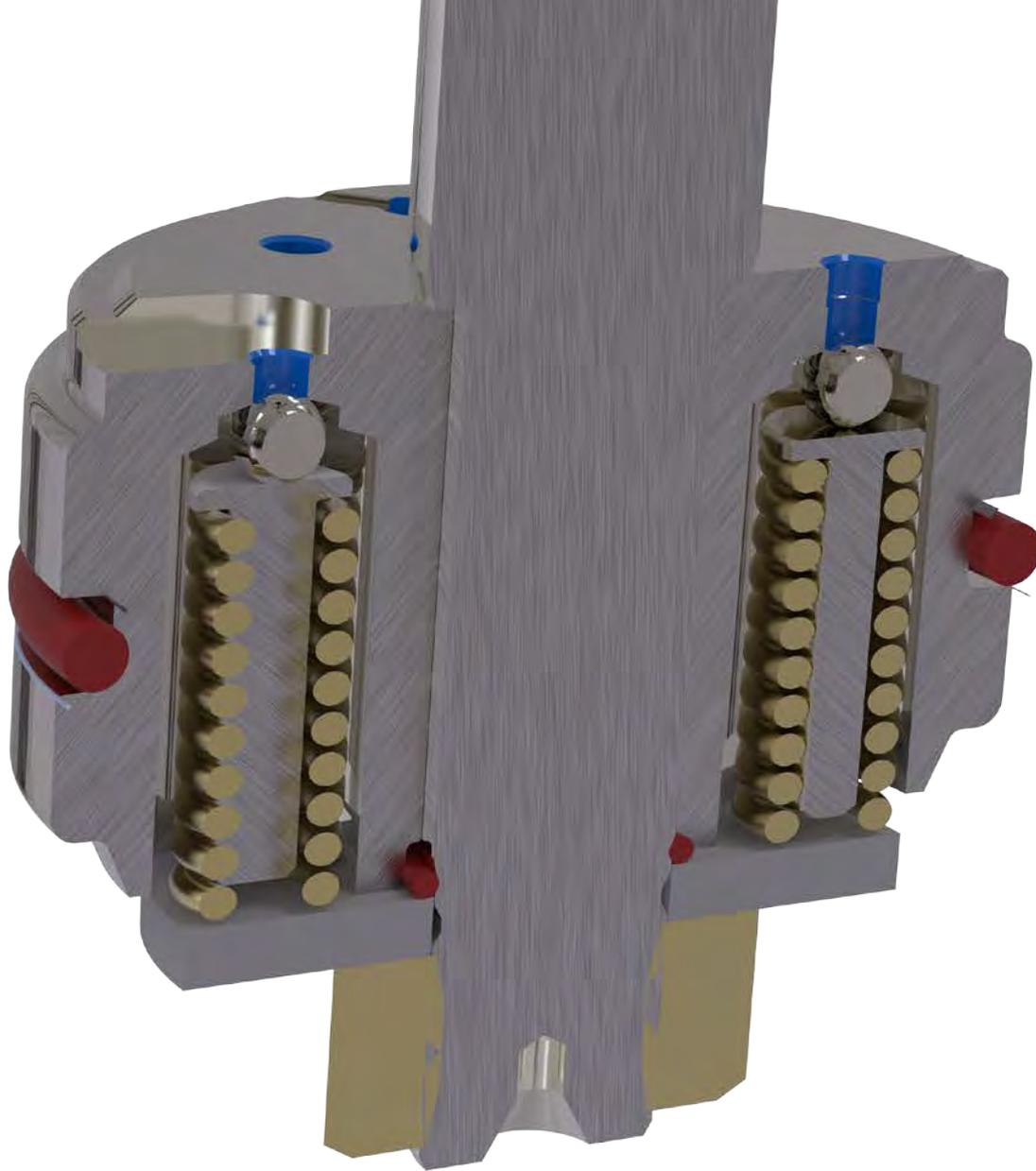
# Modern Trim Systems





Company Confidential







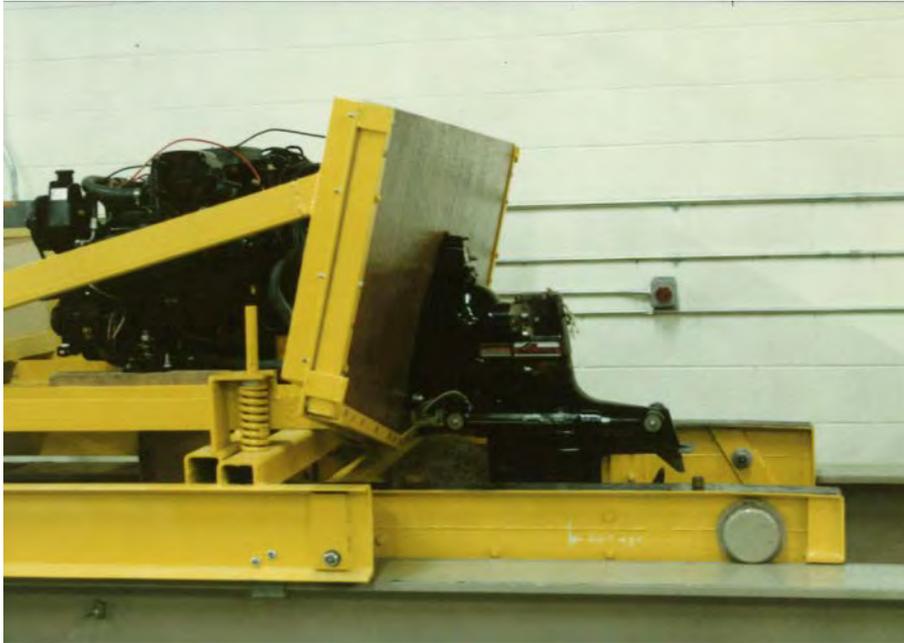
# Historical Reference – Testing Systems with In-Water Log Strikes

LOG  
JUMP  
EXAMPLES

# Development of Dry Land Simulated Impact Fixture

- The Dry Land Simulated Impact Fixture was developed to provide a repeatable test, as a measure of the structural integrity of the engine. The design speed is chosen as the speed at which you can still return home with the engine after an underwater impact.
- The design of large outboards are impacted 5 times:  
30 MPH, 35 MPH, and 3 impacts at 40 MPH







1500 fps  
Start

1/5000 sec  
frame : 532

10.4x 1024  
+00:00:00.531000...

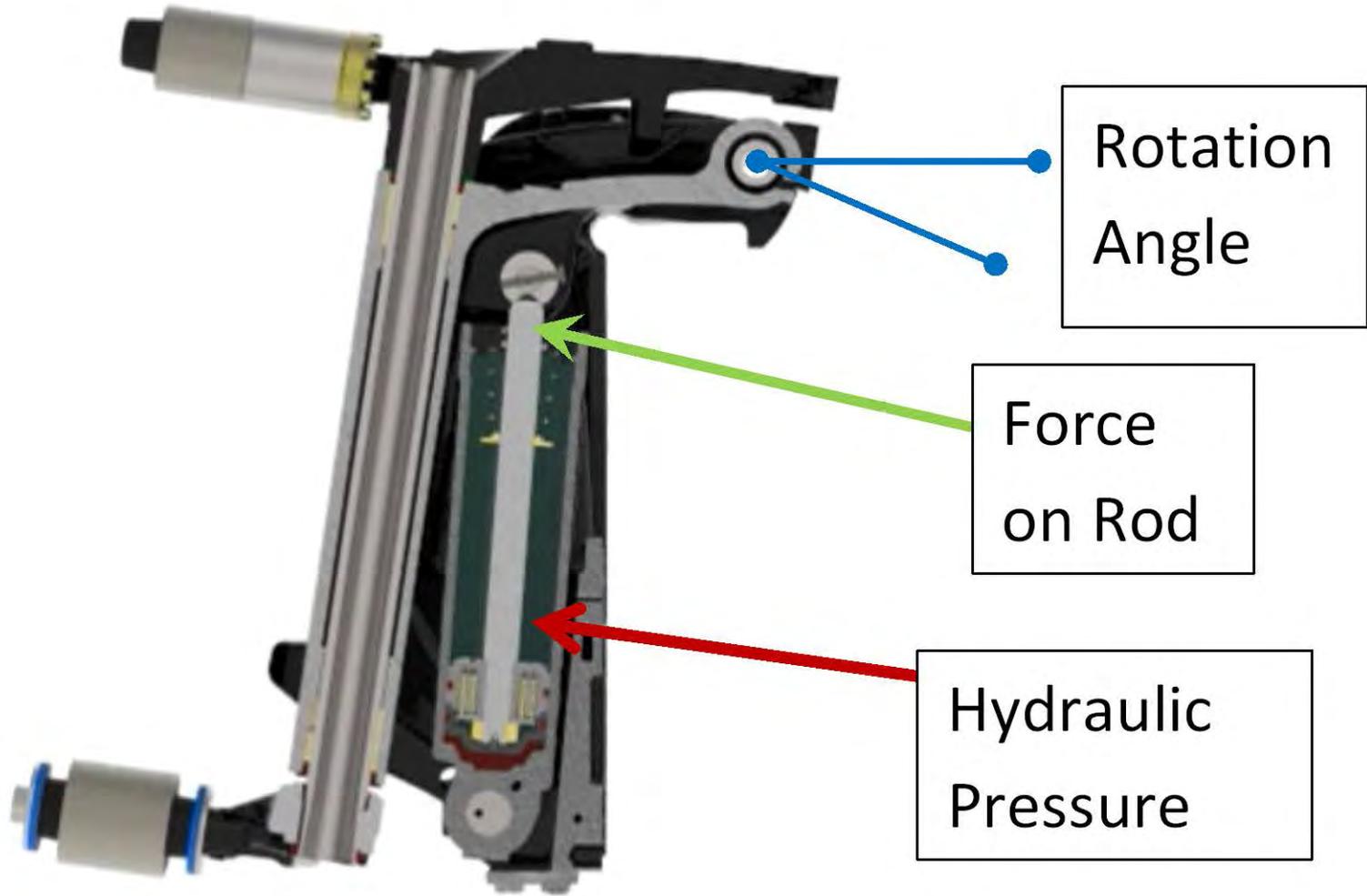


RY



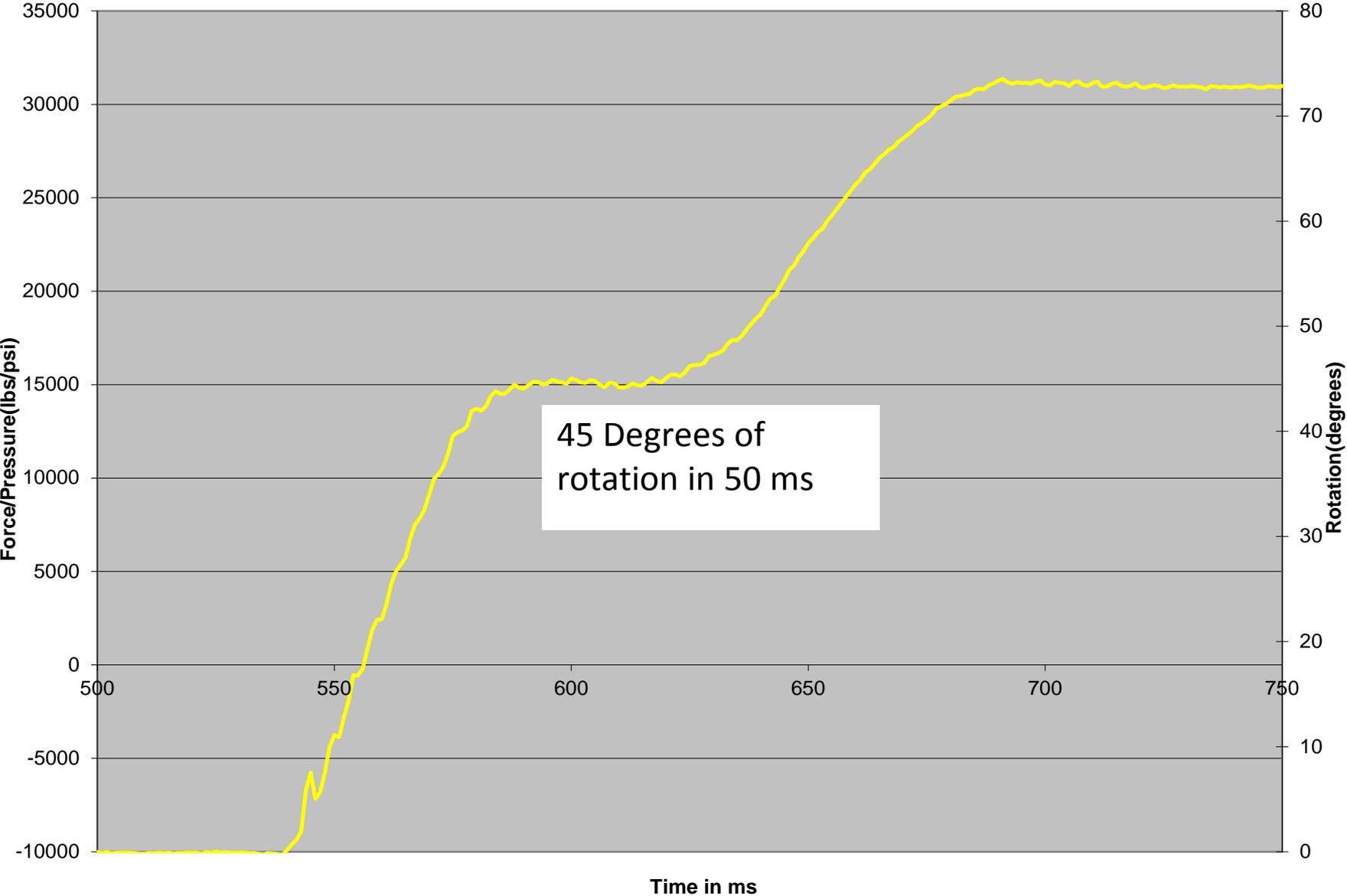


# Data Comparison



# Data Comparison

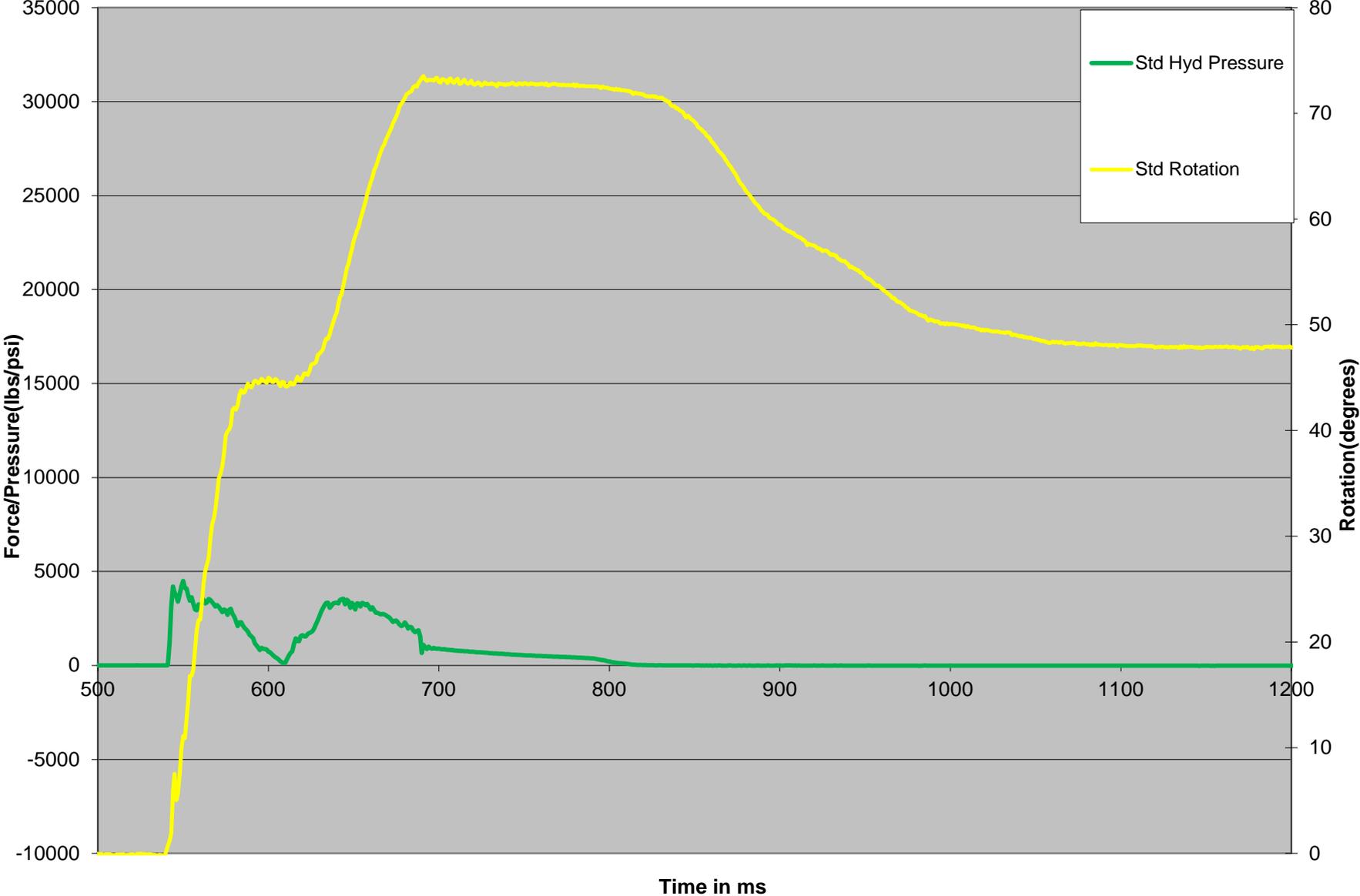
## Striking Pipe at 40 MPH



45 Degrees of rotation in 50 ms

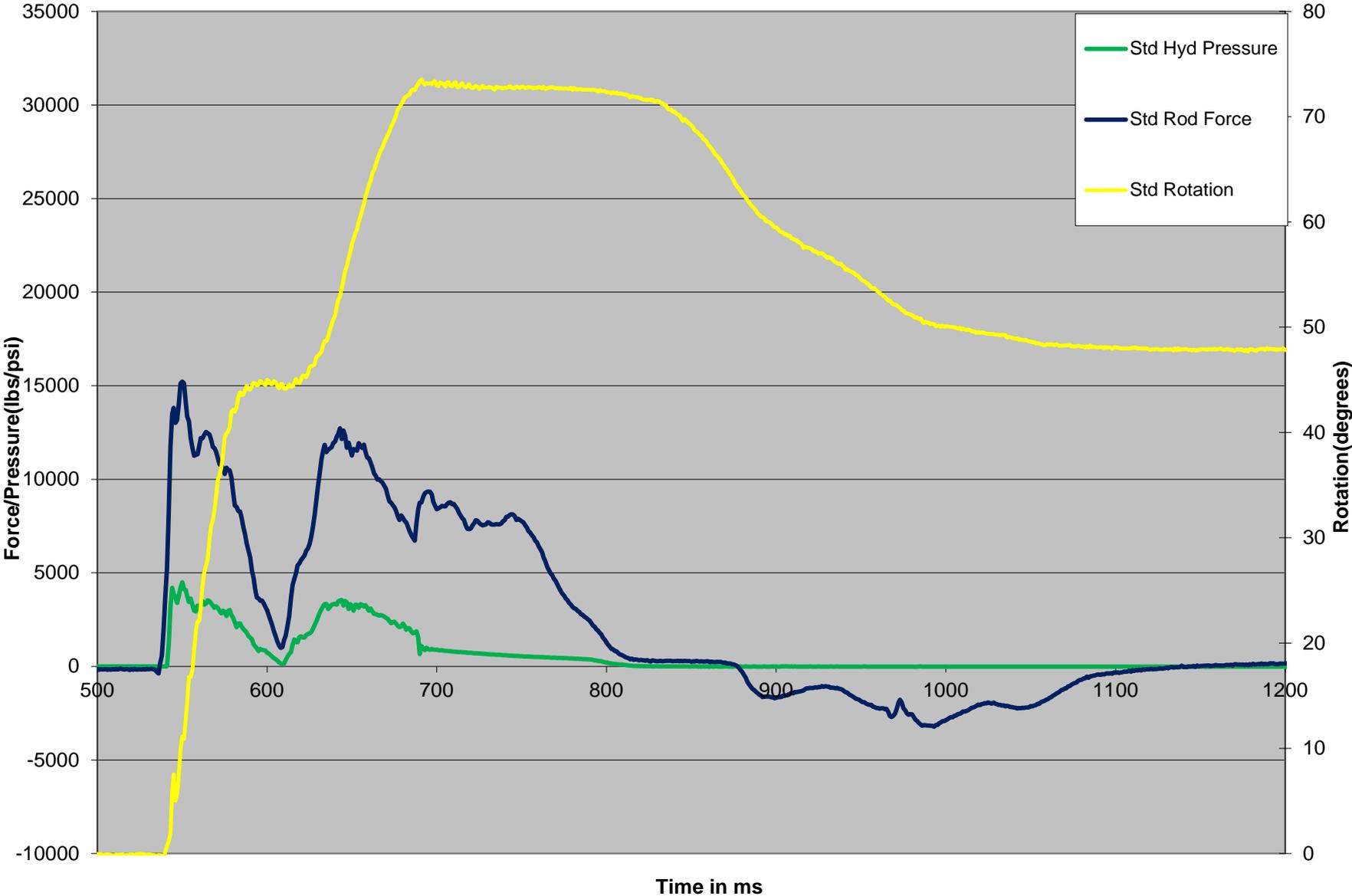
# Data Comparison

## Simulated Strike at 40 MPH



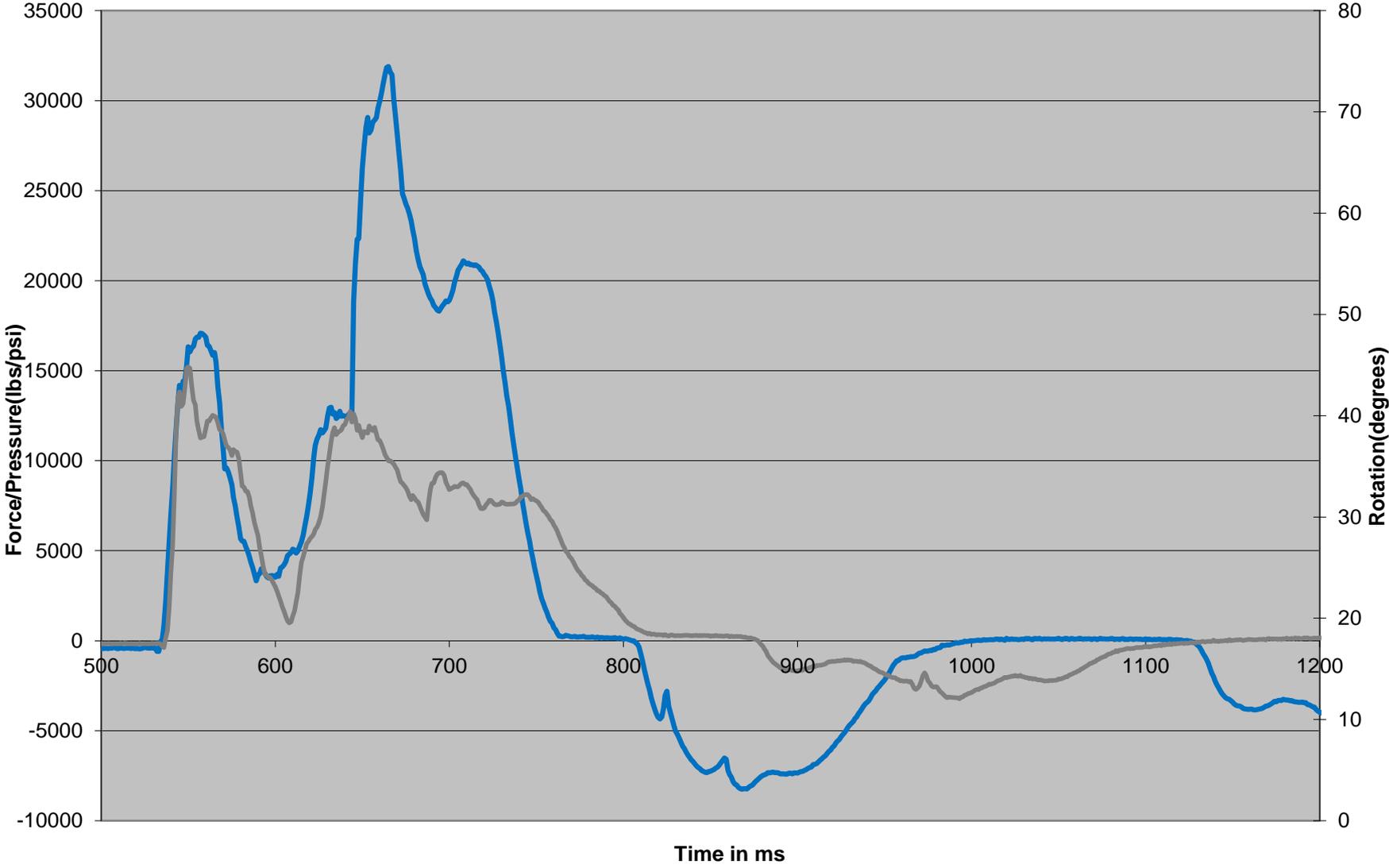
# Data Comparison

## Striking Pipe at 40 MPH



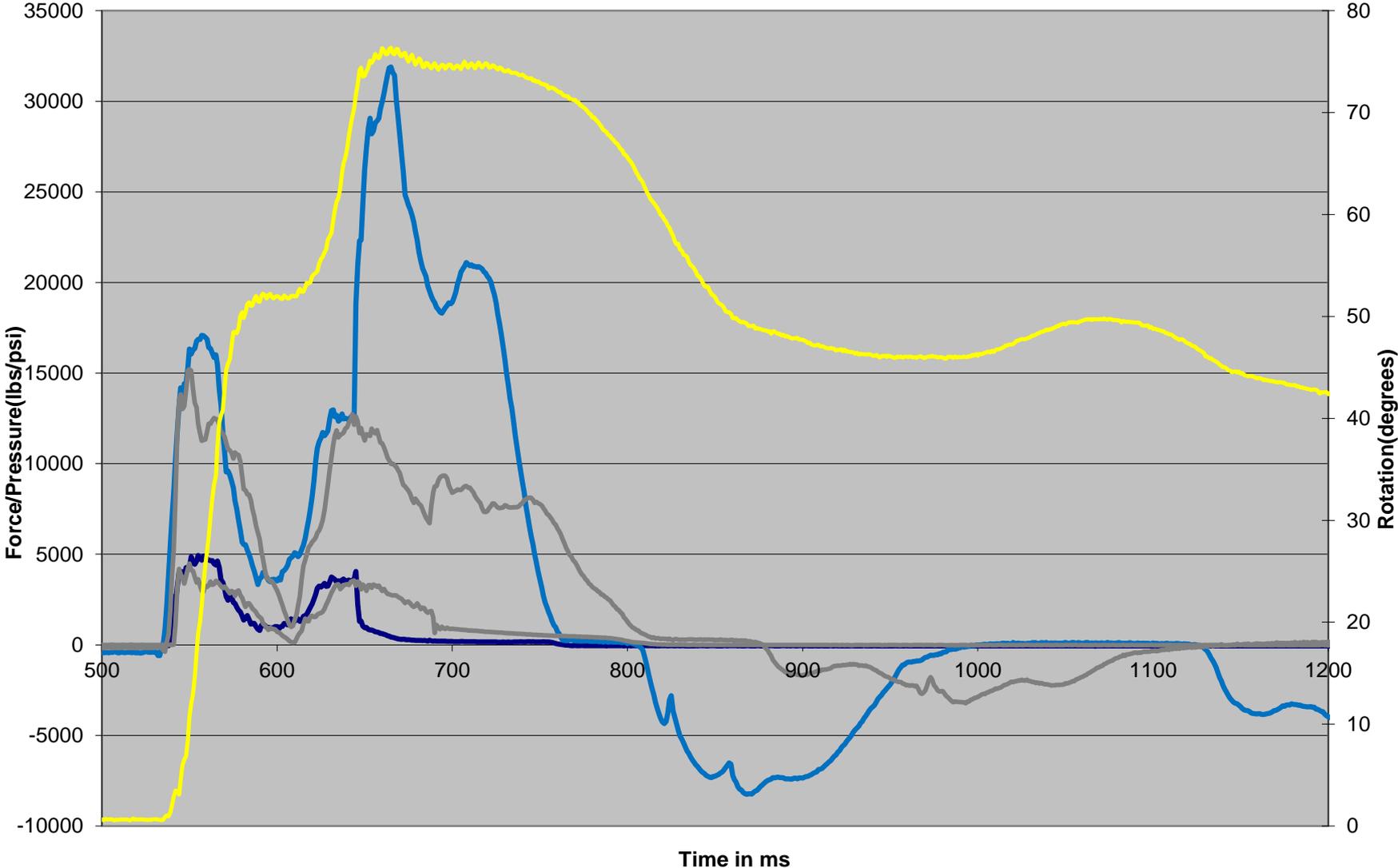
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## Striking Pipe at 40 MPH



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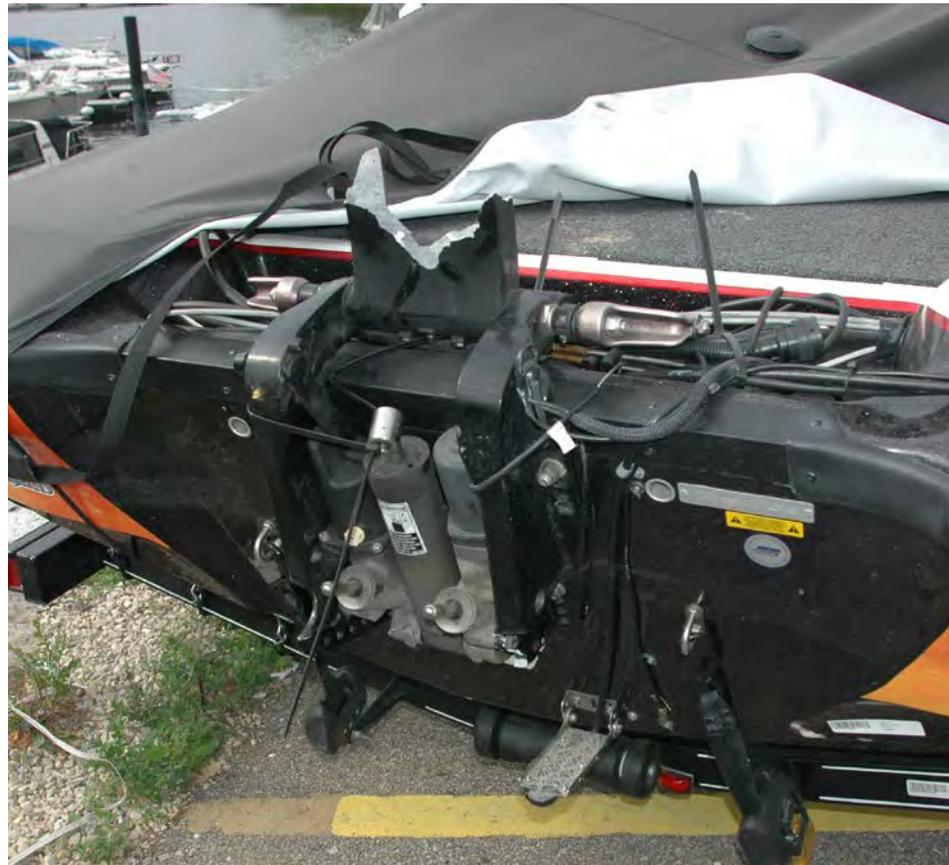


# Case Studies









## • Conclusion

- Substantial loads are generated with pipe strikes
- Design limitations
- Methods to prevent interactions between recreational boats and dredging pipes