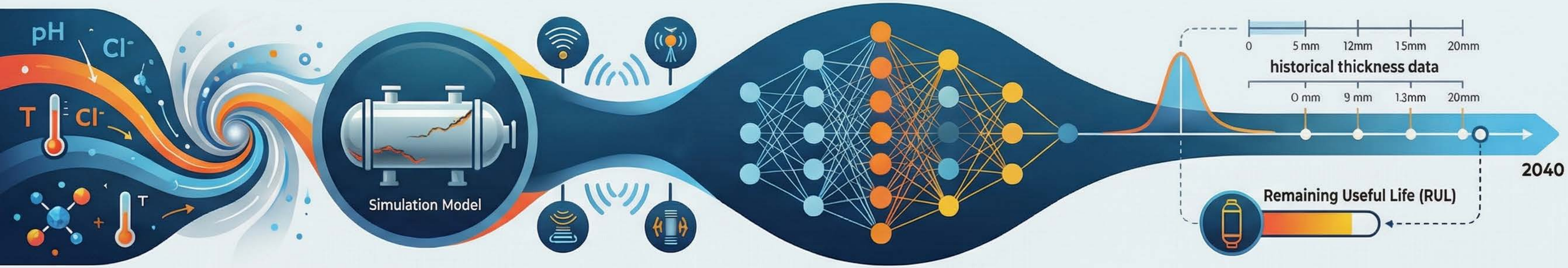
FROM DATA TO DURABILITY: HYBRID AI FOR PRESSURE VESSEL INTEGRITY

THE 4-STAGE PREDICTIVE WORKFLOW

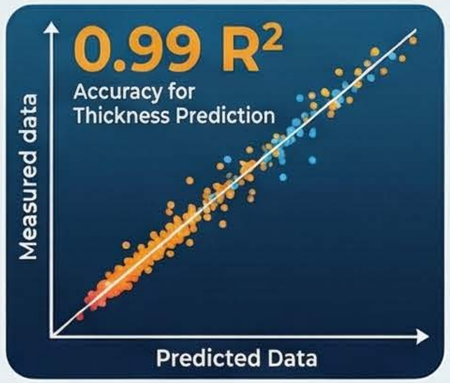


Physics-informed Data Generation
Models 11 variables including pft, temperature, and chloride levels to simulate realistic corrosion.

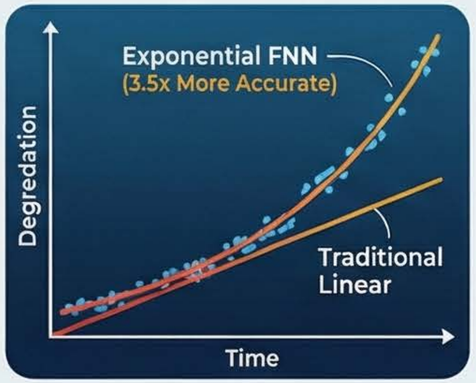
FNN Training with Monte Carlo Dropout
Uses three hidden layers to predict corrosion rates while quantifying prediction uncertairity.

Calibration and RUL Projection
Adjusts predictions using historical thickness data to estimate remaining useful life until 2040.

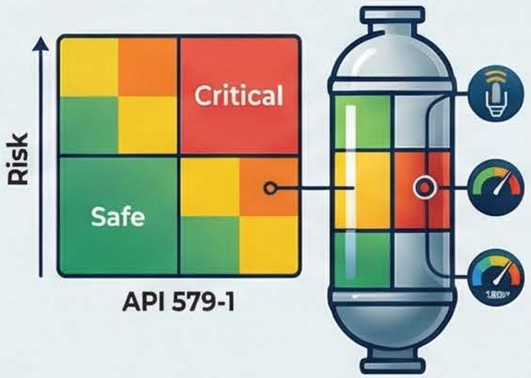
PERFORMANCE AND STRUCTURAL SAFETY



Accuracy for Thickness Prediction
The exponential model demonstrates near-perfect alignment with measured degradation trends across vessel sections.



Exponential vs Linear Modelling
Exponential FNN is 3.5 times more accurate than traditional linear constant-rate assumptions.



Risk-Informed "Safe/Unsafe" Status
Integrates API 579:1 standards to identify critical sections requiring priority maintenance.

Predictive Accuracy Comparison: Hybrid Exponential FNN vs. Linear Model

Mean Absolute Error (mm)

Exponential FNN:	0.0389
Linear:	0.1350

Mean Relative Error (%)

Exponential FNN:	0.3480%
Linear:	1.2458%

Prediction Status (2040)

Exponential FNN Model	All Sections SAFE
Linear Model	4 Sections UNSAFE