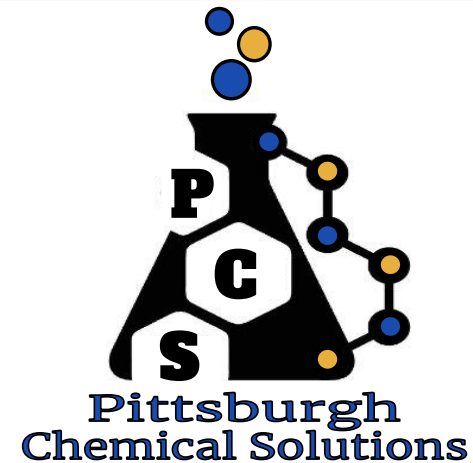




EPRI

## Balance of Plant Corrosion and Heat Transfer Conference - June 2026

*Jay Crilley, P.E.  
President  
Pittsburgh Chemical Solutions LLC*



# What is THERMOPHASE?



THERMOPHASE is a chemistry that provides a nanocoating on surfaces. It provides the following:

- Prevention of Fouling
- Improved Heat Transfer

Benefits include:

- Improved efficiency (energy savings, fuel savings, etc.)
- Reduction of required maintenance
- Improved operation capability
- Reduction of emissions
- Reduced water usage
- Non-Hazardous/Non-biocide
- Non-Toxic
  - LC50 for fish and Daphnids
  - Sustainability Prize from the University of Southern California (funded third party toxicity testing with results showing no toxic effect of the technology on any of the test organisms including maritime vertebrae and invertebrae species)

Product has been used in various industries (condensers, chillers, various types of heat exchangers, cooling towers, etc) including:

- Power Plants
- Hospitals
- Universities
- Industrial Facilities
- Marine Engines

# THERMOPHASE Mechanism of Action

Condenser tube heat transfer is proportionate to:

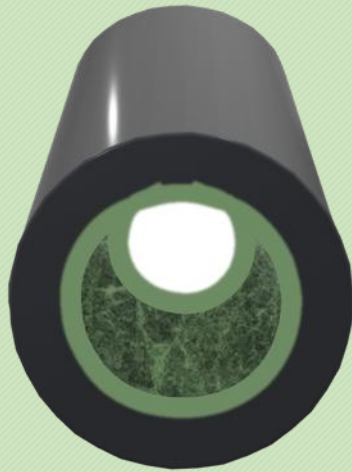
Material Resistance  $R_M$

Fouling Resistance  $R_F$

Boundary Layer  $R_B$   
Resistance



Tube Fouling over time increases the Fouling Resistance ( $R_F$ )



THERMOPHASE Reduces the Fouling Resistance ( $R_F$ ) and Boundary Layer Resistance ( $R_B$ )



- Increase Power Plant Efficiency

- Backpressure Decrease

- Increase Condenser Heat Transfer

- Lower Boundary Layer and Fouling Thermal Resistances

THERMOPHASE is an advanced material technology applied to the inside of heat exchanger components, such as condenser tubes, to lower the thermal resistance of the material by reducing fouling and/or the boundary layer.

2 Coal Fired Units @560MW each

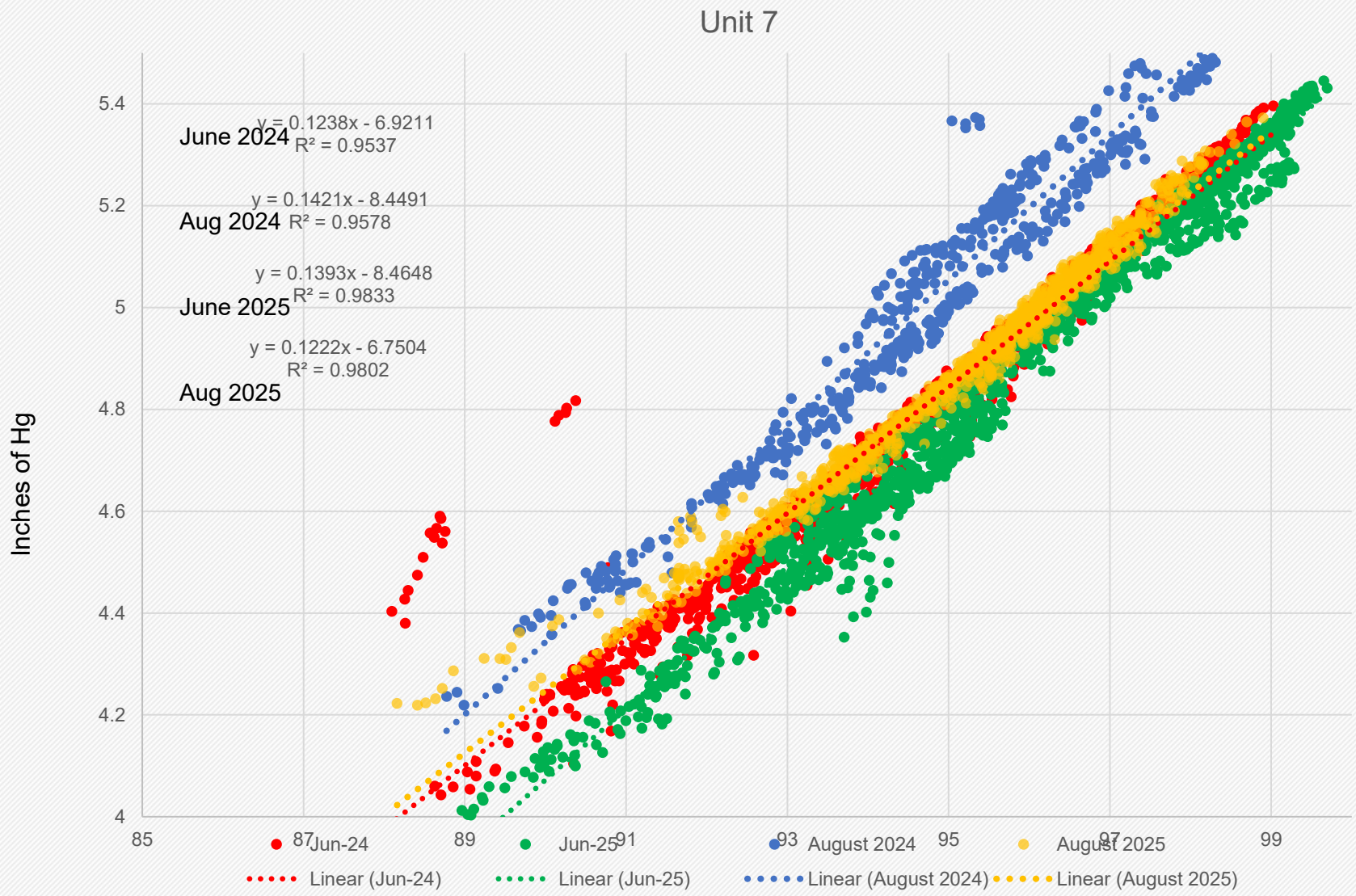
Both Condensers cleaned during outage

Unit 7 – Smaller Condenser treated with THERMOPHASE (condenser isolated & product recirculated)

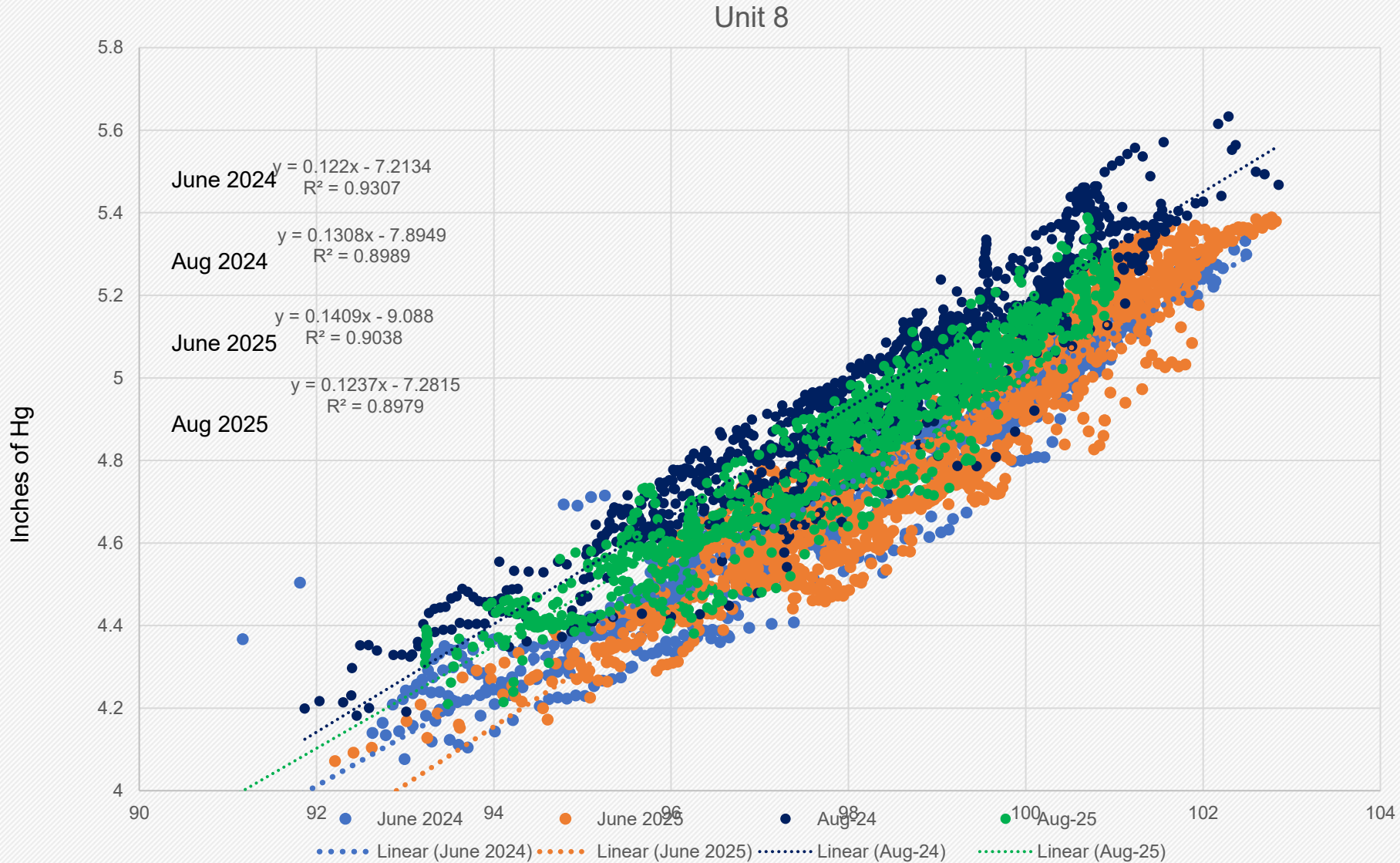
Unit 8 – Larger Condenser untreated



# 560MW Midwest Coal Fired Plant Performance – THERMOPHASE Applied (Unit 7)



# 560MW Midwest Coal Fired Plant Performance – THERMOPHASE Not Applied (Unit 8)



# THERMOPHASE Application at Midwest Facility

## Unit 7 Performance – THERMOPHASE Applied



*Table 1. Comparison of Unit 7 performance metrics between July 2024 (pre-application) and July 2025 (post-application) shows significant improvements. Terminal Temperature Difference (TTD) decreased by 5.1°F, accompanied by a 12.4% increase in condenser efficiency, and a 6.5°F reduction in LMTD, indicating enhanced heat transfer and overall condenser performance.*

THERMOPHASE	July 2024 (Pre-Application)	July 2025 (Post-Application)	Difference	Percent Change
ITD (°F)	37.37	32.10	-5.27	-14.09%
TR (°F)	25.20	27.83	2.63	10.46%
TTD (°F)	10.77	5.67	-5.19	-47.41%
Condenser Efficiency (%)	69.46	81.82	12.36	17.79%
LMTD (°F)	21.32	14.83	-6.48	-30.42%



Table 2. Comparison of Unit 8 performance metrics between July 2024 and July 2025 shows negligible differences. Terminal Temperature Difference (TTD) increased slightly by 0.42°F, accompanied by a 1.7% decrease in condenser efficiency, and a 0.69°F increase in LMTD, indicating no enhancement in heat transfer or overall condenser performance and actually showing decreasing performance.

Control	July 2024 (Pre-Application)	July 2025 (Post-Application)	Difference	Percent Change
ITD (°F)	30.67	29.65	-1.01	-3.31%
TR (°F)	27.04	22.49	-4.55	-16.81%
TTD (°F)	3.84	4.26	0.41	10.79%
Condenser Efficiency (%)	87.04	85.34	-1.70	-1.96%
LMTD (°F)	12.81	13.50	0.69	5.35%

### **Economic Impact: Estimated Power and Revenue Gains**

While plant engineers and PCS personnel can likely extrapolate the operational savings from these results on their own, it's worth highlighting the potential economic impact. Based on this article, [Enhance Condenser Back Pressure and Turbine Efficiency - Bionetics Corporation](#), a **0.1 inch Hg increase in back pressure can result in a 0.17% increase in heat rate**. At Miami Fort plant, a **0.3 inch Hg reduction** in back pressure (as observed in Condenser 7) translates to an estimated **3 MW of power gain**

And this estimate only reflects the **initial heat transfer enhancement**. It does not yet account for the **longer-term benefits** of THERMOPHASE, such as reduced biofouling, lower maintenance costs, and sustained performance over time.

508MW Combined Cycle  
4 Gas Turbines x 2 HRSGs x 2 Steam Turbines  
Zero discharge facility  
Condensers cleaned

THERMOPHASE applied by adding half tote to each cooling tower basin



# Combined Cycle Plant Unit 1 Performance



*Table 1. Comparison of Unit 1 performance metrics between July 2024 (pre-application) and July 2025 (post-application) shows significant improvements. Terminal Temperature Difference (TTD) decreased by 8.5°F, accompanied by a 23.3% increase in condenser efficiency, a 9.9°F reduction in LMTD, and a 0.71 inHg drop in backpressure, indicating enhanced heat transfer and overall condenser performance.*

Unit 1	July 2024 (Pre-Application)	July 2025 (Post-Application)	Difference	Percent Change
ITD (°F)	30.73	22.12	-8.61	-28.03%
TR (°F)	18.71	17.99	-0.73	-3.88%
TTD (°F)	12.06	3.53	-8.54	-70.78%
Condenser Efficiency (%)	60.53	83.84	+23.31	+38.51%
LMTD (°F)	19.93	10.07	-9.86	-49.47%
Backpressure (inHg)	2.98	2.27	-0.71	-23.79%

# Combined Cycle Plant

## Unit 2 Performance



*Table 2. Comparison of Unit 2 performance metrics between July 2024 (pre-application) and July 2025 (post-application) shows significant improvements. Terminal Temperature Difference (TTD) decreased by 9.5°F, accompanied by a 25.4% increase in condenser efficiency, a 10.1°F reduction in LMTD, and a 0.40 inHg drop in backpressure, indicating enhanced heat transfer and overall condenser performance.*

Unit 2	July 2024	July 2025	Difference	Percent Change
ITD (°F)	29.25	21.65	-7.59	-25.97%
TR (°F)	15.29	16.56	+1.27	+8.32%
TTD (°F)	14.1082	4.6031	-9.5052	-67.373%
Condenser Efficiency (%)	52.23	77.59	+25.36	+48.55%
LMTD (°F)	20.80	10.73	-10.07	-48.40%
Backpressure (inHg)	2.79	2.39	-0.40	-14.28%

1,000MW

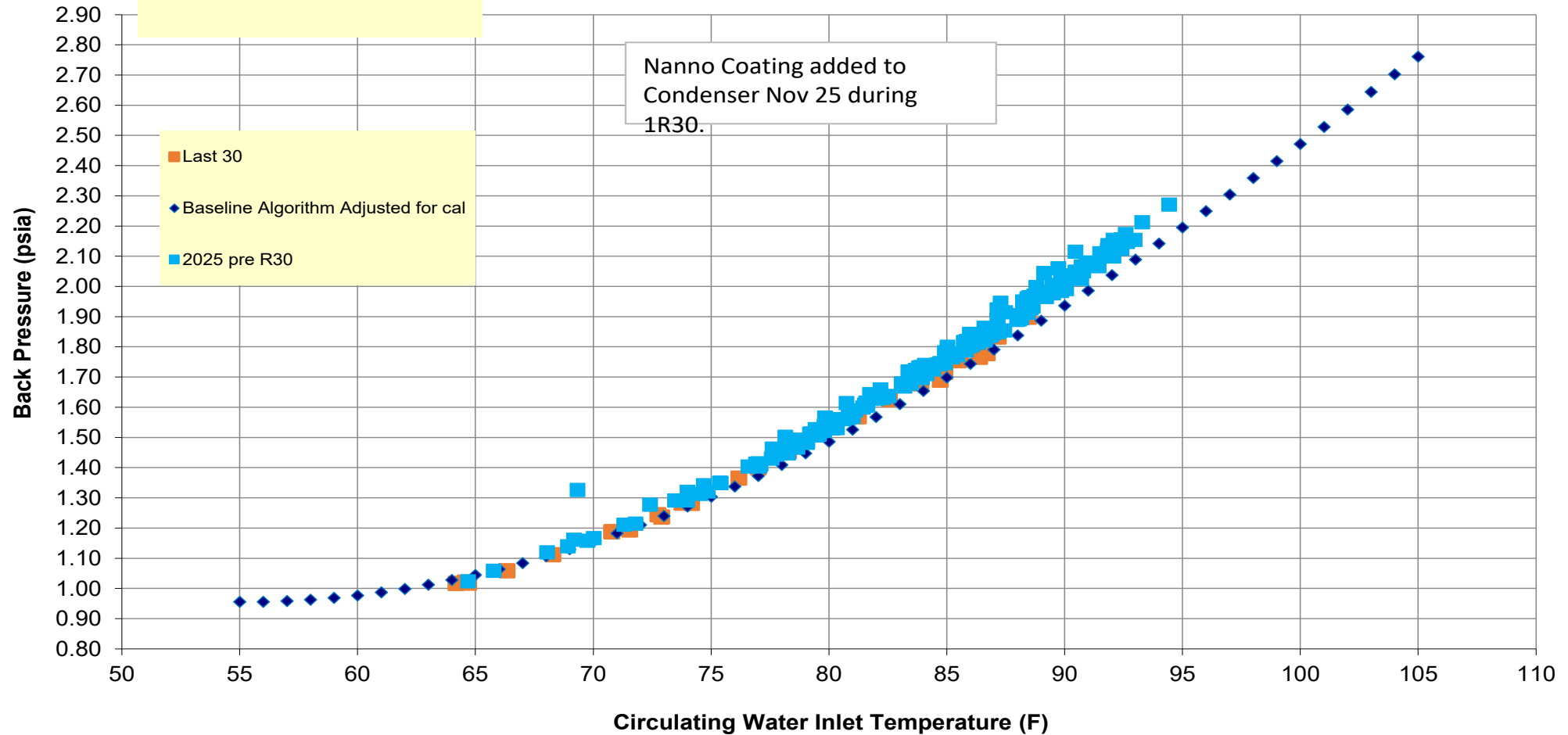
Condensers cleaned during outage

Condenser isolated & product recirculated

# Back Pressure Improvement A Side

8/22/18 FIN performed  
Loop Cal and Prime std on  
Temp & Pressure Inst.

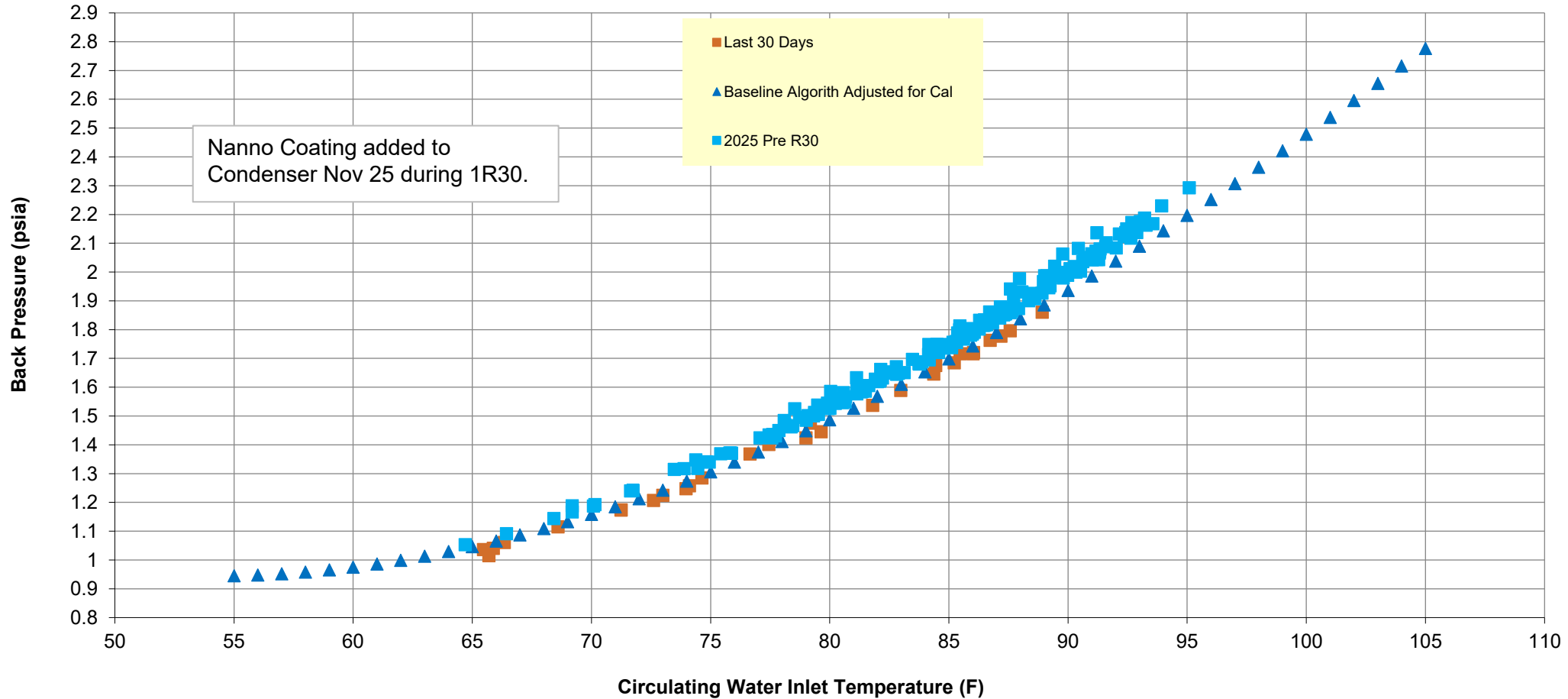
### A Back Pressure Vs. A average Circulating Water Inlet Temperature



# Back Pressure Improvement B Side



B Back Pressure Vs. B average Circulating Water Inlet Temperature

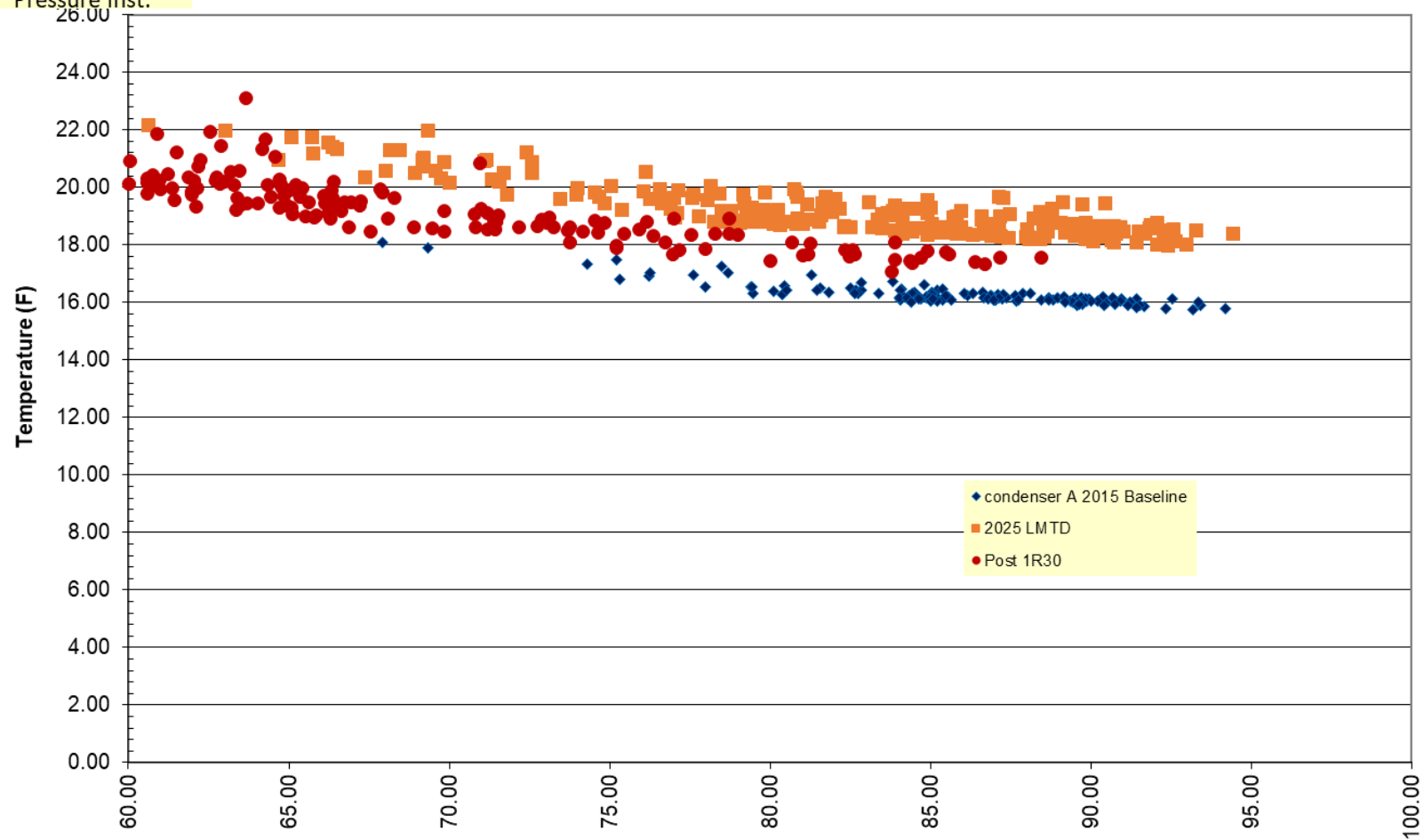


# LMTD Improvement A Side

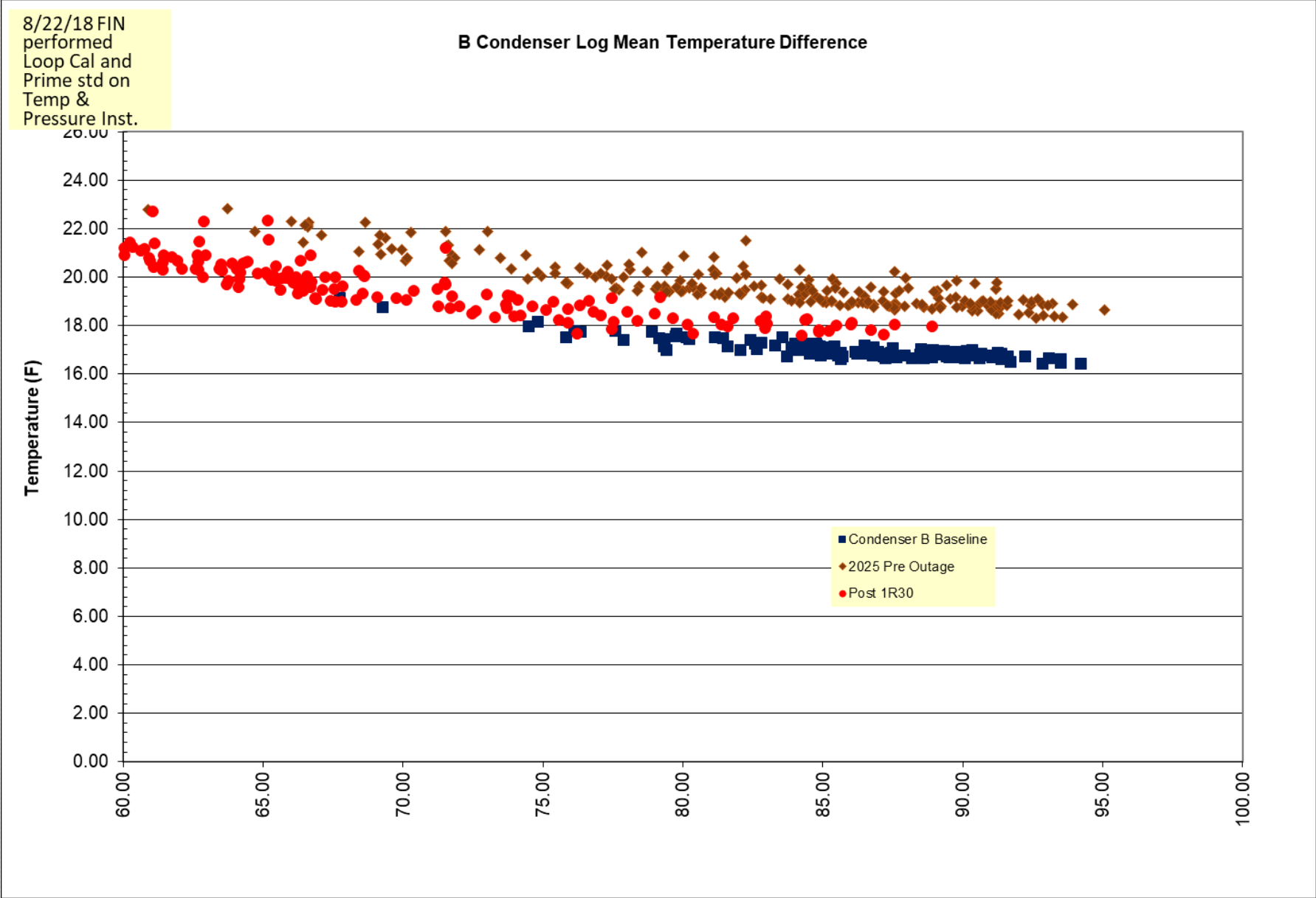


8/22/18 FIN  
performed  
Loop Cal and  
Prime std on  
Temp &  
Pressure Inst.

### A Condenser Log Mean Temperature Difference



# LMTD Improvement B Side



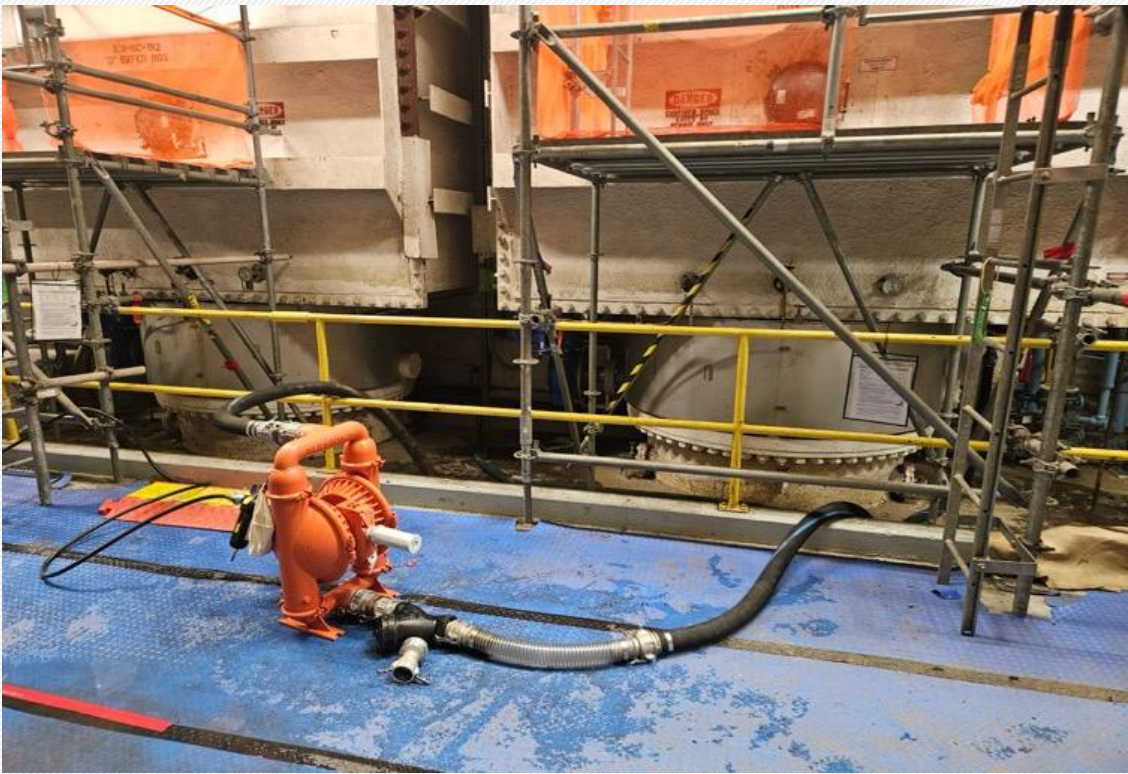
- Data shows significant improvement in back pressure, LMTD, TTD, etc. with THERMOPHASE
- THERMOPHASE back pressure performance was compared to 2015 baseline outstanding meeting and at times beating the baseline. And this all with the following:
  - Twice as many tubes plugged from 2015 baseline
    - 2015 – 886 Tubes Plugged
    - 2026 – 1748 Tubes Plugged
  - Circ Water Pumps Rebuilds
    - 2015 - 3 out of 4 Cooling Tower Pumps had been Overhauled within the previous 2 Years
    - 2026 - 3 out of 4 have not been overhauled since 2015 (B Pump Overhauled in 2025)
  - Cooling Tower Fill Replacement
    - The 3 previous outages leading up to 2015, 100% of the Cooling Tower Fill had been replaced. Since 2015 have not replaced fill material. Replaced some in 1R30 but the amount replaced was minimal.

- During January 25, 2026 snow storm unit was able to show a 2MW gain. This provided an approximately 30 hour-return of investment for the application with the PJM rates at that time.
- Expectation is during summer (warm weather) runs a gain of 5-6MW on unit 1 will be recognized due to THERMOPHASE

## Other

Typically, when only one circ water pump runs, sediment issues lead to heat transfer degradation occurs (fouling on tubes). With THERMOPHASE, after start-up with one circ water pump operational the plant did not experience this problem.

# Simple Application of THERMOPHASE – 1,000MW



# Simple Application of THERMOPHASE – 1,000MW



## Entity Validation of THERMOPHASE

- United States Department of Energy (DOE)
- National Energy Technology Labs (NETL)
- Electric Power Research Institute (EPRI)
- U.S. Department of Transportation Maritime Administration (MARAD)
- United States Navy
- India Central Electric Authority (CEA) & State-Owned Utilities
- Many Installations

**THERMOPHASE**



- Reduces build-up of inorganic & biological fouling
- Enhances heat transfer
- Improves cleanability of surfaces
- Allows for less frequent cleanings

THERMOPHASE has been demonstrated on marine engines, chillers, heat exchangers, and condensers.

Installations include 10,000MW in Power (expected to more than double/triple in next year), industrial, commercial, etc.

Have begun work on Data Centers with agreement from major industry leader

THANK YOU!