

# 2H offshore

**Riser & Conductor Engineering**

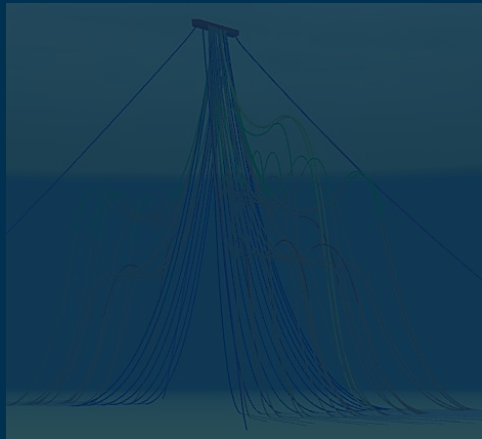
Houston | Rio de Janeiro | Aberdeen | London | Kuala Lumpur | Perth | Beijing

# **Flexible Life Extension with Innovative Monitoring**

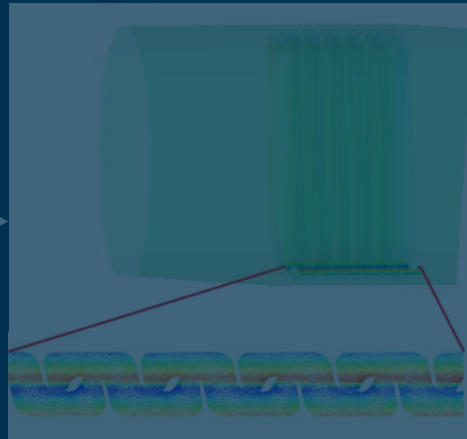
14<sup>th</sup> March 2019

Christian Wiebe

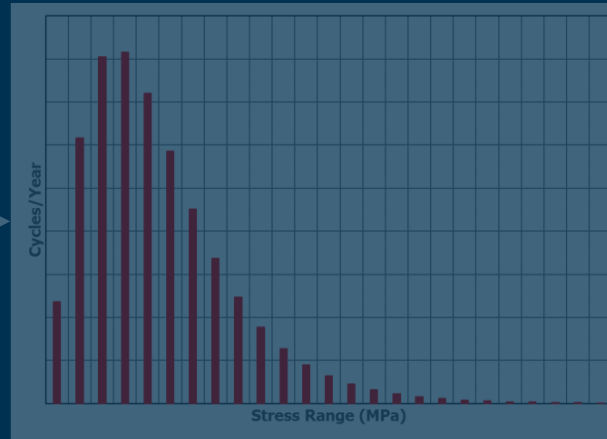
# Fatigue Design/Life Extension – Conventional Approach



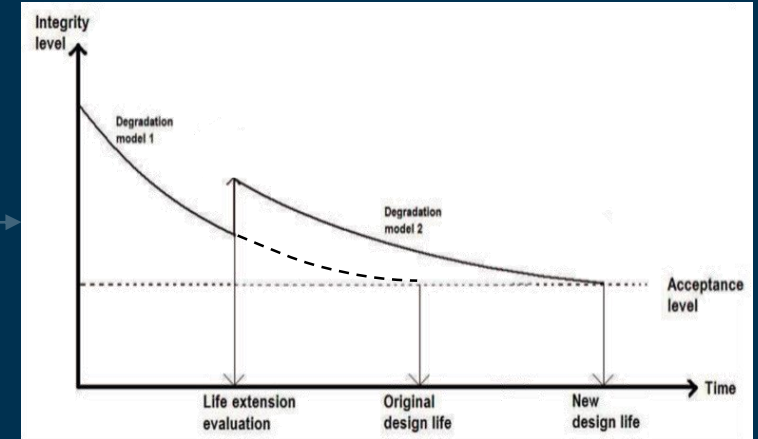
**Global Response Analysis**



**Local Stress Analysis**



**Stress Histogram**

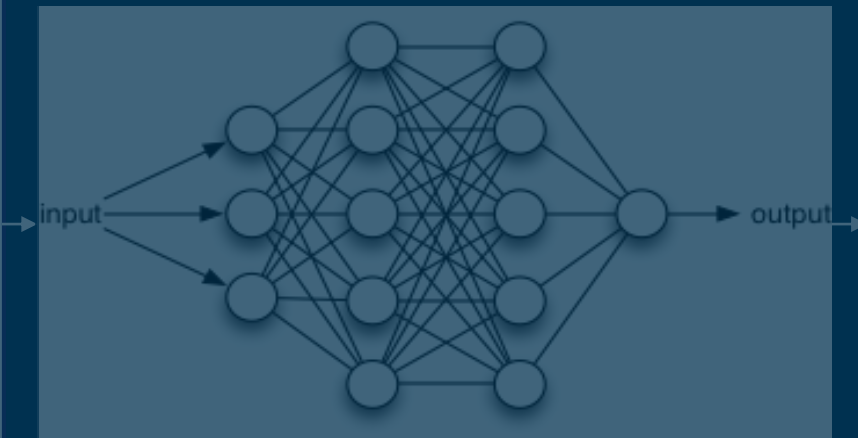


**Revised Fatigue Damage**

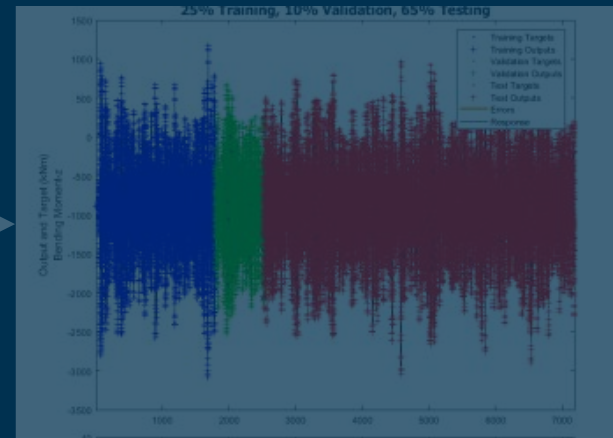
Source: NORSOK



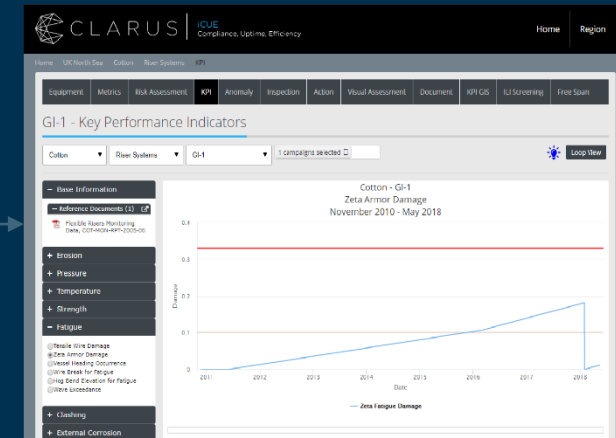
**Measured  
Response**



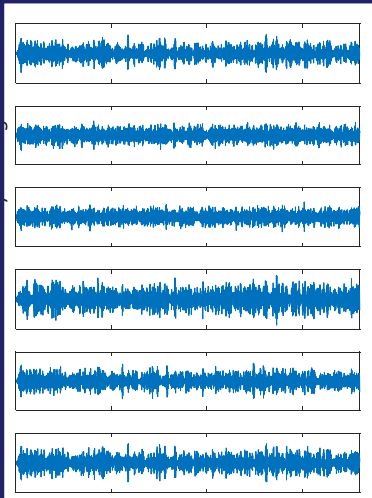
**Artificial Neural Network  
(ANN)**



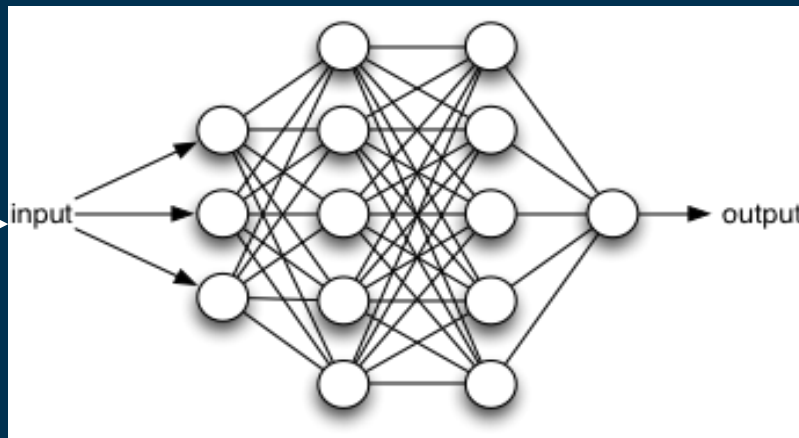
**Stress Time History**



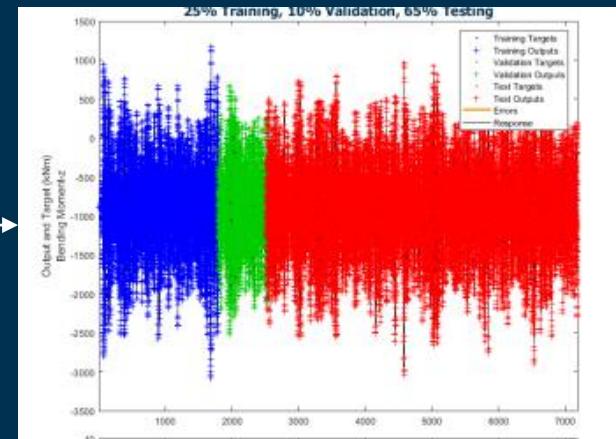
**Real-Time  
Fatigue Damage**



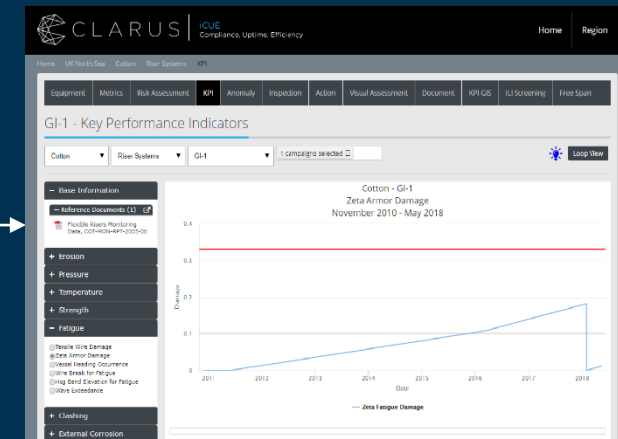
**Measured  
Response**



**Artificial Neural Network  
(ANN)**



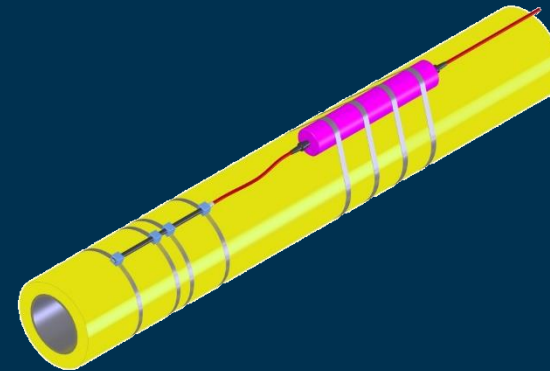
**Stress Time History**



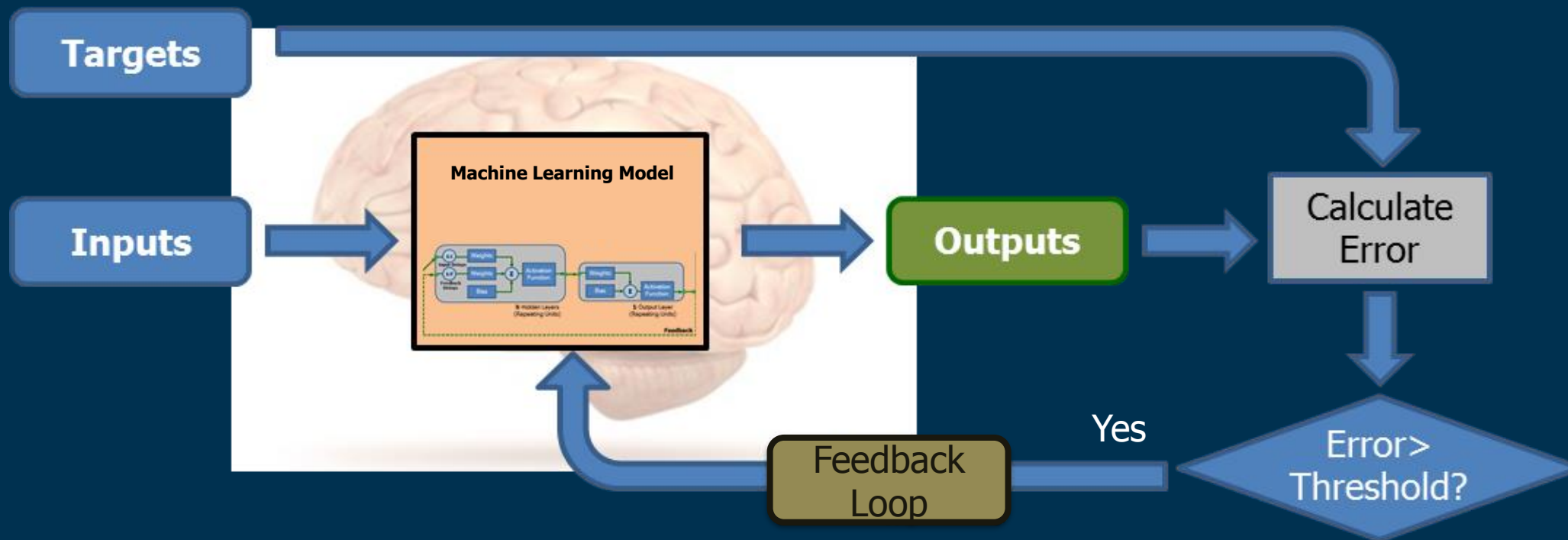
**Real-Time  
Fatigue Damage**

-

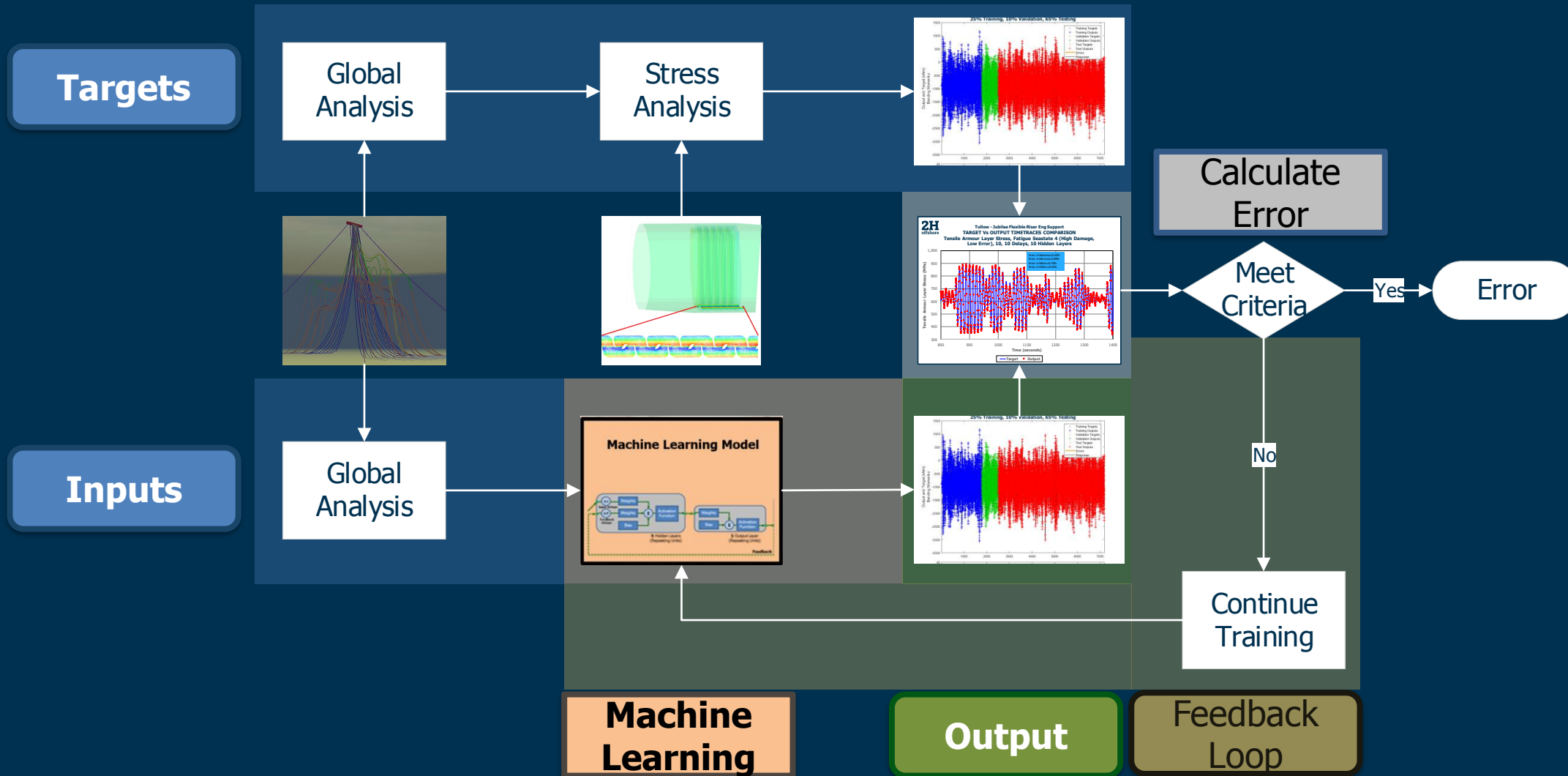
- **Riser Curvature**
- **Proven Technology**



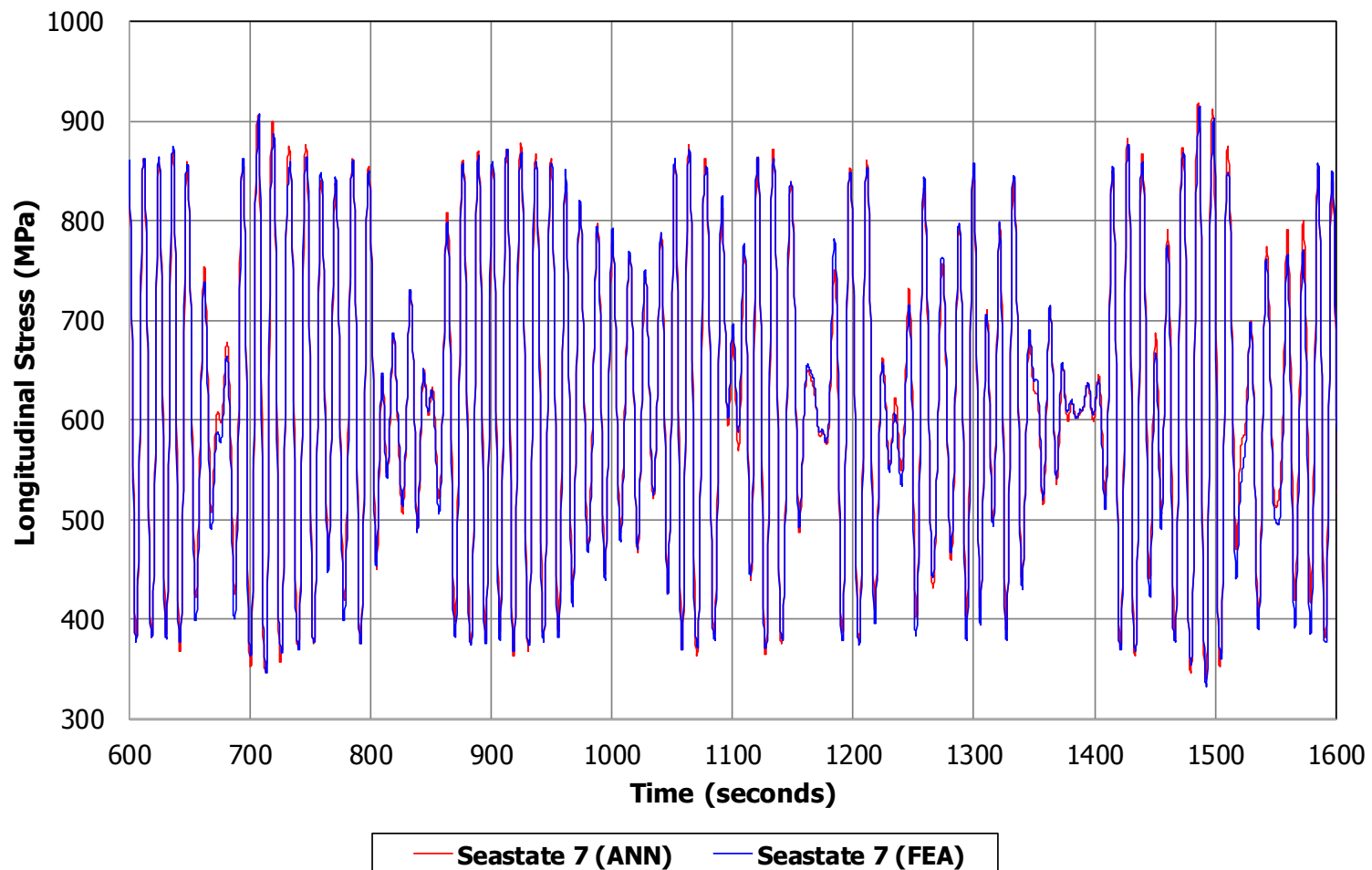




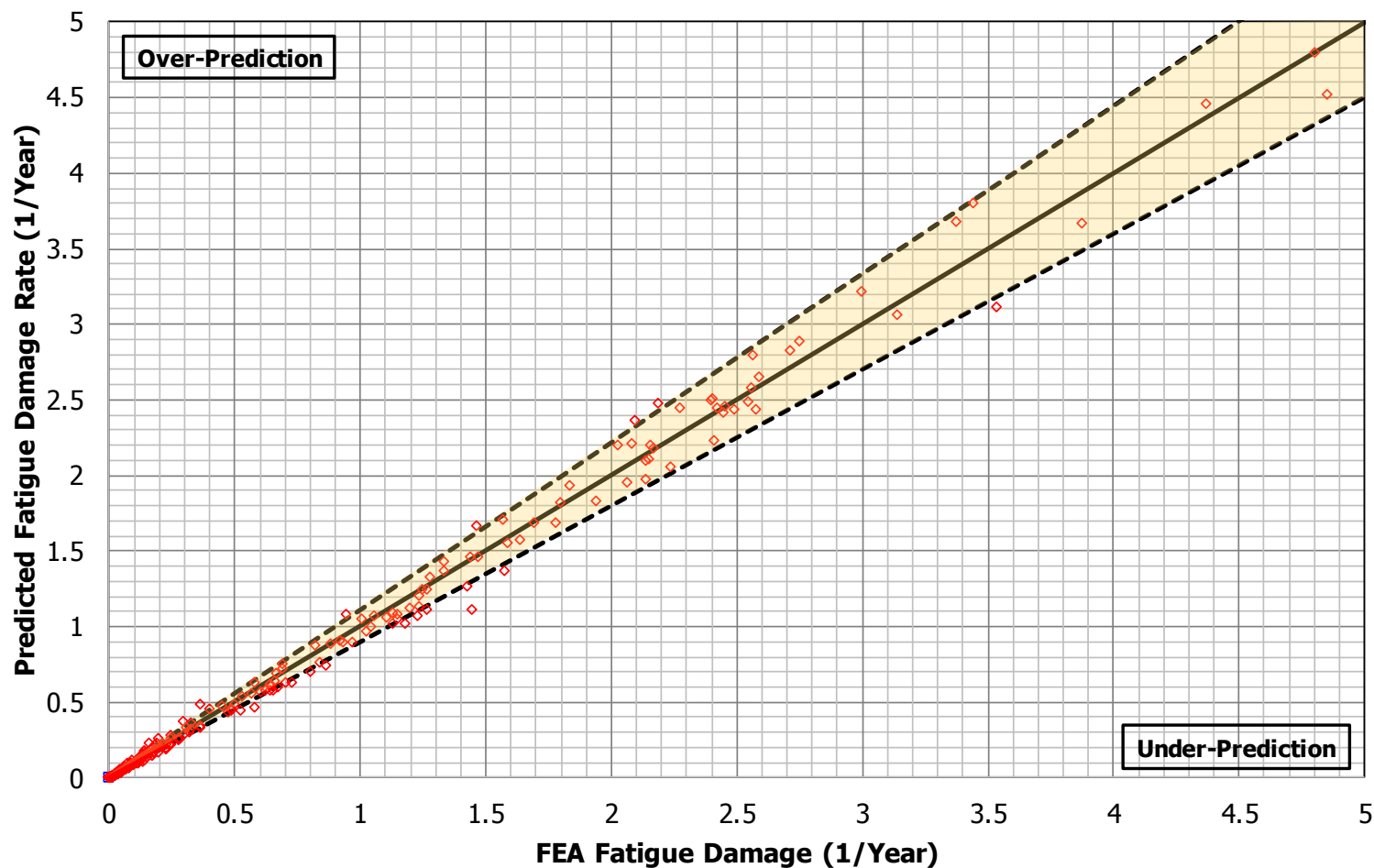


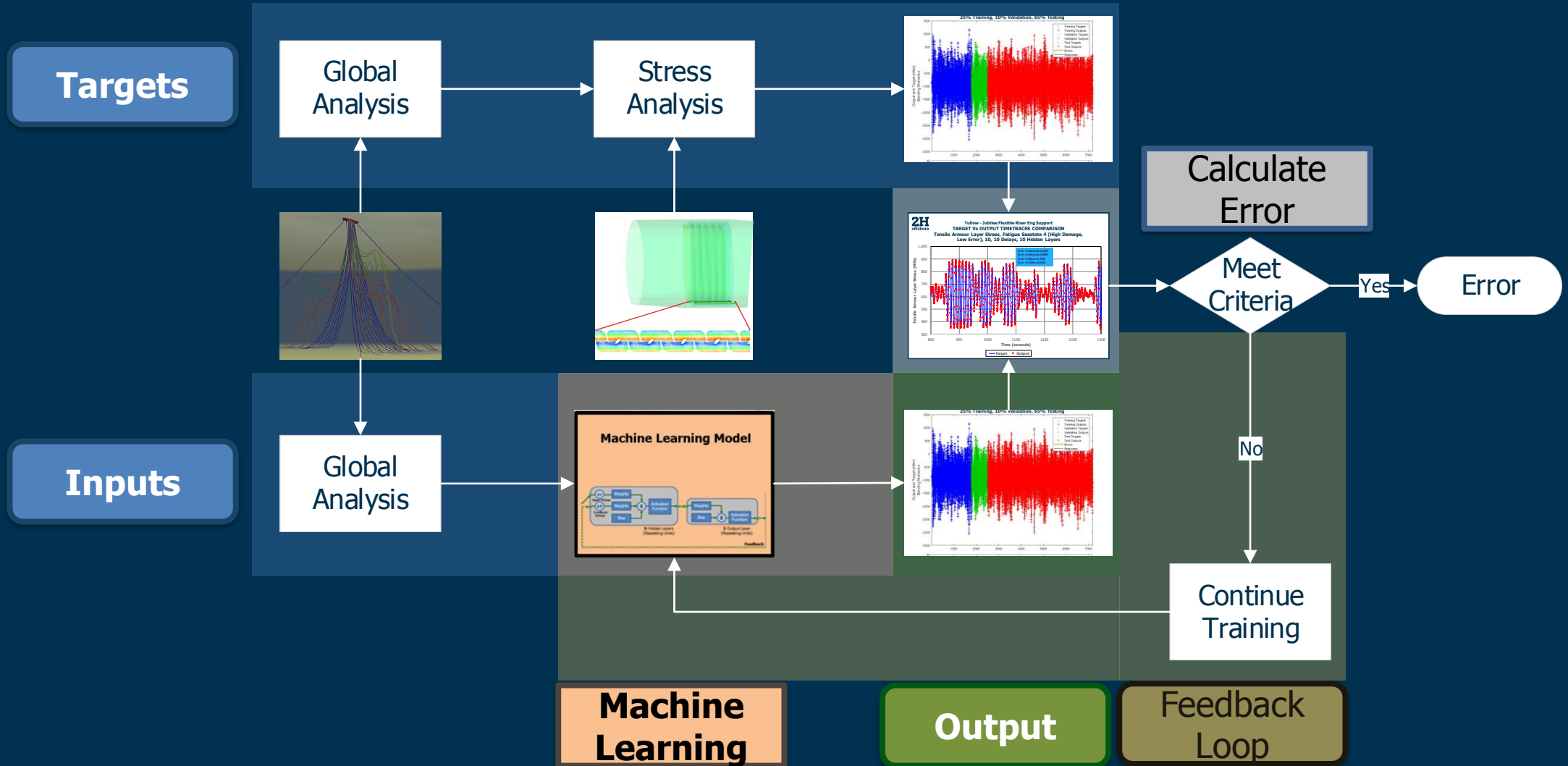


**Flexible Riser Fatigue Tracker**  
**MACHINE LEARNING - NARX/LM STRESS TIME TRACE**  
**FATIGUE DAMAGE, EXPONENT 6 - Seastate 7**



**Flexible Riser Fatigue Tracker**  
**MACHINE LEARNING - STRESS TIME TRACE**  
ENARX/LM, Exponent 6 - 251 Seastates, Rainflow Counting





**Targets**

Global  
Analysis

Stress  
Analysis

Calculate  
Error

Meet  
Criteria

Error

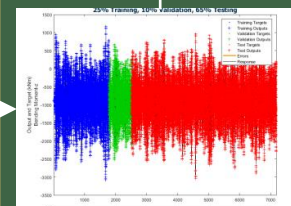
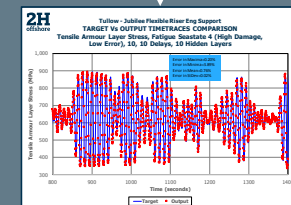
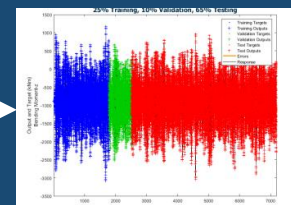
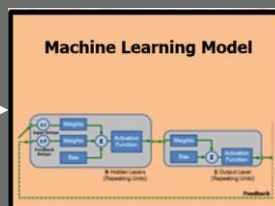
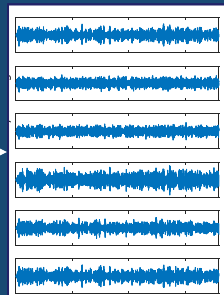
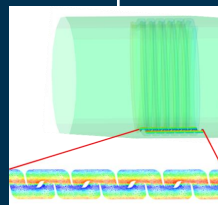
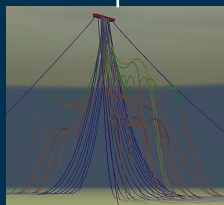
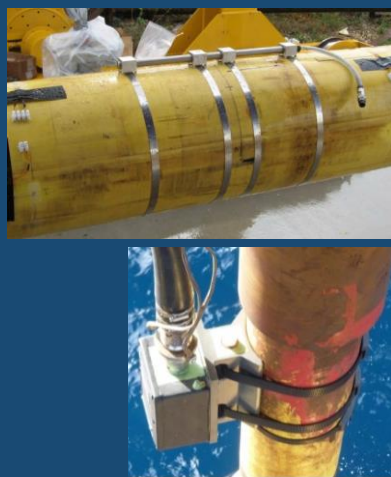
Continue  
Training

**Inputs**

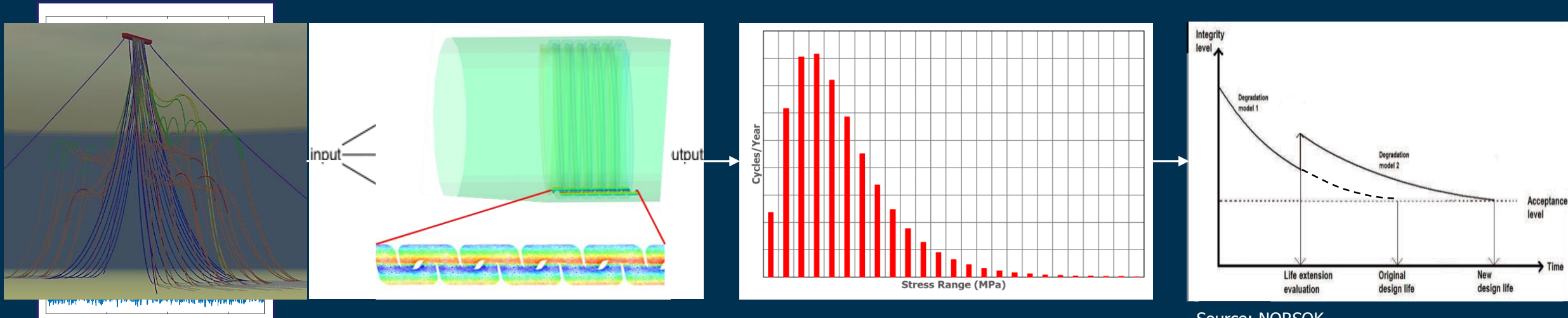
**Machine  
Learning**

**Output**

**Feedback  
Loop**



# Flexible Life Extension with Innovative Monitoring



Source: NORSOK

**Global Response  
Analysis**

**Artificial Neural Network  
(ANN)**

**Stress History**

**Real Time  
Fatigue Damage**

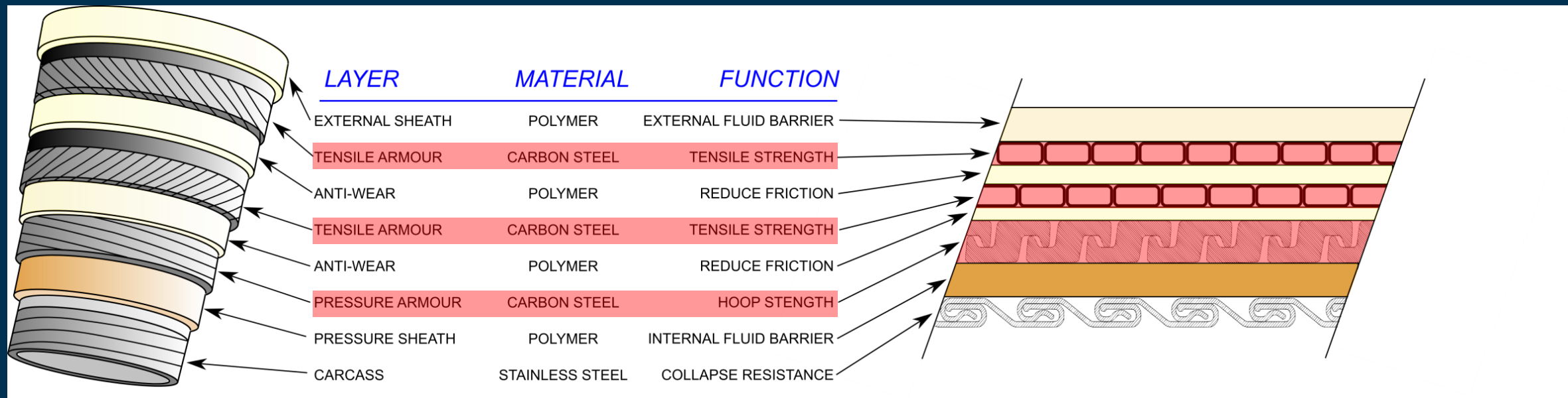
# Thank you

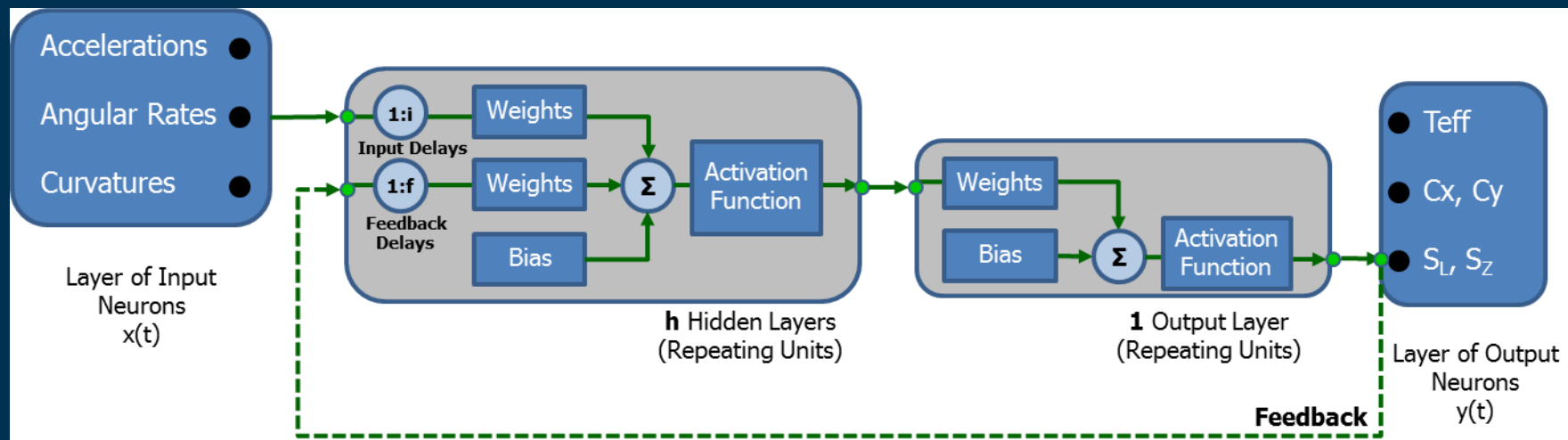


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# Flexible Riser Fatigue

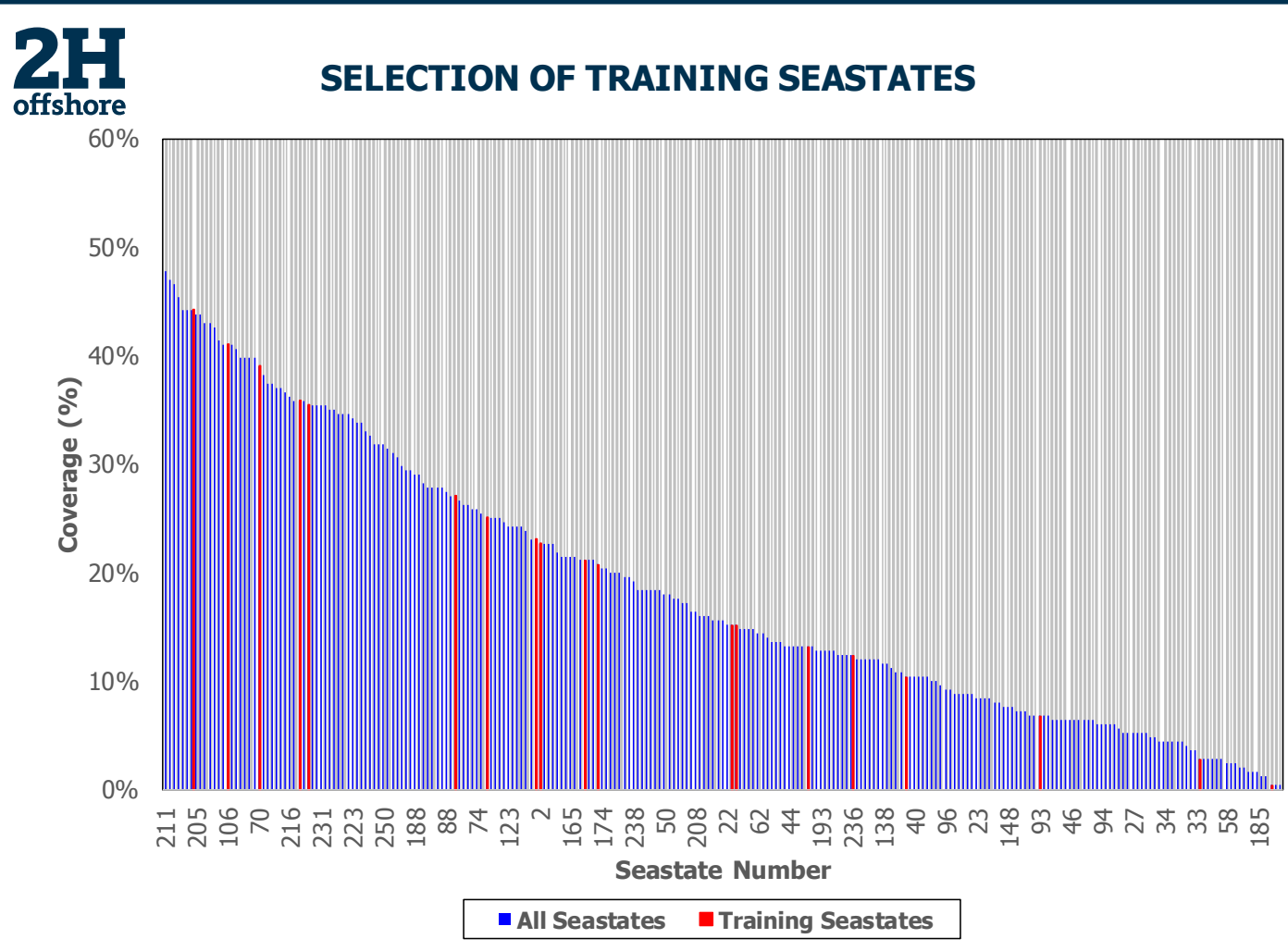




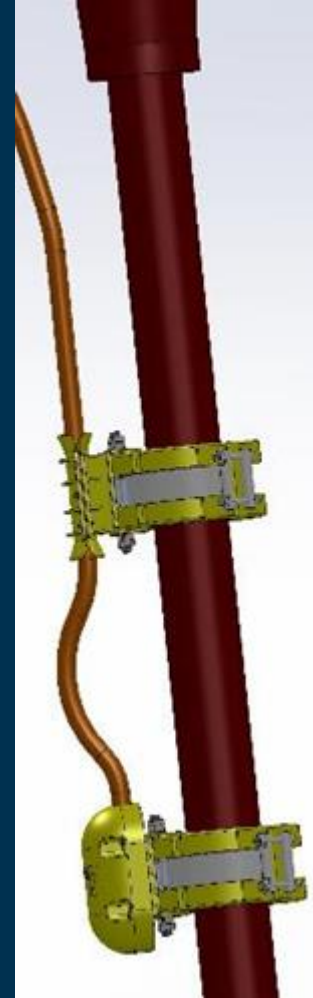
## NARX/Levenberg-Marquardt

- Typically used for time series
- High accuracy with minimal training datasets

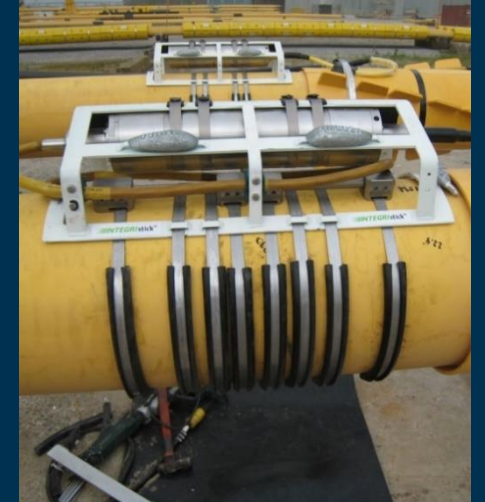
# Selected Training Seastates



- **OSX-3**
- **26 – 14 – 5**
- **Real Time**



- **Motion & Strain**
- **Fatigue**
- **Unexpected**



# Presentation Title

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Rev	Description	Date	Author	Checked	Approved
Document No:			Client Ref:		
ppppp-TTT-nnnn			ppppp-ttt-nnnn-xxx-zzzzz		
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