

POWERGEN



Pittsburgh
Chemical Solutions



THE TOTAL ENERGY MIX:
POWERING THE FUTURE

Nanocoating in Action: Efficiency Gains and Increased Output Across Utilities

Presenters:

- *Nathaniel Larson – EthosEnergy, Ocean State Facility Manager*
- *Jay Crilley – Pittsburgh Chemical Solutions, President*

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HENRY B. GONZALEZ CONVENTION CENTER
SAN ANTONIO, TEXAS, USA

HOST UTILITY:



What is THERMOPHASE?



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

- Prevention of Fouling
- Improved Heat Transfer

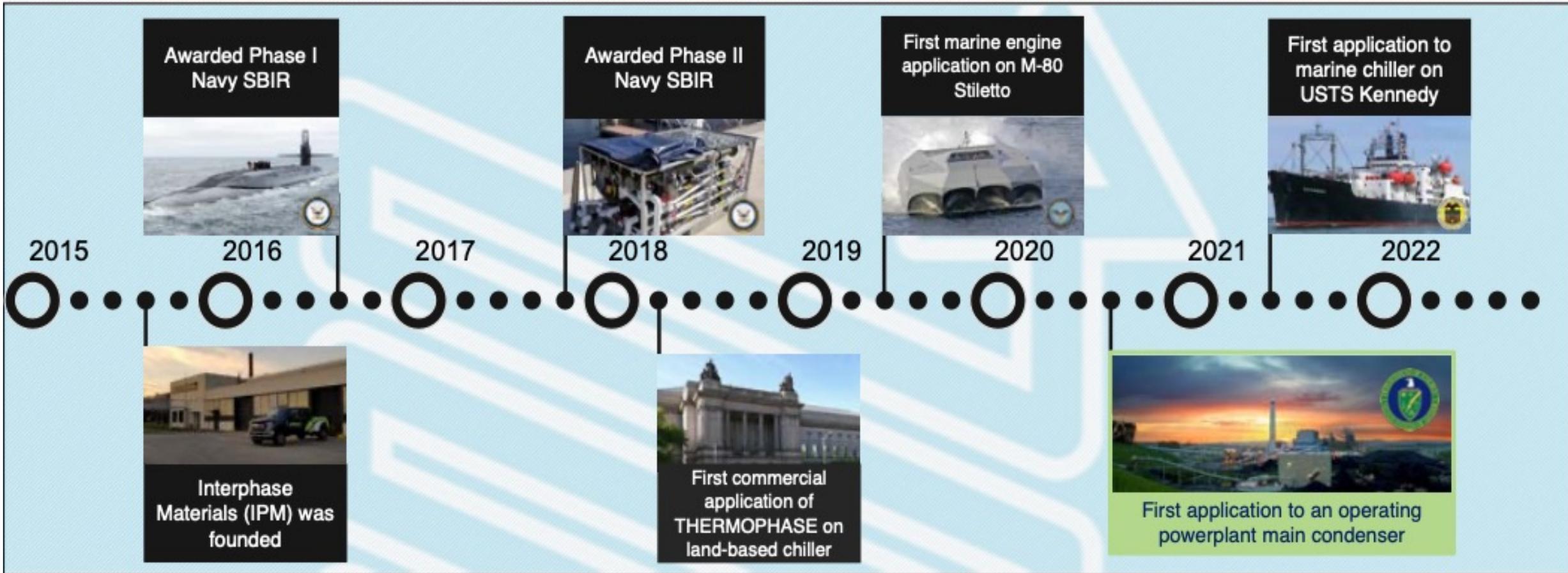
Benefits include:

- Improved efficiency (energy savings, fuel savings, etc.)
- Increased MW
- Reduction of required maintenance
- Improved operation capability
- Reduction of emissions
- Reduced water usage
- Non-Hazardous/Non-biocide/No Chlorides
- 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 Development History



- THERMOPHASE has been in development since Interphase Materials was founded in 2015 and has been funded from a variety of sources including the U.S. Navy Small Business Innovation Program (SBIR), the Rapid Reaction Technology Office (within the Department of Defense), the U.S. Department of Transportation Maritime Administration (MARAD) and the Department of Energy. THERMOPHASE has been available commercially for building cooling systems since 2018.

THERMOPHASE Mechanism of Action

Condenser tube heat transfer is proportionate to:

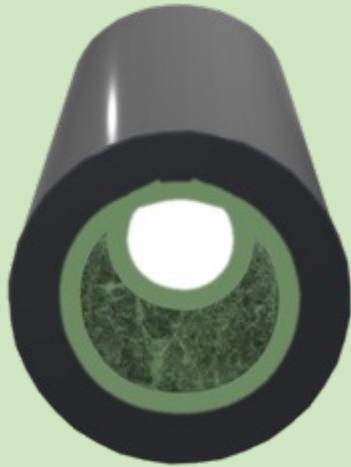
Material Resistance R_M

Fouling Resistance R_F

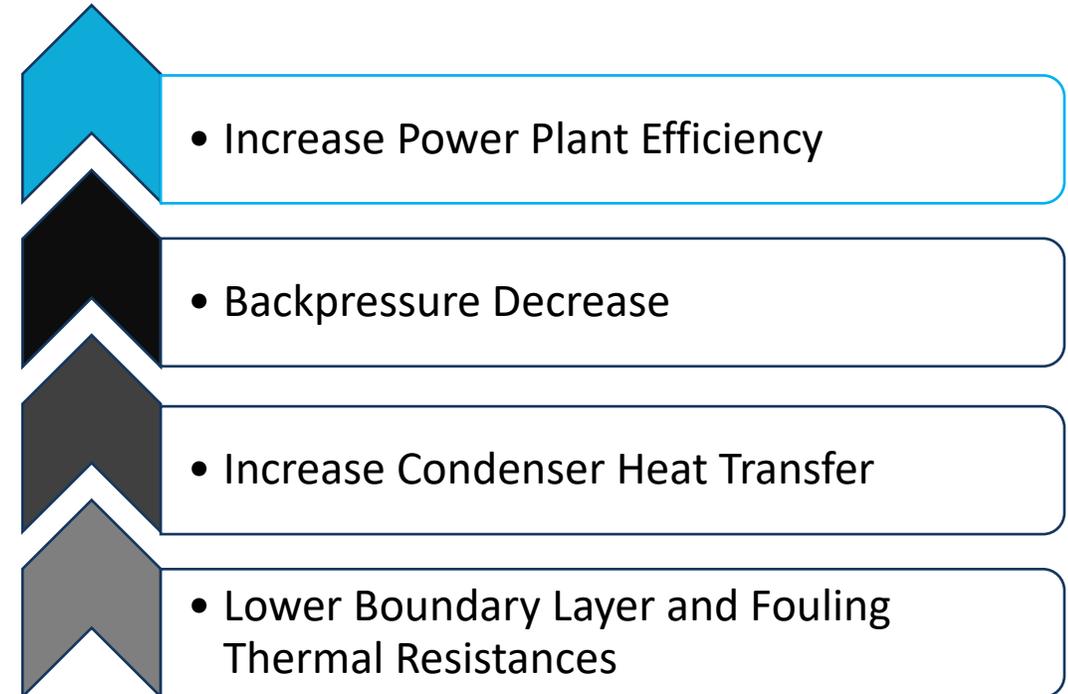
Boundary Layer Resistance R_B



Tube Fouling over time increases the Fouling Resistance (R_F)



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



- 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.

Fouling

THERMOPHASE Results - Fouling

Fouling Reduction in Operating Tube Heat Exchanger Onboard the USTS Kennedy using Interphase Materials Proprietary THERMOPHASE Product



Clarity of Tube Rifling Emphasizes Cleanliness of THERMOPHASE treated system

Untreated Tubes Show Increased Presence of Fouling Debris and Loss of Ability to Visualize Tube Rifling

INTERPHASE MATERIALS

This demonstration occurred using a 1 hr flush of THERMOPHASE product on the USTS Kennedy's HVAC chillers. These chillers are fed raw seawater without treatment. The duration of this demonstration 4 months based on the ships schedule. A reduction in fouling observed here will provide significant benefits to the operation of the system and in costs/time associated with system maintenance.

THERMOPHASE reduced chiller tube fouling on the USTS Kennedy (DOT MARAD Project #693JF71850005, <https://www.maritime.dot.gov/sites/marad.dot.gov/files/2022-09/Interphase%20Materials%20MMA%20Final%20Report.pdf>).

Image 1: Borescope Image of Fouled Chiller Tubes from UPMC Children's Hospital Chiller in 2021



Image 2: Borescope Image of Chiller Tube After Cleaning from UPMC Children's Hospital Chiller in 2021



Image 3: Borescope Image of Chiller Tube 1 Year after THERMOPHASE application Without Cleaning in 2022



Image 4: Borescope Image of Chiller Tube 1 Year after THERMOPHASE application Without Cleaning in 2023



- THERMOPHASE was applied by circulating it through the offline chiller. The chillers were treated between February and March of 2021. Without any cleaning, the chiller tubes were borescoped the following year in January/February 2022. This was duplicated in 2023 and tubes no longer clean the tubes. In 2024 and now 2025 inspections, with multiple years without cleaning and THERMOPHASE annual application the tubes remains clean. Yearly Eddy current testing by the plant is being moved to every 3 years.

Heat Transfer Improvements

Electric Power Research Institute (EPRI) Validation

- Interphase Materials was asked by the Electric Power Research Institute (EPRI) to include samples of THERMOPHASE in a project to evaluate coatings for condenser tubes.
- During the first phase of testing, THERMOPHASE was ranked the highest compared to 5 other coatings being evaluated on a basis of hydrophobicity (ASTM D7334), thermal conductivity (ASTM E1461), adhesion (ASTM C1624), and abrasion (ASTM G133) testing.
- THERMOPHASE was shown to increase the heat transfer coefficient by 1.9% when compared to clean, unmodified tubes. A month later, the improvement increased to 2.4% and was improving when test was stopped. The test was a short duration and THERMOPHASE was the only internal coating that showed improvement during the test time frame.
- Data is consistent with the DOE/NETL two-year program at Longview and other installations of THERMOPHASE

770MW

Condenser as-is condition

Cooling Tower Basin Application

THERMOPHASE Application at Longview Power - Overview



Generator
Siemens
SGen6-3000W



Turbine System
Siemens HMNN
770 MW
4 Turbines



Condenser

Siemens
SCon6000

| | |
|------------------------|--------------------------|
| Condensing Area: | 292992.1 ft ² |
| Tube Outside Diameter: | 0.87 in. |
| Tube Wall Thickness: | 0.02 in. |
| Tube Length: | 422.79 in. |
| Number of Tube: | 36,648 |
| Tube Material: | X5CrNiMo17-12-2 |
| Flow Velocity*: | 8.17 ft/s |
| Maximum Flow Velocity: | 11.48 ft/s |

- *Flow velocity at rated temperature rise
- Source: The Future of Reliable Clean Coal Power. Retrieved December 13, 2022, from <https://longviewpower.com/clean-coal-power>

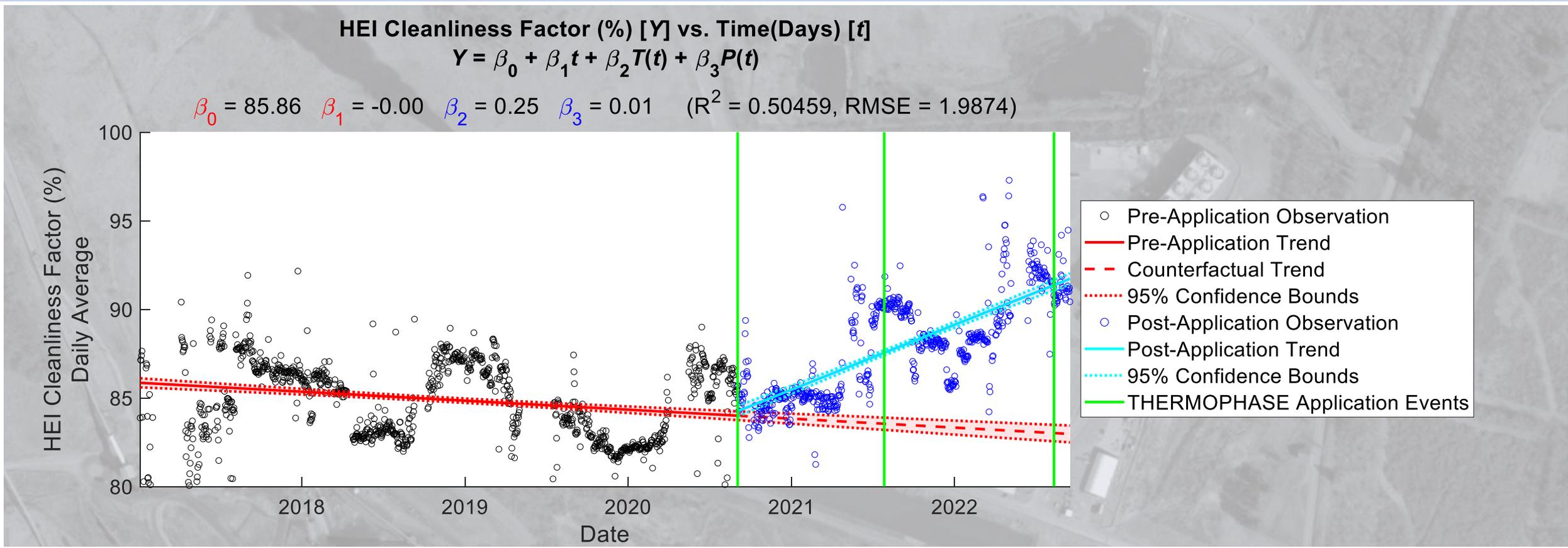
THERMOPHASE Application at Longview Power



- THERMOPHASE was applied to the Longview Power plant beginning on September 2nd, 2020. The second and third applications were on July 27th, 2021, and August 11th, 2022. In the first application, THERMOPHASE was slowly added over two weeks with the system concentration not exceeding 6 ppm (based on an estimated 2 million-gallon system volume). The second and third applications were performed by adding the material directly into the cooling tower sump with a peak concentration of ~ 25 ppm. The tubes of the condenser were not cleaned before or after THERMOPHASE application.

THERMOPHASE Application at Longview Power

HEI Cleanliness Factor



- The daily average of the HEI Cleanliness Factor is plotted above through September 16th, 2022. The HEI Cleanliness Factor is a historian calculation recorded in the Longview Power historian (variable 1OPM.CONDENSER:Cleanliness). The HEI Cleanliness Factor is defined as $\frac{u_{\text{Observed}}}{u_{\text{Expected}}} \times 100$.

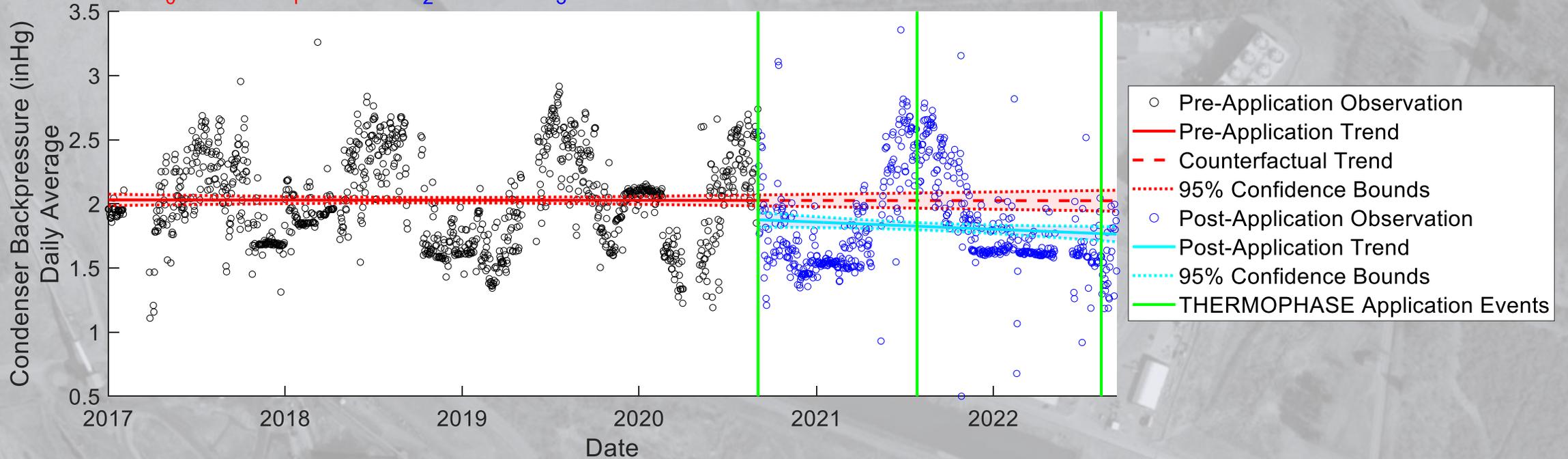
THERMOPHASE Application at Longview Power

Condenser Backpressure

Condenser Backpressure (inHg) [Y] vs. Time(Days) [t]

$$Y = \beta_0 + \beta_1 t + \beta_2 T(t) + \beta_3 P(t)$$

$\beta_0 = 2.03$ $\beta_1 = -0.00$ $\beta_2 = -0.15$ $\beta_3 = -0.00$ ($R^2 = 0.070972$, $RMSE = 0.36598$)



- The daily average of the condenser backpressure is plotted above through September 16th, 2022. The condenser backpressure is an instrument value recorded in the Longview Power historian (variable 10MAG10CP002.XQ01).

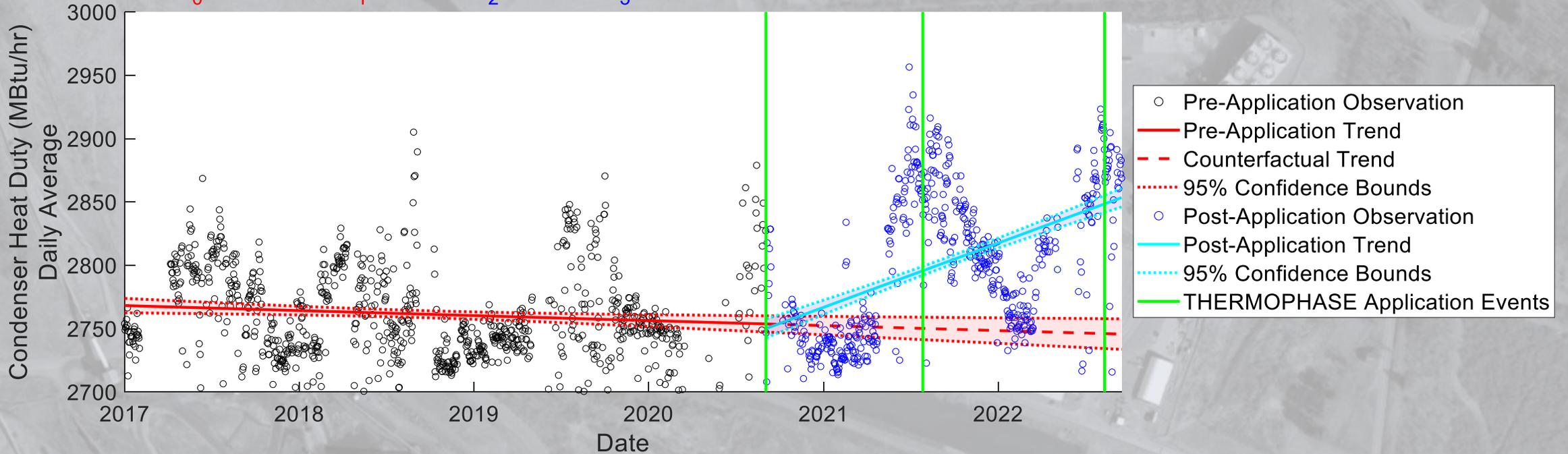
THERMOPHASE Application at Longview Power

Condenser Heat Duty

Condenser Heat Duty (MBtu/hr) [Y] vs. Time(Days) [t]

$$Y = \beta_0 + \beta_1 t + \beta_2 T(t) + \beta_3 P(t)$$

$$\beta_0 = 2768.22 \quad \beta_1 = -0.01 \quad \beta_2 = -3.70 \quad \beta_3 = 0.15 \quad (R^2 = 0.288, \text{RMSE} = 41.415)$$



- The daily average of the condenser heat duty is plotted above through September 16th, 2022. The condenser heat duty is an historical calculation recorded in the Longview Power historian (variable 10PM.CONDENSER:DUTY).

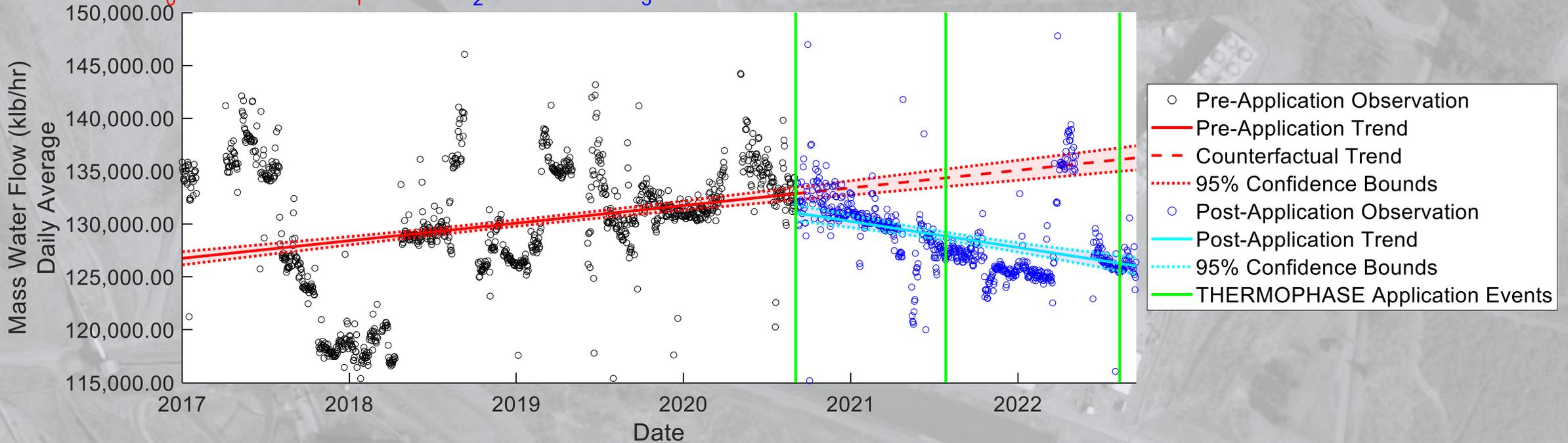
THERMOPHASE Application at Longview Power

HEI Cleanliness Factor

Mass Water Flow (klb/hr) [Y] vs. Time(Days) [t]

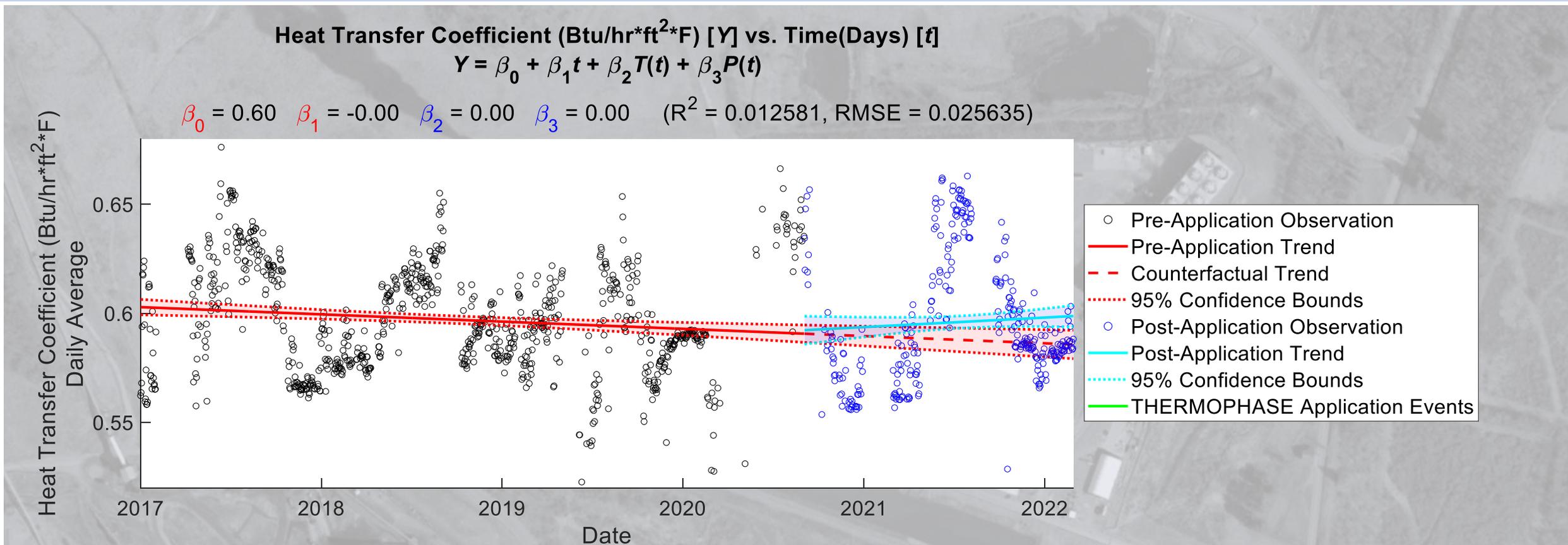
$$Y = \beta_0 + \beta_1 t + \beta_2 T(t) + \beta_3 P(t)$$

$\beta_0 = 126765.41$ $\beta_1 = 4.56$ $\beta_2 = -1802.11$ $\beta_3 = -11.30$ ($R^2 = 0.10631$, RMSE = 5020.2353)



- The daily average of the mass circulation water flow is plotted above through September 16th, 2022. The mass circulation water flow is a historian calculated value recorded in the Longview Power historian (variable 1OPM.CIRC_WATER_IN:FLOW).

THERMOPHASE Application at Longview Power



- The daily average of the heat transfer coefficient is plotted above through September 12th, 2022. The heat transfer coefficient is an offline calculation. The heat transfer coefficient (U) is defined as, $U = \frac{Q}{A \cdot LMTD}$.

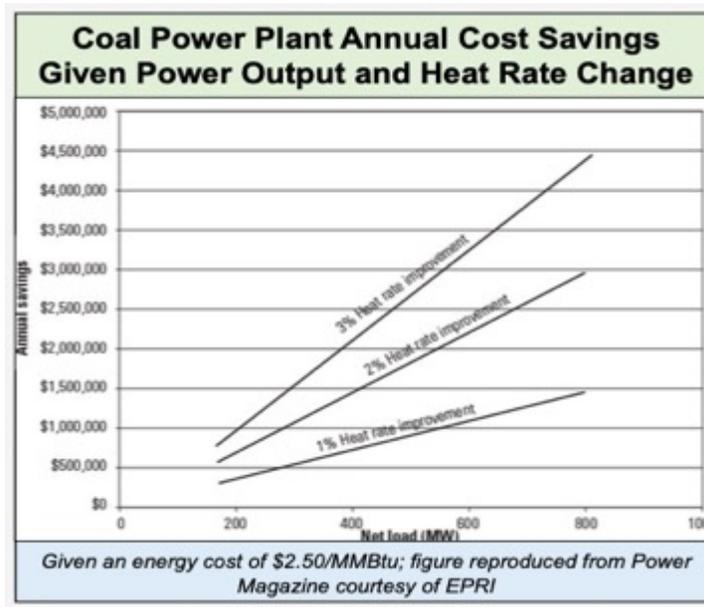
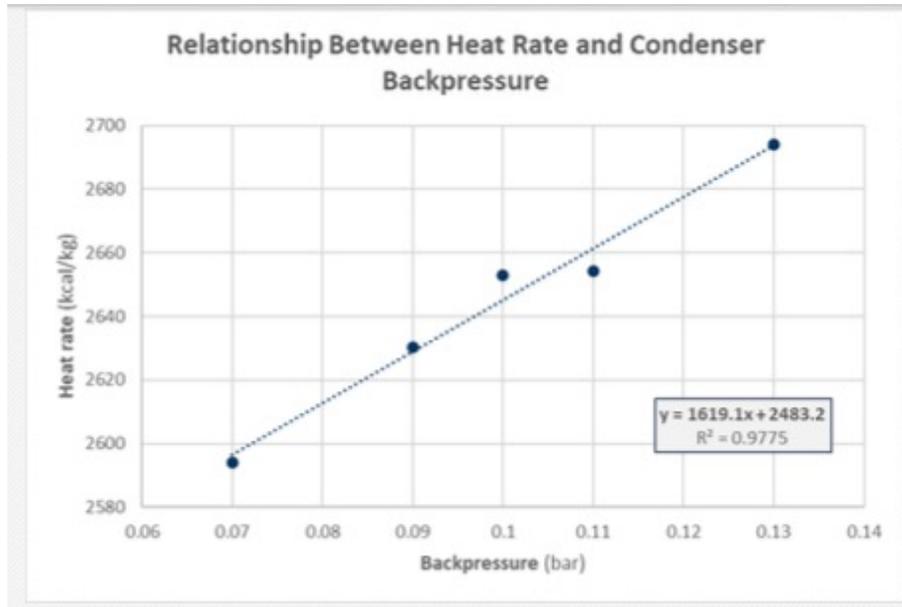
THERMOPHASE Application at Longview Power

Data provided to DOE/NETL and presented that validates THERMOPHASE Benefits include :

- HEI Cleanliness Factor
- Condenser Backpressure
- Terminal Temperature Difference
- Condenser Heat Duty
- Temperature Rise
- Log-Mean Temperature Difference
- Heat Transfer Coefficient
- Water Flow
- Condenser Water Outlet Temperature
- Condenser Water Inlet Temperature
- Wet Bulb Temperature/Dry Bulb Temperature
- Cooling Tower Approach Temperature

THERMOPHASE Application at Longview Power

Operational Savings



THERMOPHASE 24-Month Savings

| Savings Type | Longview Power Plant |
|---------------------------|----------------------|
| Water Withdrawal | 1,287 ± 750.8 Mgal |
| CO ₂ Emissions | 136 ± 79.3 Mlbs |
| Fuel Cost (in Millions) | \$3.35 ± 1.68 |

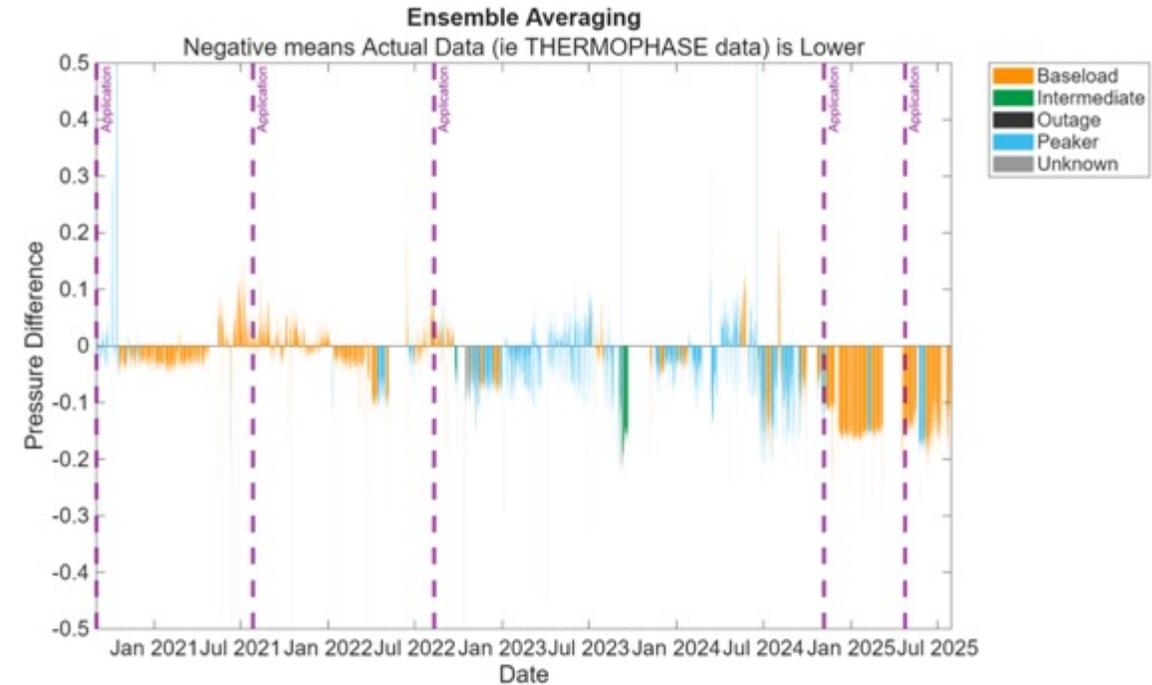
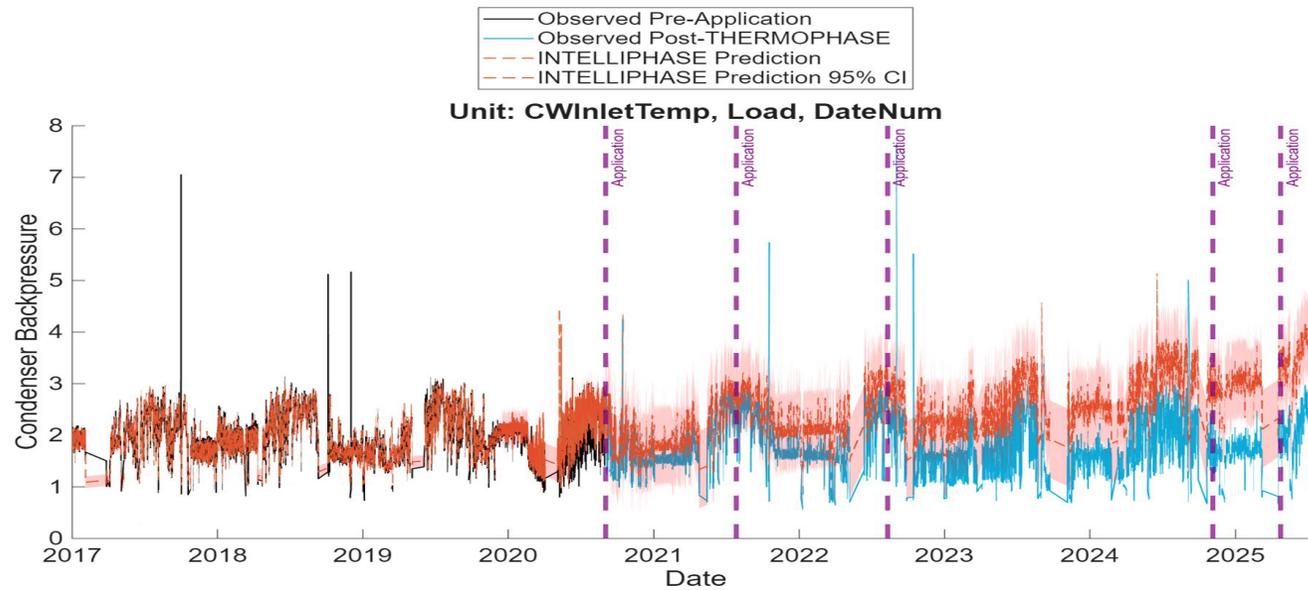
Other Savings not quantified:

- Less NO_x, SO_x, Hg emissions
- Less ammonia, lime and activated carbon used
- Less ash to dispose

- Heat Transfer Coefficient Improvements at Longview (4%) were consistent with laboratory results (5.8%)
- Immediate and Sustained Backpressure improvements are consistent with condenser performance improvements (TTD, U, and HEI CF%)
- Based on a net decrease of 0.26 inHg after two years (13% reduction), the water, emissions, and fuel cost savings are significant and in support of the DOE/NETLs mission to provide solutions for an environmentally sustainable and prosperous energy future

THERMOPHASE Application at Longview Power

5 years of performance improvement (condenser backpressure)



THERMOPHASE Application at Midwest Facility

2 Coal Fired Units @560MW each

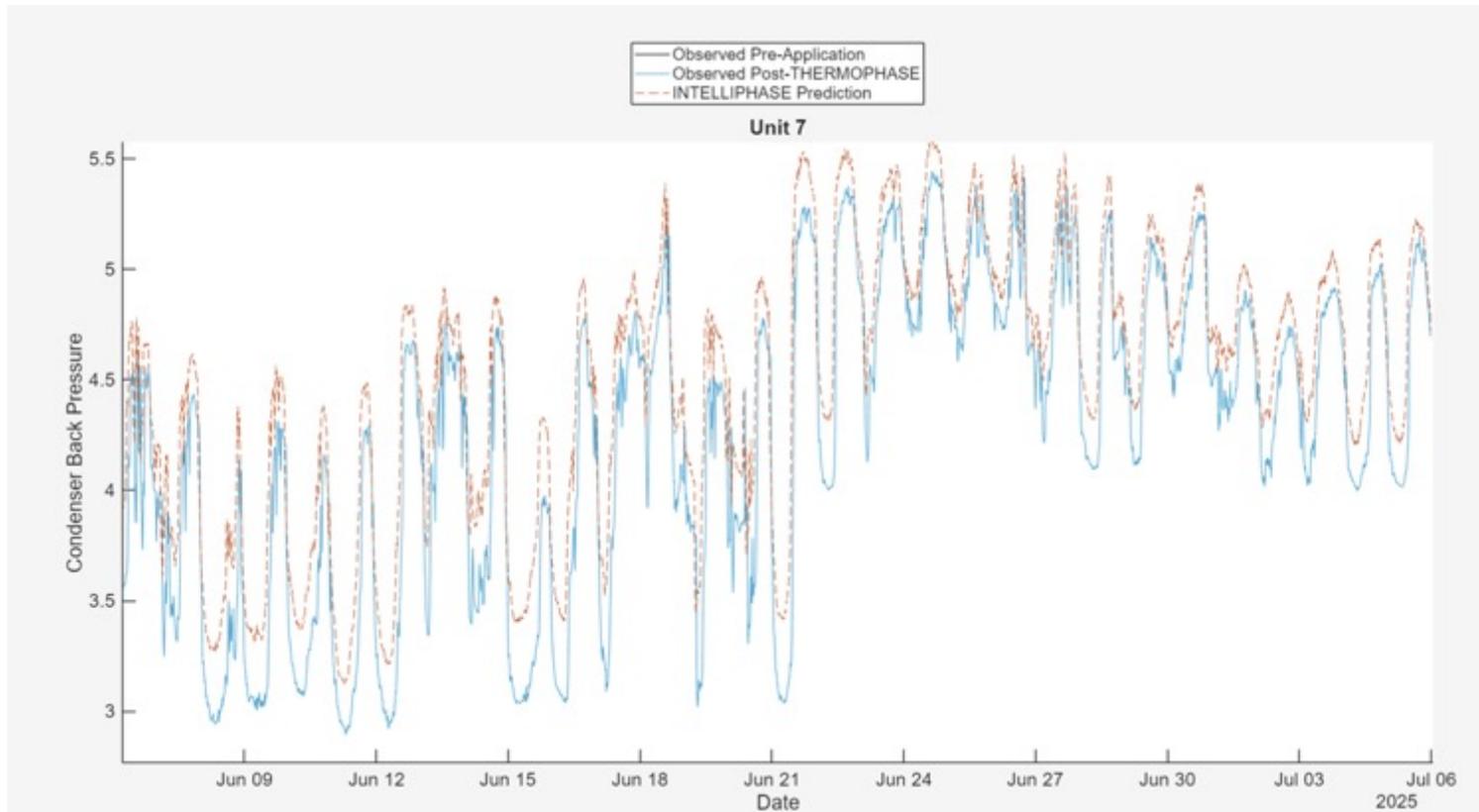
Both Condensers cleaned during outage

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

Unit 8 – Larger Condenser untreated

THERMOPHASE Application at Midwest Facility

Condenser Backpressure Unit 7

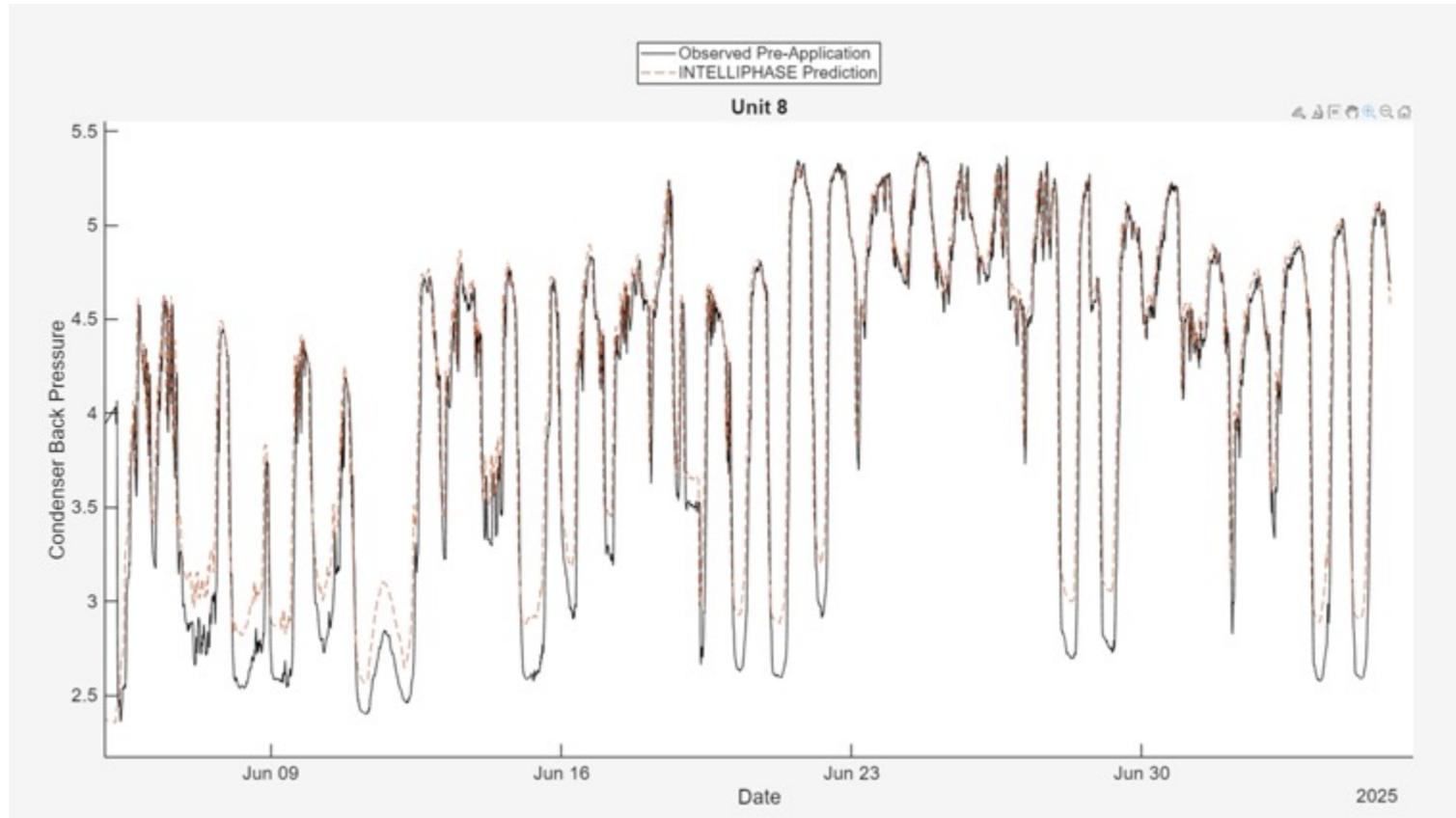


Condenser 7: Substantial Improvement

Following THERMOPHASE treatment, Condenser 7 shows a **reduction in back pressure of approximately 0.2 to 0.3 inches Hg** compared to expected values without treatment. This is a meaningful improvement, especially considering that overall back pressure values are typically around 4 inches Hg.

THERMOPHASE Application at Midwest Facility

Condenser Backpressure Unit 8

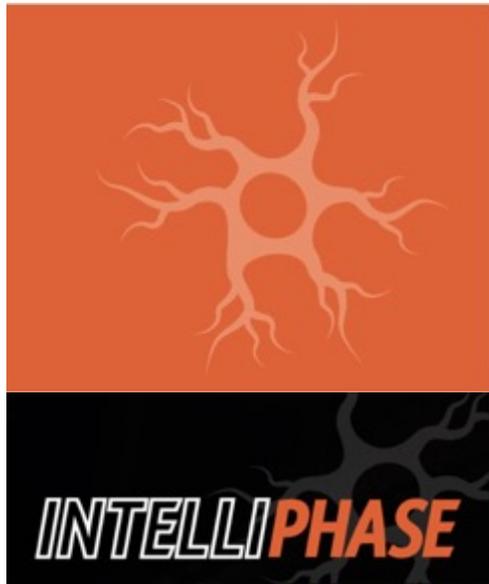


Condenser 8: Control Case Validates Methodology

In contrast, **Condenser 8**, which did not receive THERMOPHASE treatment but was cleaned, showed only a **modest improvement of 0.03 to 0.07 inches Hg**. This aligns closely with our predicted values for an untreated but cleaned unit.

THERMOPHASE Application at Midwest Facility

Condenser and INTELLIPHASE

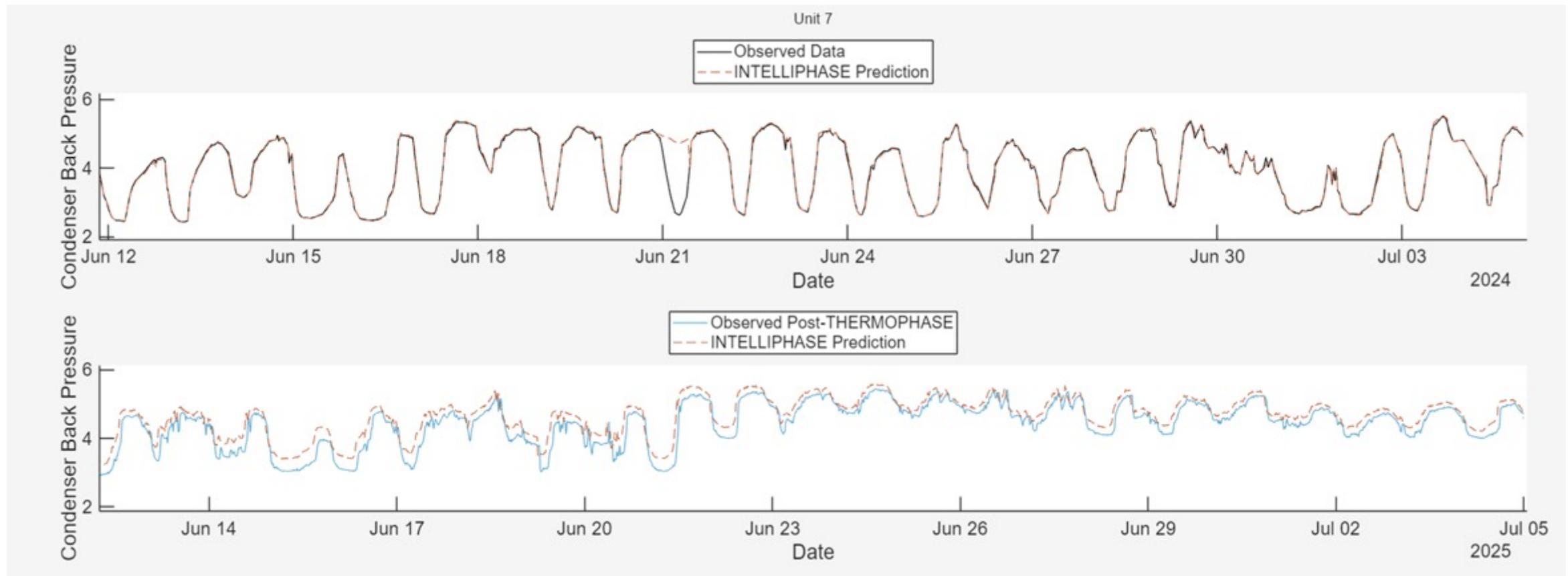


What makes these results particularly compelling is the performance of **INTELLIPHASE**, our AI-guided sensor fusion model. INTELLIPHASE not only accurately predicted the summer performance of Condenser 8, but also successfully modeled the **historical back pressure behavior** of both Condenser 7 and Condenser 8 prior to the shutdown. This dual validation, both forward-looking and retrospective, demonstrates that INTELLIPHASE is reliably capturing the underlying thermodynamic behavior of the system.

INTELLIPHASE developed with National Science Foundation (NSF), US Army, US Department of Transportation, US Department of Interior (DOI) in conjunction with US Department of Energy (DOE) and National Energy Technology Labs (NETL)

THERMOPHASE Application at Midwest Facility

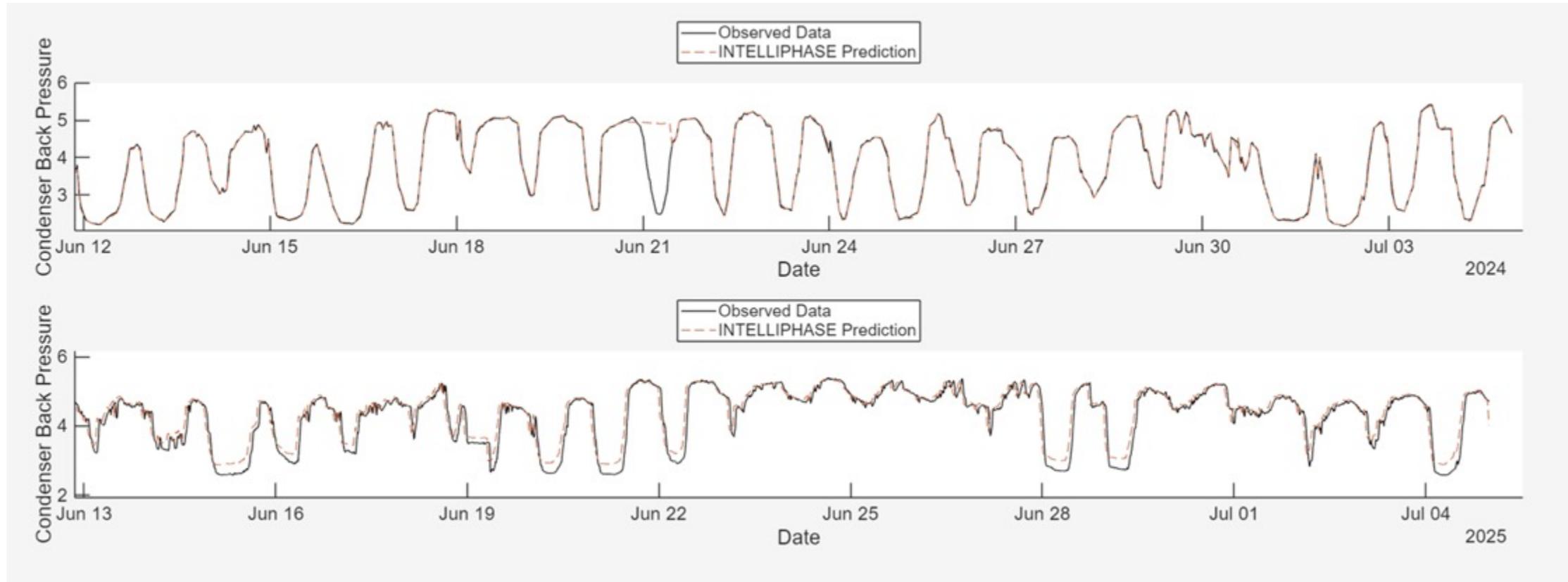
Unit 7 - Condenser Backpressure Observed and Predicted in 2024 (Top) and 2025 (Bottom)



This modeling accuracy is critical. It confirms that the observed post-treatment improvements in Condenser 7 are not anomalies or artifacts of data noise, but rather the result of **THERMOPHASE fundamentally altering the heat transfer characteristics** of the condenser system. The model's ability to predict untreated behavior so precisely gives us high confidence that the deviations observed in the treated unit are real, significant, and attributable to the treatment itself.

THERMOPHASE Application at Midwest Facility

Unit 8 - Condenser Backpressure Observed and Predicted in 2024 (Top) and 2025 (Bottom)



The fact that INTELLIPHASE correctly modeled Condenser 8's behavior gives us high confidence in the methodology behind backpressure predictions. This, in turn, makes the performance gains observed in Condenser 7 even more compelling—because they are not just improvements, they are improvements **beyond what our validated model predicted**.

THERMOPHASE Application at Midwest Facility

THERMOPHASE Impact & Summary

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**. Applying this to a 525 MW plant, a **0.3 inch Hg reduction** in back pressure (as observed in Condenser 7) translates to an estimated **2.68 MW of power gain** which corresponds to approximately **\$770,000 in additional revenue**.

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.

Summary

Condenser 7 (THERMOPHASE-treated): 0.2–0.3 in Hg lower back pressure than predicted.

Condenser 8 (untreated, cleaned): 0.03–0.07 in Hg lower back pressure, consistent with model, and likely due to condenser cleaning.

INTELLIPHASE accurately predicted both historical and current performance for untreated units, validating the methodology and strengthening the case for THERMOPHASE's effectiveness.

Estimated economic impact: 2.68 MW power gain and \$770,000 in revenue for a 525 MW plant, based on initial performance improvements alone.

THERMOPHASE Application at Midwest Facility

Terminal Temperature Difference Unit 7 & Unit 8

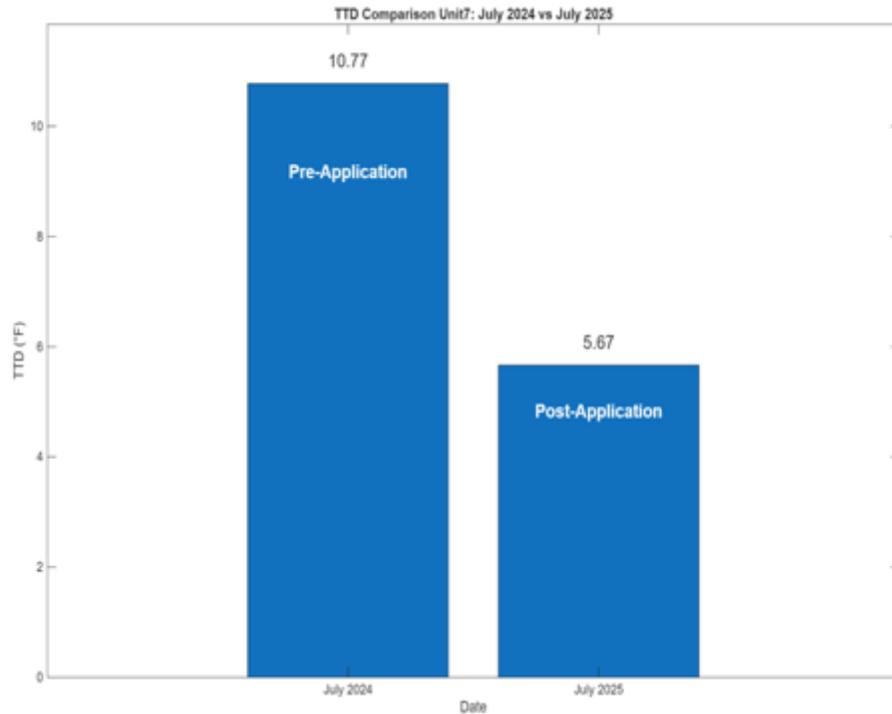


Figure 3. Terminal Temperature Difference (TTD) comparison for Unit 7 between July 2024 and July 2025 shows a reduction from 10.77°F pre-THERMOPHASE application to 5.67°F post-application. This decrease indicates improved condenser heat transfer performance, suggesting a positive impact of THERMOPHASE.

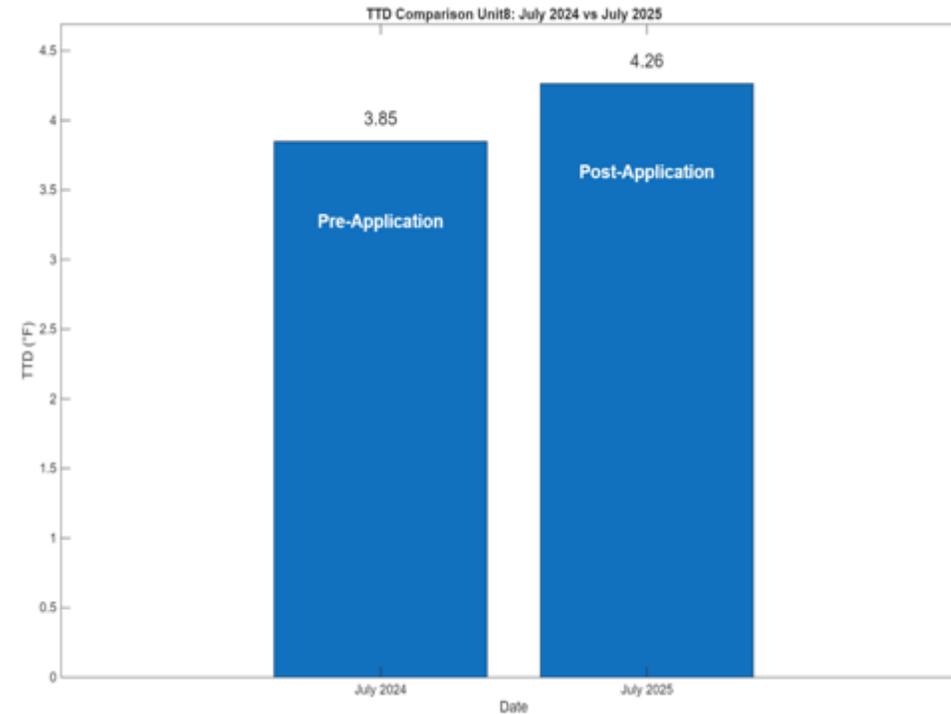


Figure 4. Terminal Temperature Difference (TTD) comparison for Unit 8 between July 2024 and July 2025 shows a slight increase from 3.85°F to 4.26°F. This increase indicates no significant change in condenser heat transfer performance, suggesting the Unit 8's system remained relatively stable. By comparing Unit 7 to Unit 8 results, there is a clear change that can be attributed to the addition of THERMOPHASE in Unit 7.

THERMOPHASE Application at Midwest Facility

Terminal Temperature Difference Unit 7 & Unit 8

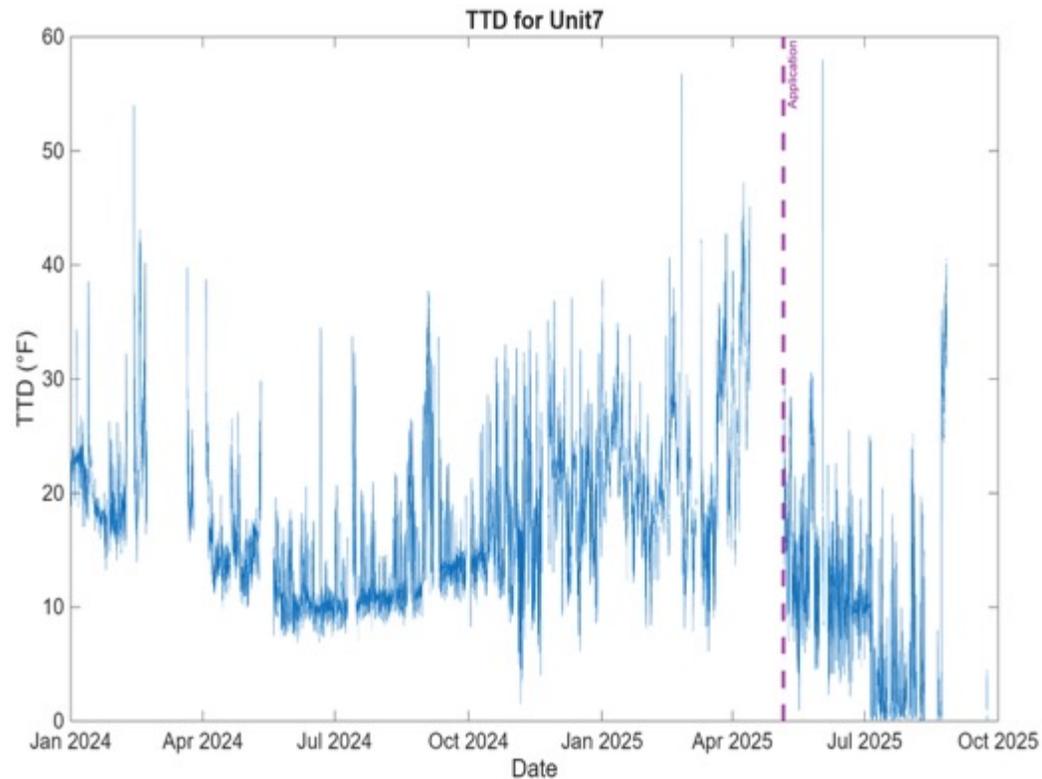


Figure 5. Time series plot of terminal temperature difference (TTD) for Unit 7 from January 2024 to September 2025 highlights a reduction in TTD following the THERMOPHASE application. The post-application data (purple line) indicates improved thermal performance, as evidenced by the sustained decrease in TTD. values.

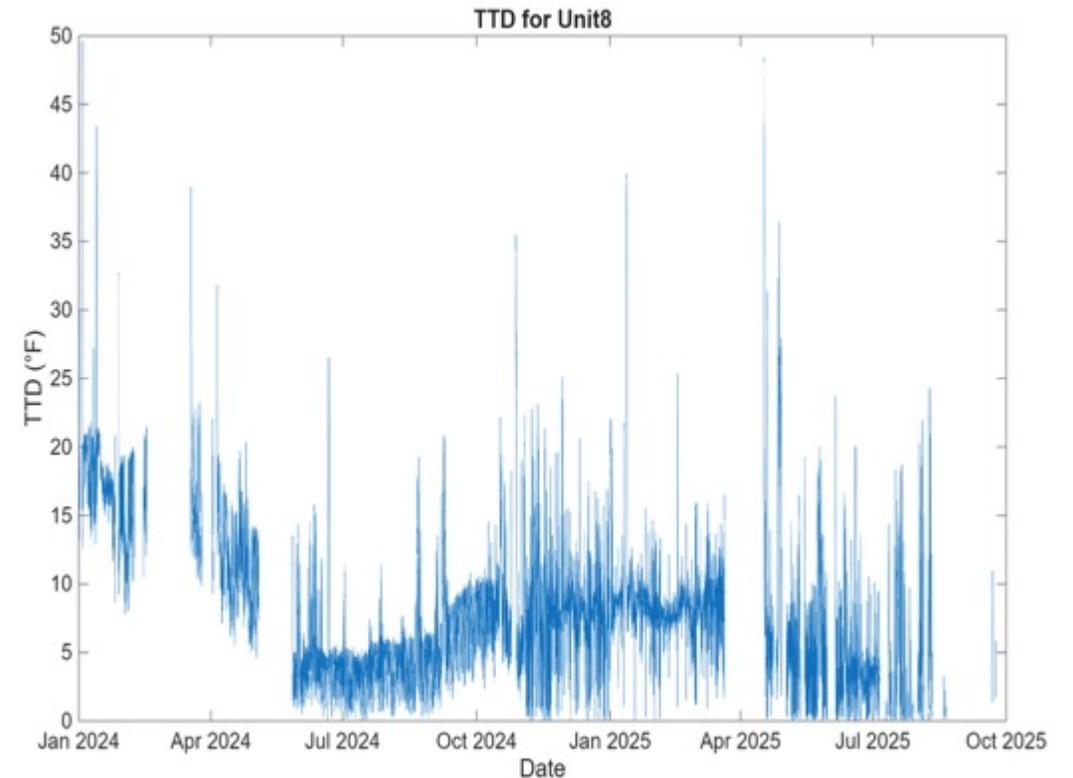


Figure 6. Time series plot of terminal temperature difference (TTD) for Unit 8 from January 2024 to September 2025 shows relatively stable performance over time. While a slight decrease in TTD is observed, no major trend shift is evident, consistent with the absence of a THERMOPHASE application.

THERMOPHASE Application at Midwest Facility

Terminal Temperature Difference Unit 7

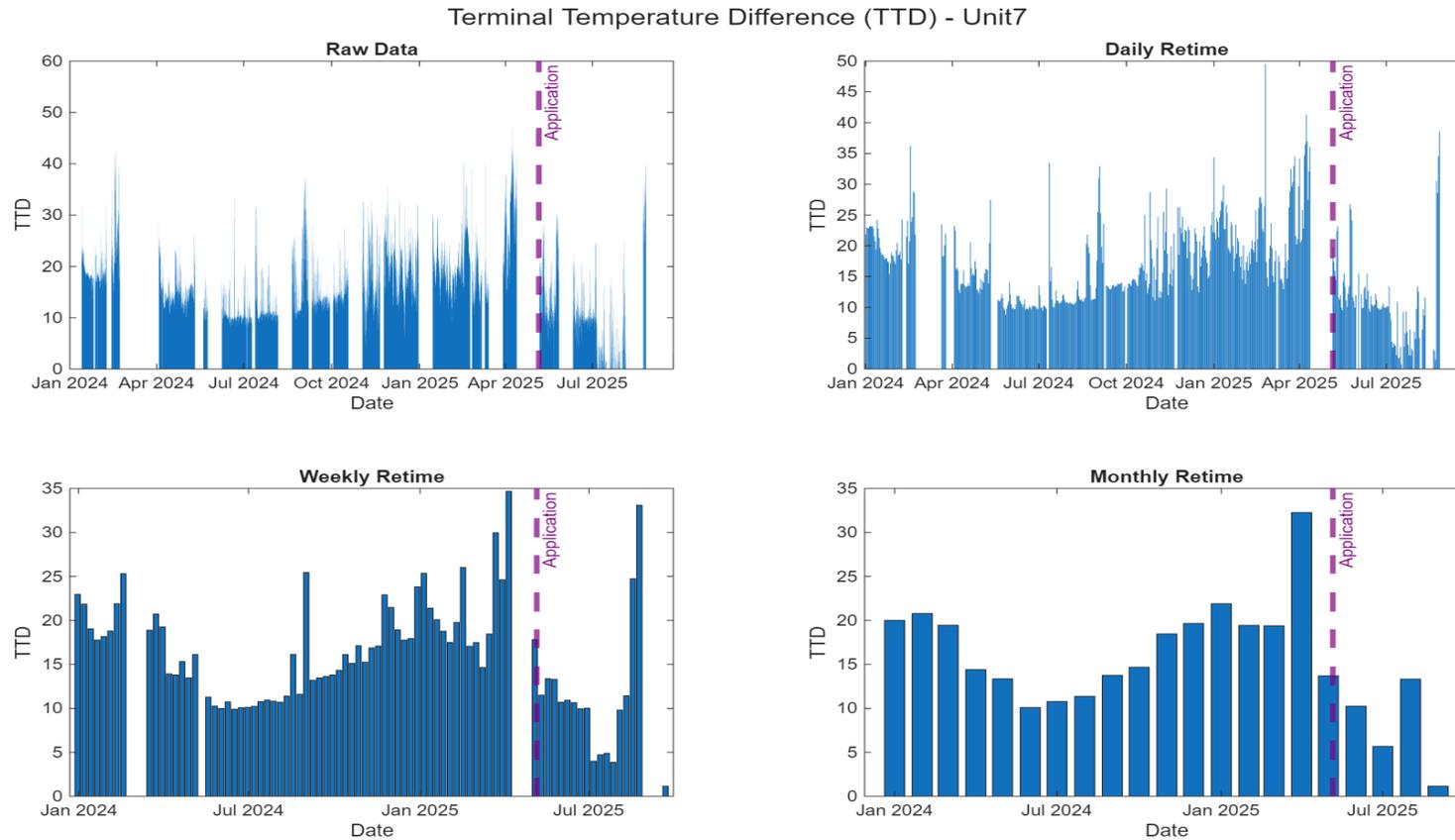


Figure 7. Terminal Temperature Difference (TTD) for Unit 7 from January 2024 through September 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views indicate a clear decrease in TTD after THERMOPHASE application, suggesting improved condenser heat transfer performance.

THERMOPHASE Application at Midwest Facility

Terminal Temperature Difference Unit 8

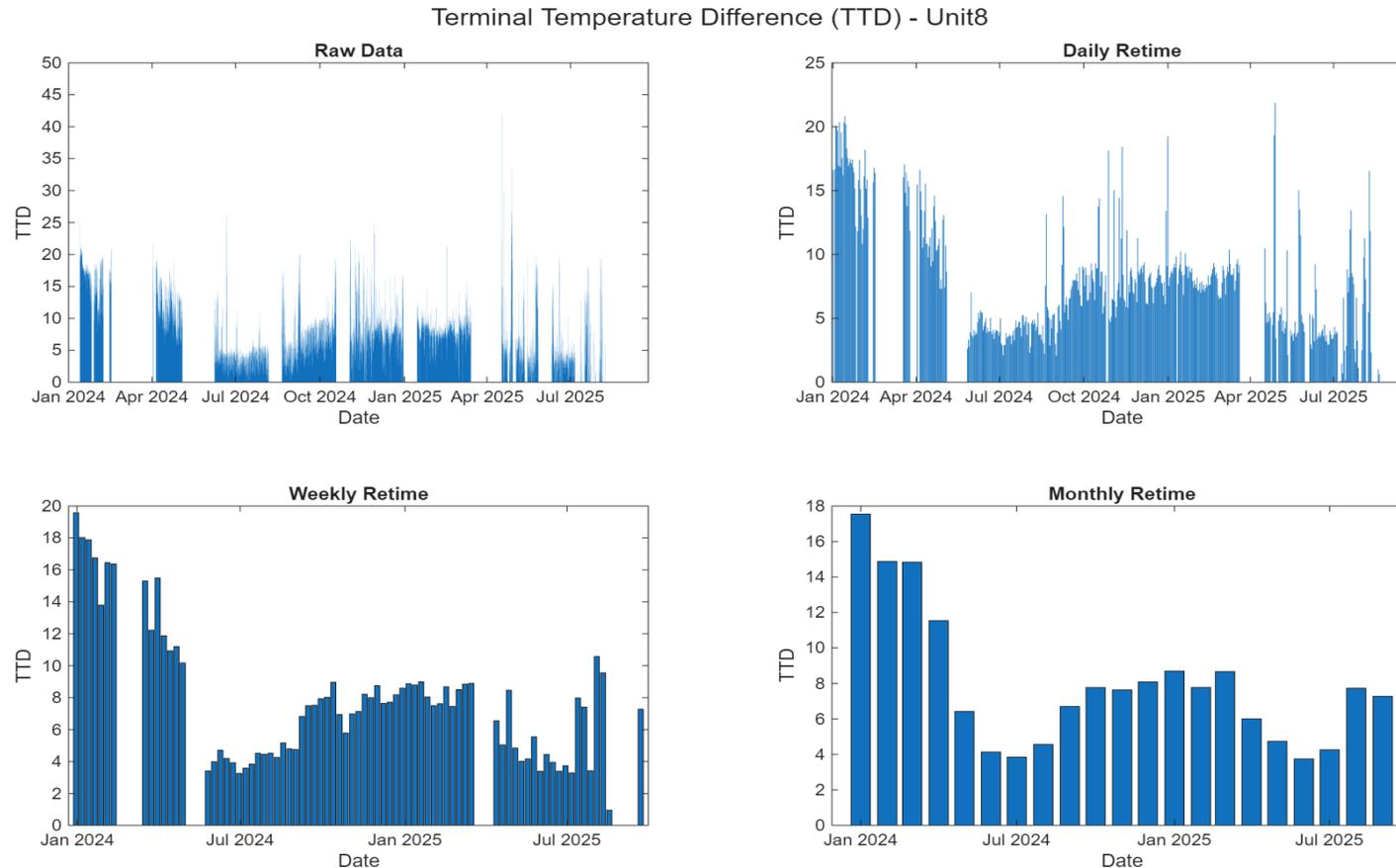


Figure 8. Terminal Temperature Difference (TTD) for Unit 8 from January 2024 through September 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views show relatively stable TTD values over time, with no significant trend change, consistent with the absence of a THERMOPHASE application.

THERMOPHASE Application at Midwest Facility

Condenser Efficiency Unit 7 & Unit 8

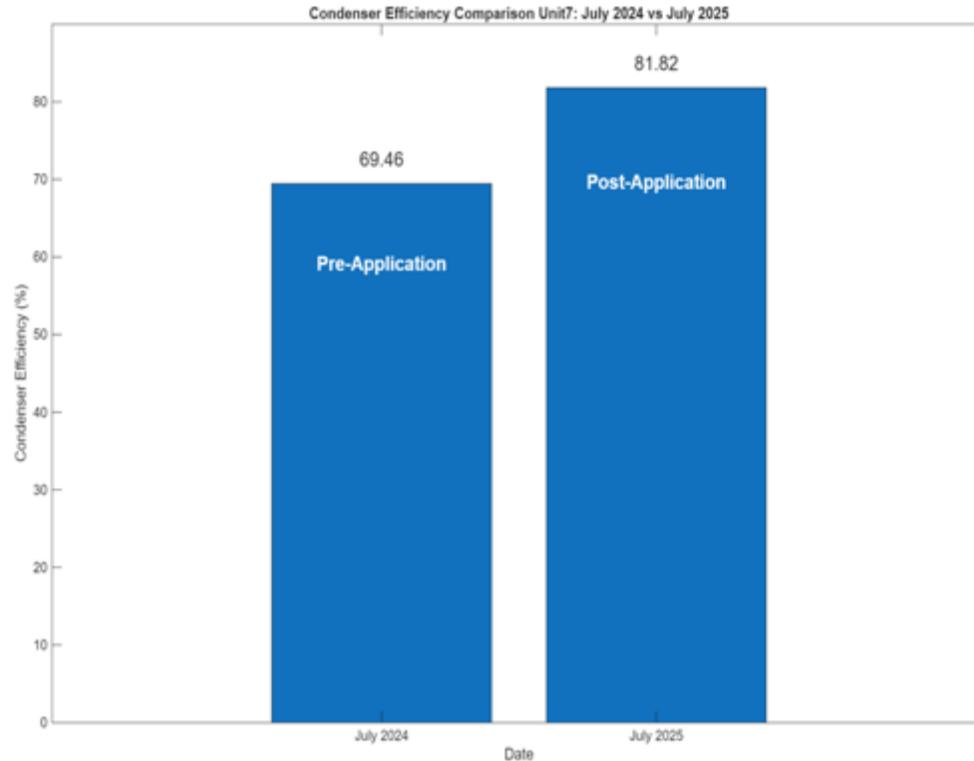


Figure 9. Condenser Efficiency comparison for Unit 7 between July 2024 and July 2025 shows an increase from 69.46% pre-THERMOPHASE application to 81.82% post-application. This increase indicates improved condenser heat transfer performance, suggesting a positive impact of THERMOPHASE.

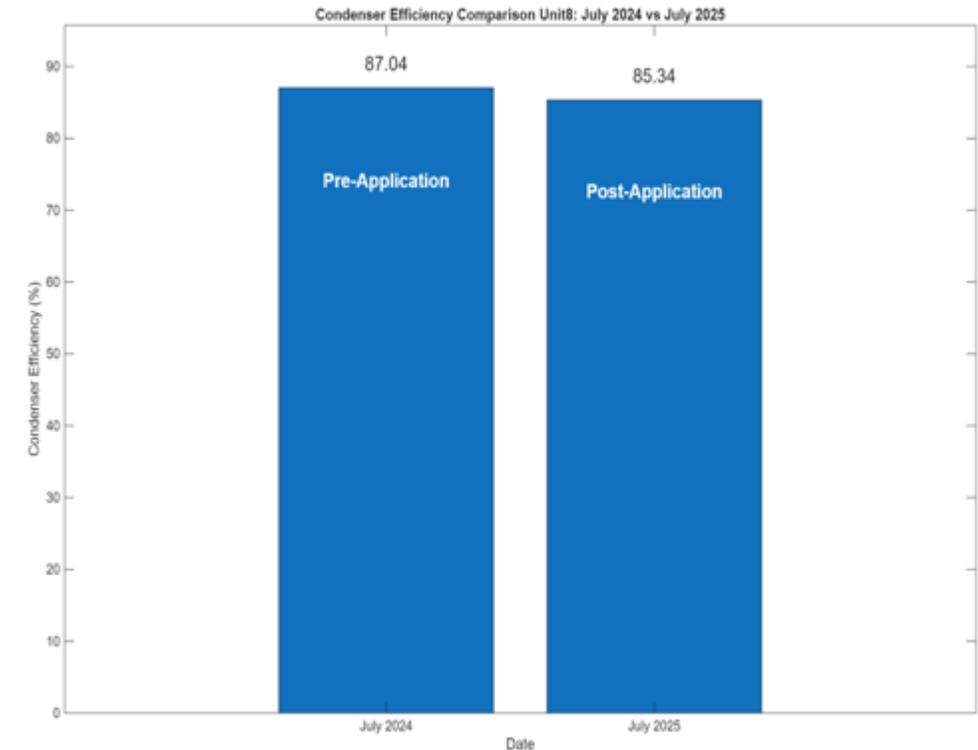


Figure 10. Condenser Efficiency comparison for Unit 8 between July 2024 and July 2025 shows a slight decrease from 87.04% to 85.34%. This comparison indicates no significant change in condenser heat transfer performance, suggesting the Unit 8's system remained relatively stable. By comparing Unit 7 to Unit 8 results, there is a clear change that can be attributed to the addition of THERMOPHASE in Unit 7.

THERMOPHASE Application at Midwest Facility

Condenser Efficiency Unit 7 & Unit 8

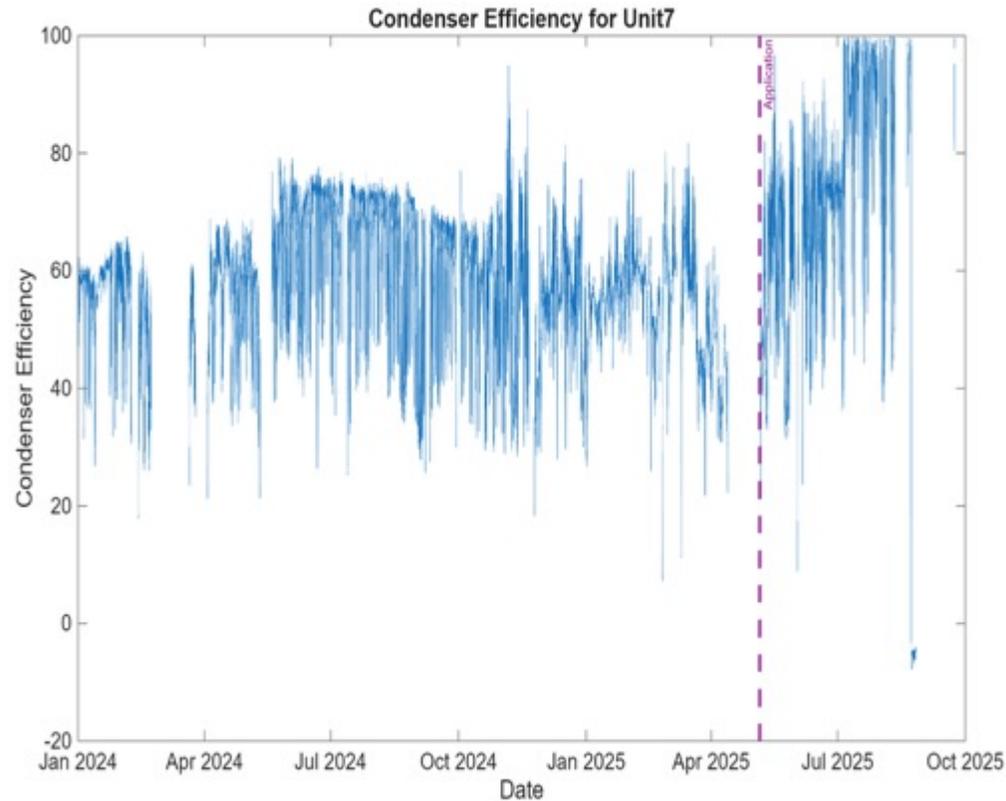


Figure 11. Time series plot of condenser efficiency for Unit 7 from January 2024 to September 2025 highlights a reduction in condenser efficiency following the THERMOPHASE application. The post-application data (purple line) indicates improved thermal performance, as evidenced by the sustained increase in condenser efficiency values.

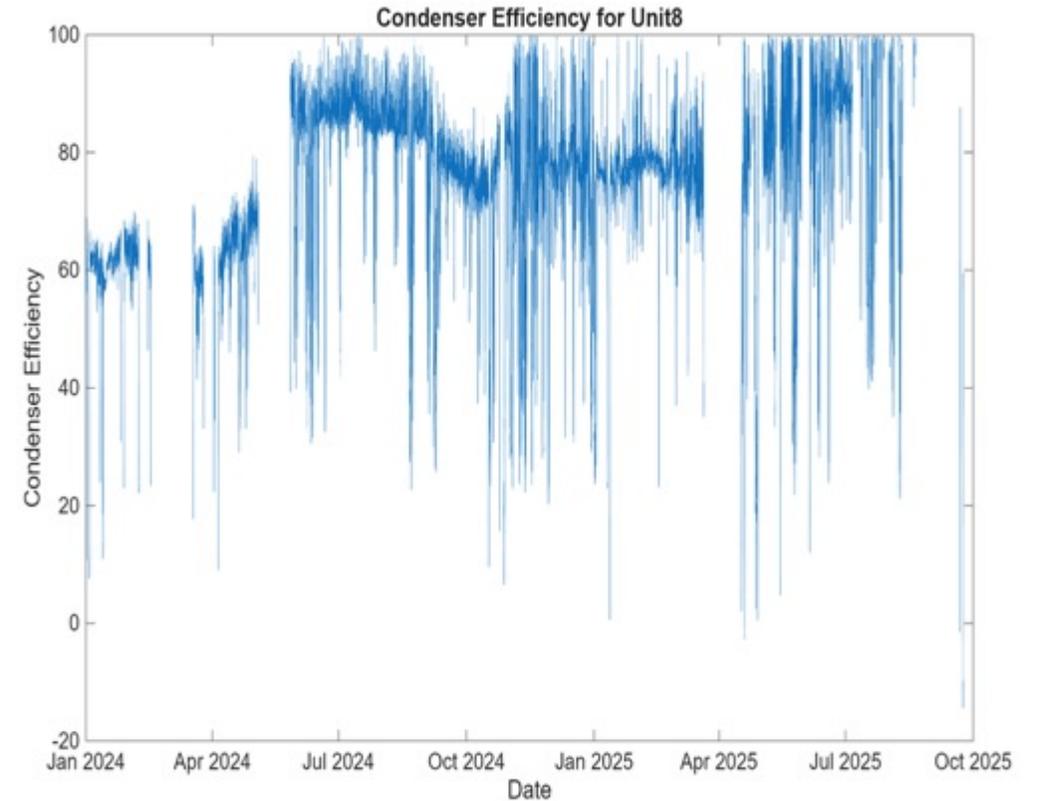


Figure 12. Time series plot of condenser efficiency for Unit 8 from January 2024 to September 2025 shows relatively stable performance over time. While seasonality of the condenser efficiency observed, no major trend shift is evident, consistent with the absence of a THERMOPHASE application

THERMOPHASE Application at Midwest Facility

Condenser Efficiency Unit 7

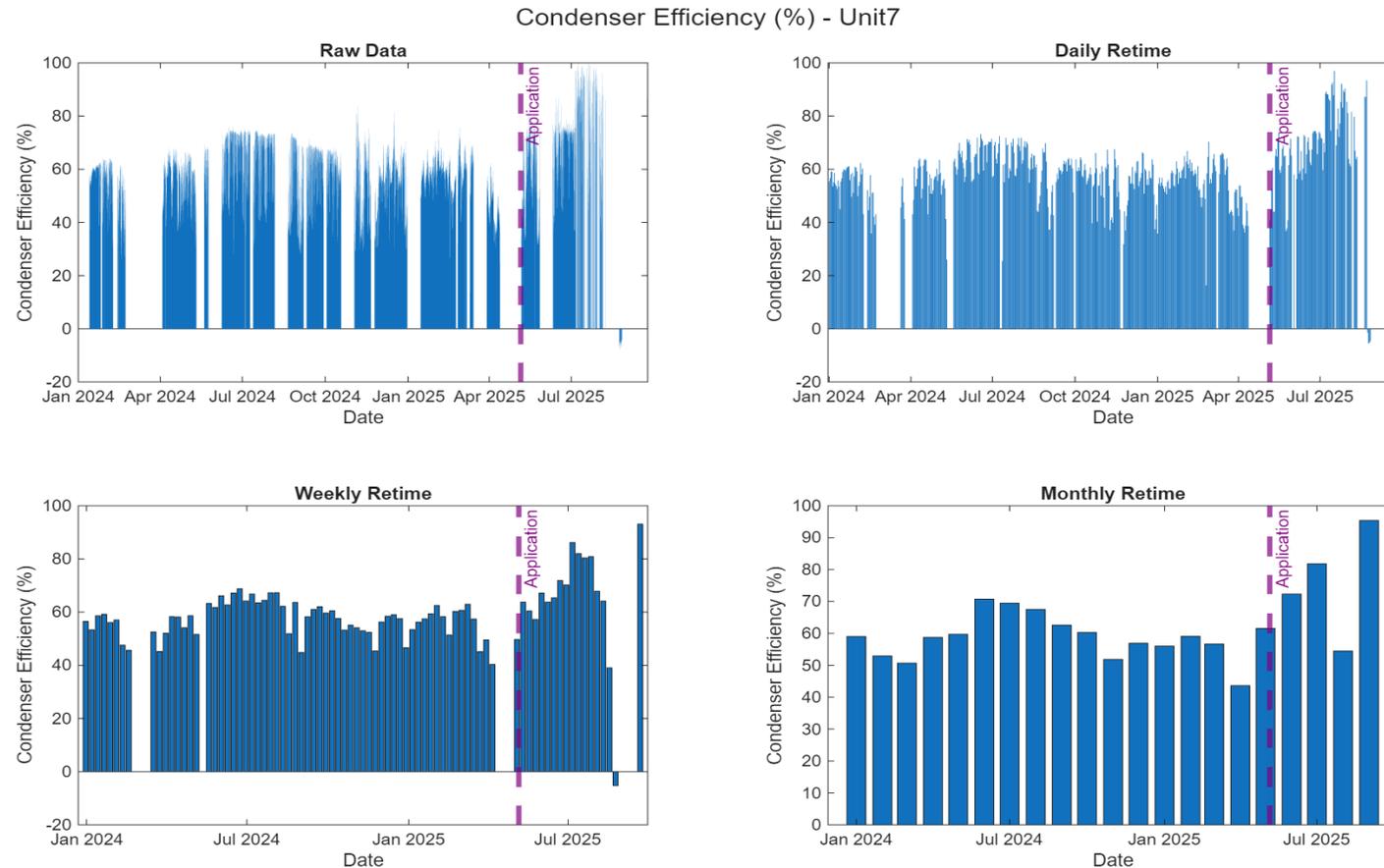


Figure 13. Condenser efficiency for Unit 7 from January 2024 through September 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views indicate a clear increase in condenser efficiency after THERMOPHASE application, suggesting improved condenser heat transfer performance.

THERMOPHASE Application at Midwest Facility

Condenser Efficiency Unit 8

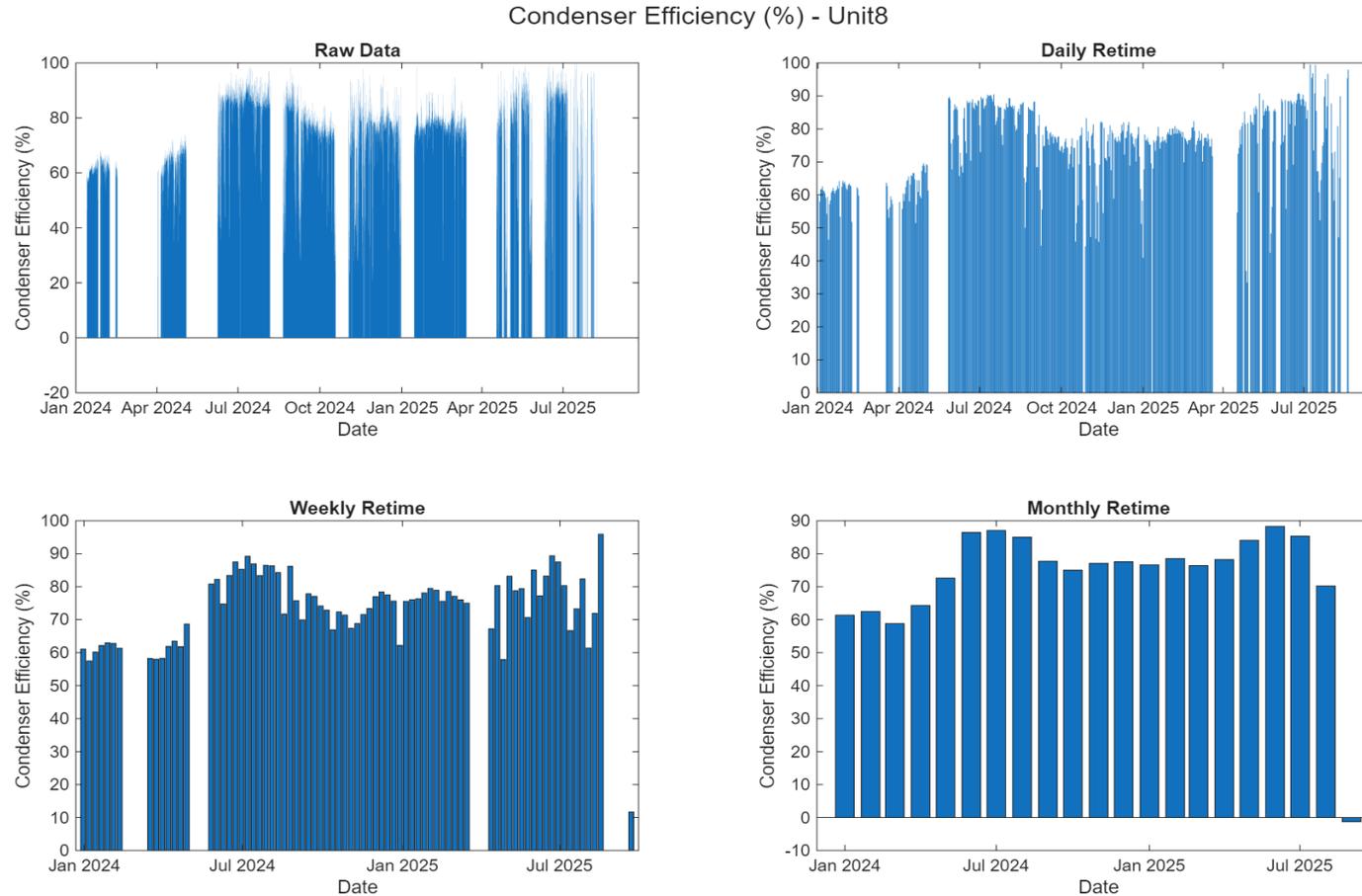


Figure 14. Condenser efficiency for Unit 8 from January 2024 through September 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views show relatively stable condenser efficiency values over time, with no significant trend change, consistent with the absence of a THERMOPHASE application.

THERMOPHASE Application at Midwest Facility

LMTD Unit 7 & Unit 8

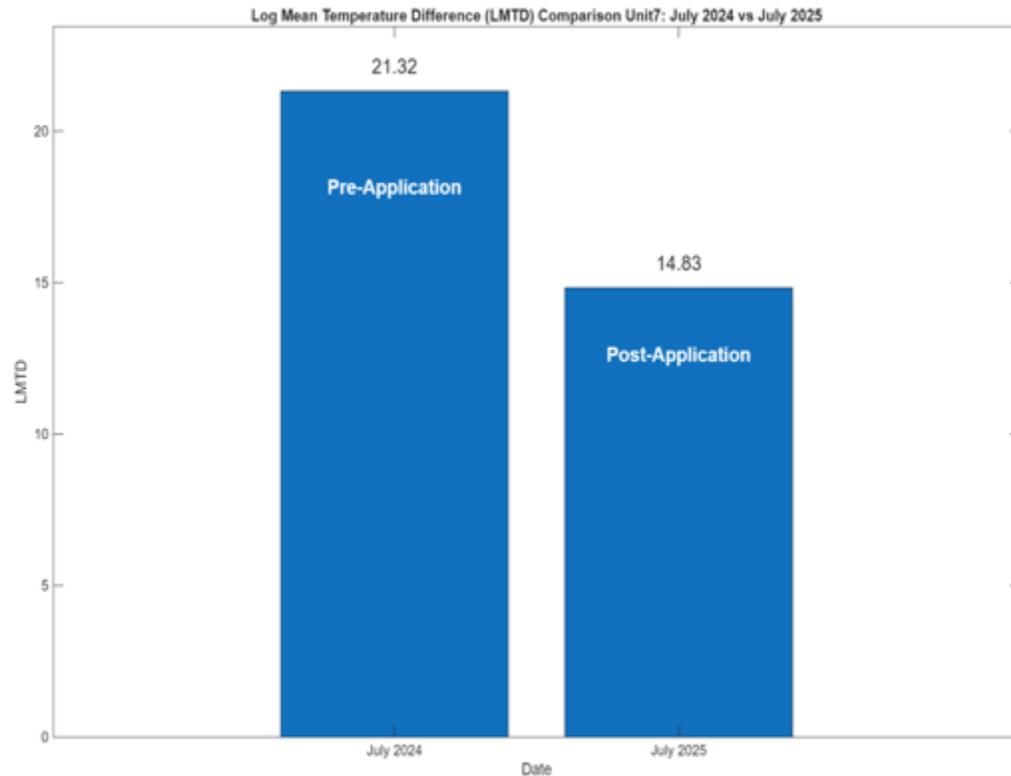


Figure 15. Log mean temperature difference (LMTD) comparison for Unit 7 between July 2024 and July 2025 shows a reduction from 21.32°F pre-THERMOPHASE application to 14.83°F post-application. This decrease indicates improved condenser heat transfer performance, suggesting a positive impact of THERMOPHASE.

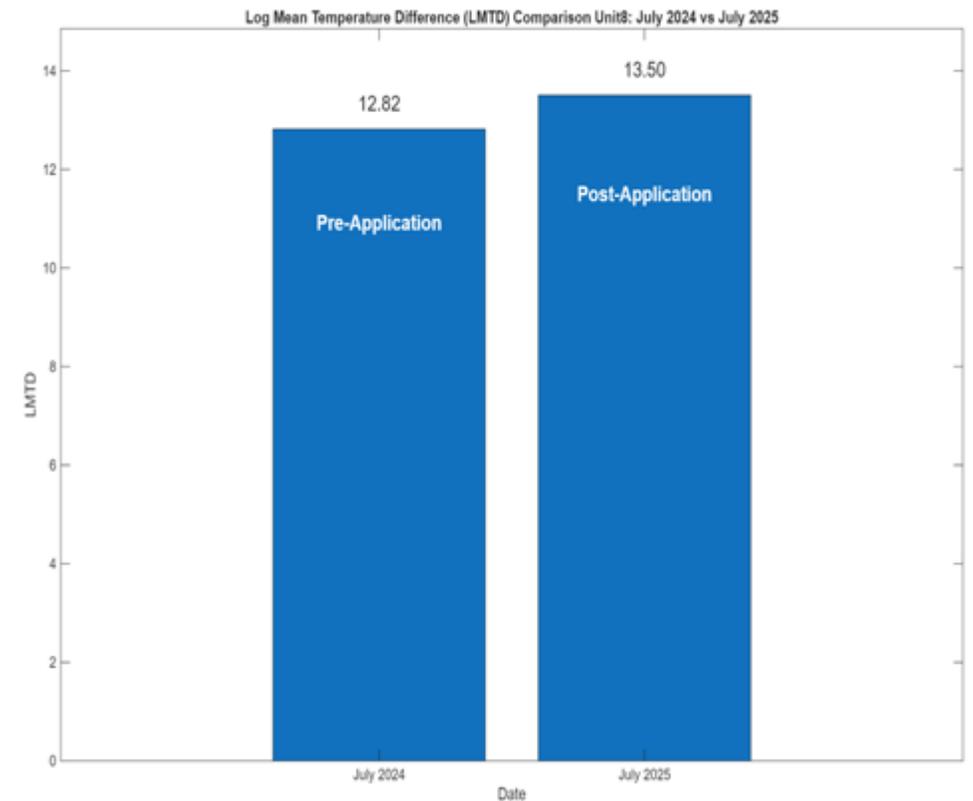


Figure 16. Log mean temperature difference (LMTD) comparison for Unit 8 between July 2024 and July 2025 shows a slight increase from 12.82°F to 13.50°F. This increase indicates no significant change in condenser heat transfer performance, suggesting the Unit 8's system remained relatively stable. By comparing Unit 7 to Unit 8 results, there is a clear change that can be attributed to the addition of THERMOPHASE in Unit 7.

THERMOPHASE Application at Midwest Facility

LMTD Unit 7 & Unit 8

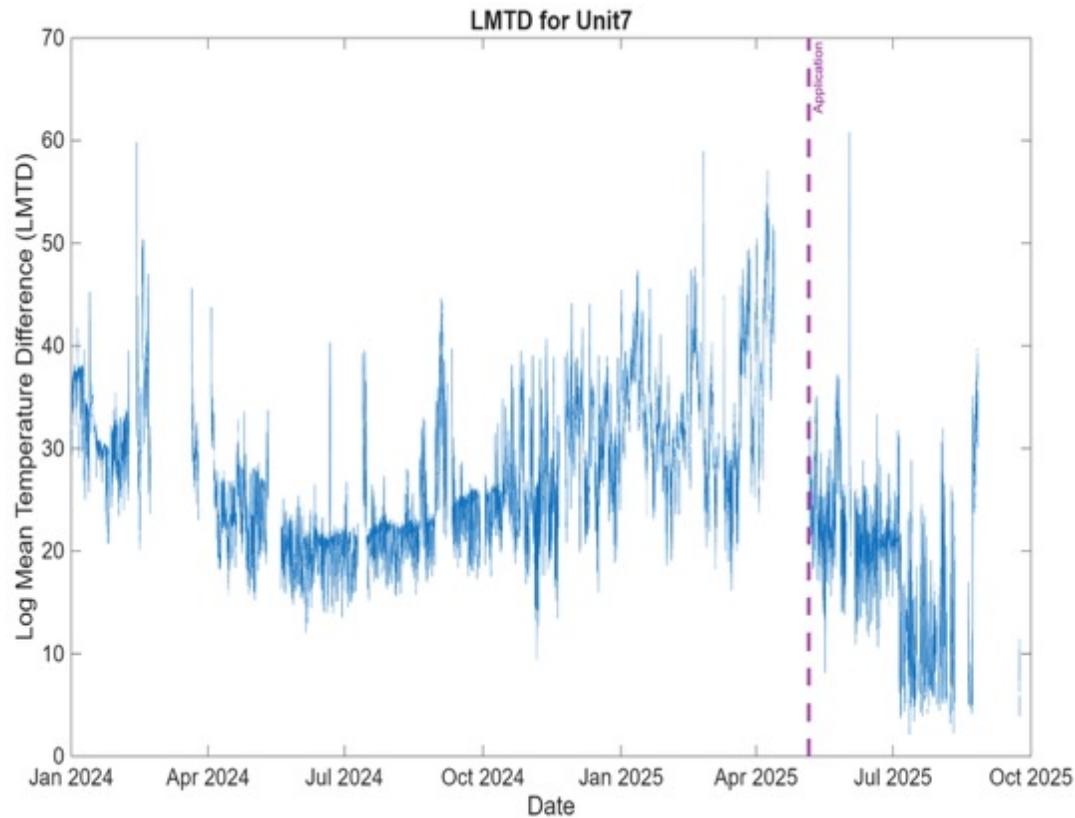


Figure 17. Time series plot of log mean temperature difference (LMTD) for Unit 7 from January 2024 to September 2025 highlights a reduction in LMTD following the THERMOPHASE application. The post-application data (purple line) indicates improved thermal performance, as evidenced by the sustained decrease in LMTD.

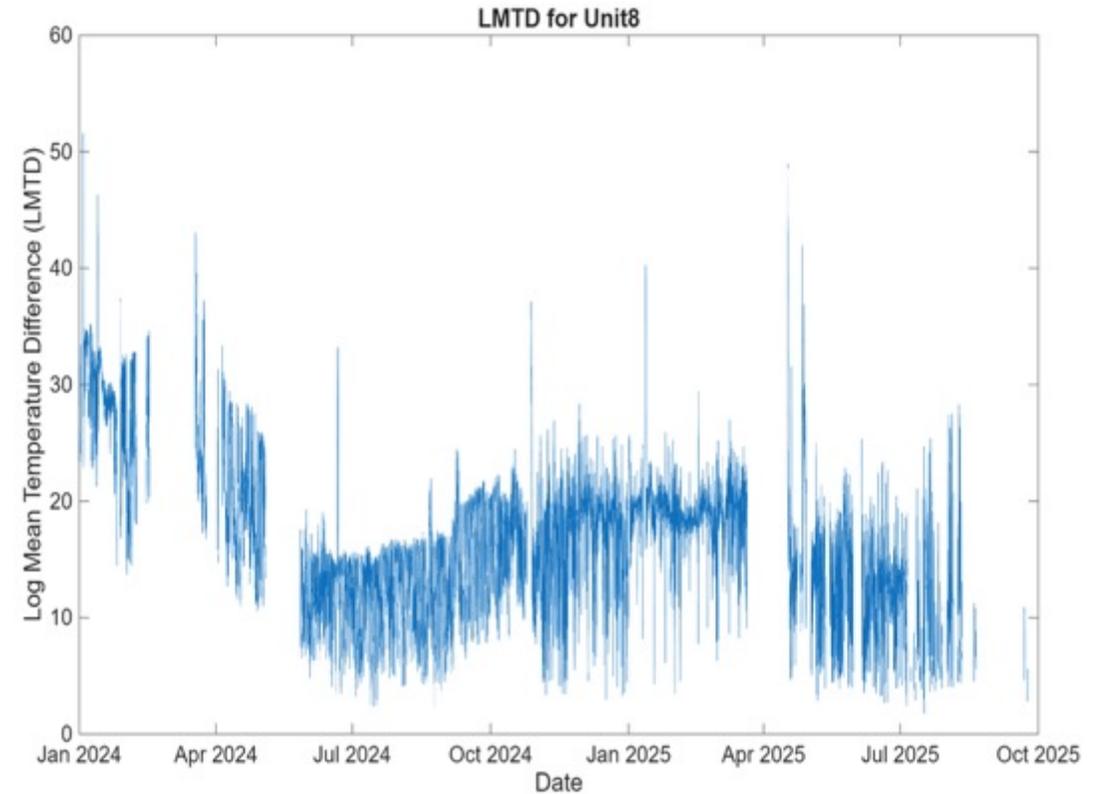


Figure 18. Time series plot of log mean temperature difference (LMTD) for Unit 8 from January 2024 to September 2025 shows relatively stable performance over time. No major trend shift in LMTD is evident, consistent with the absence of a THERMOPHASE application

THERMOPHASE Application at Midwest Facility

LMTD Unit 7

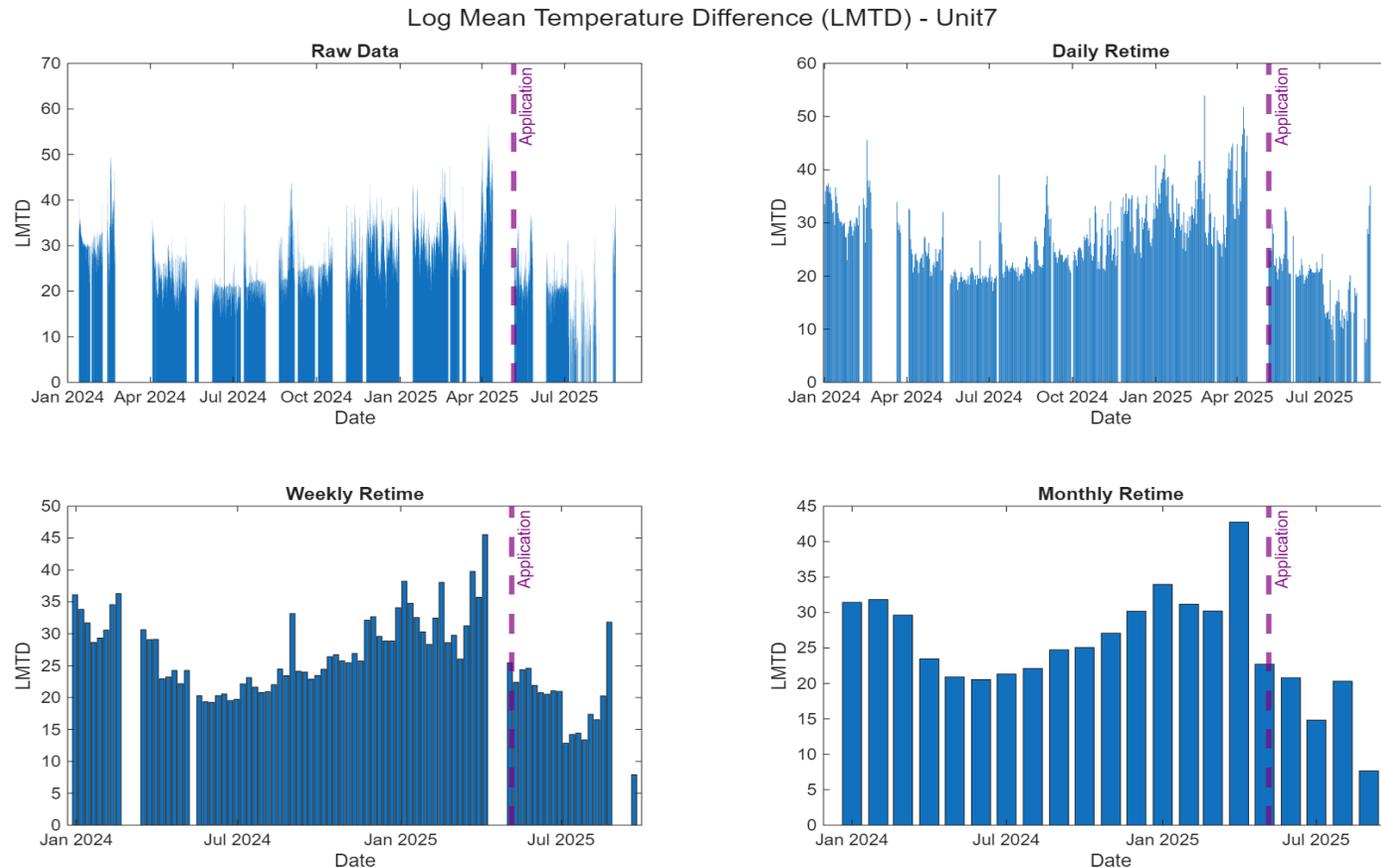


Figure 19. Log mean temperature difference (LMTD) for Unit 7 from January 2024 through September 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views indicate a clear decrease in LMTD after THERMOPHASE application, suggesting improved condenser heat transfer performance.

THERMOPHASE Application at Midwest Facility

LMTD Unit 8

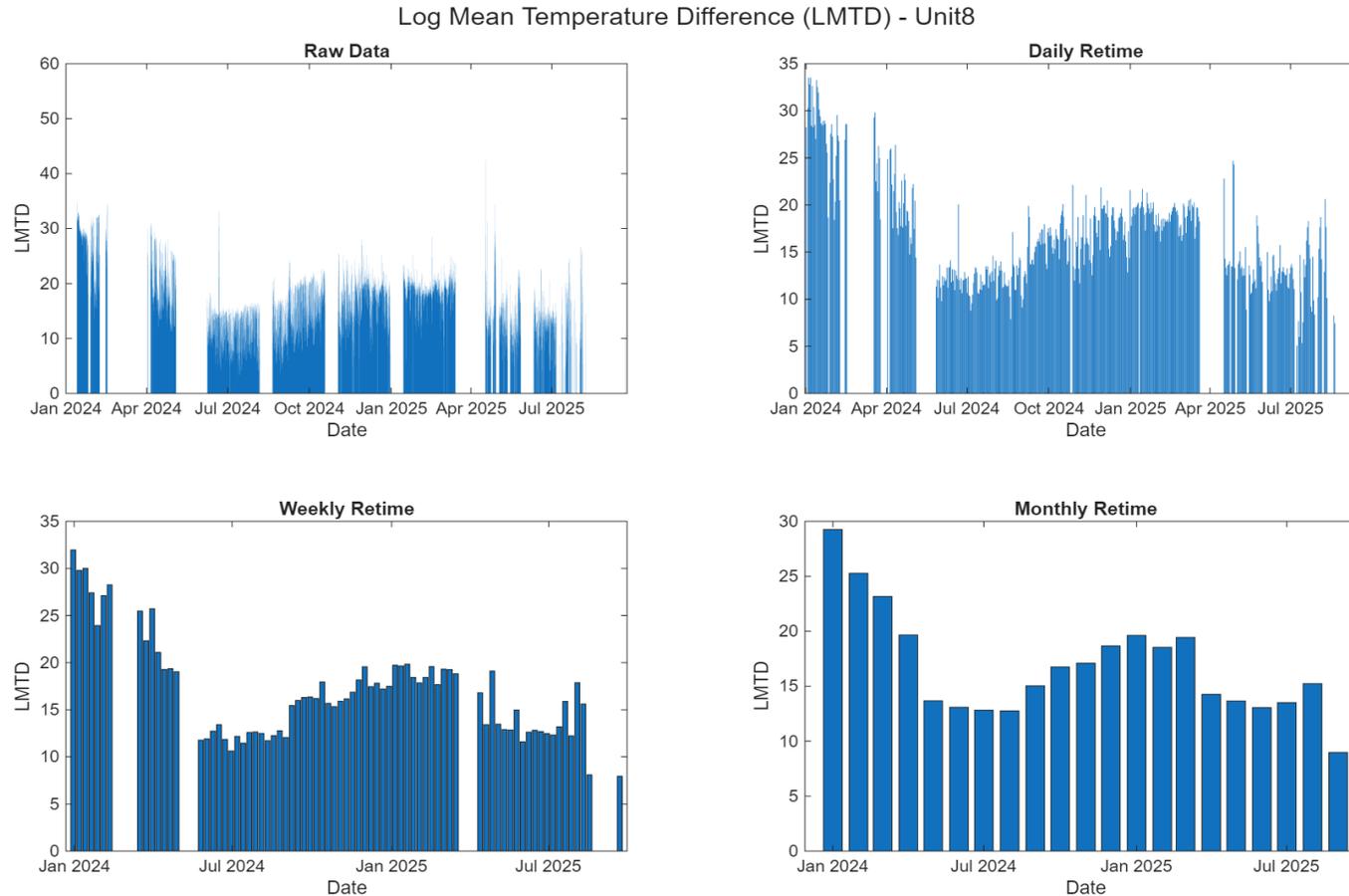


Figure 20. Log mean temperature difference (LMTD) for Unit 8 from January 2024 through September 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views show relatively stable LMTD values over time, with no significant trend change, consistent with the absence of a THERMOPHASE application.

THERMOPHASE Application at Midwest Facility

Unit 7 Performance

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 5.109°F, accompanied by a 12.359% increase in condenser efficiency, and a 6.485°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) | 37.3696 | 32.1024 | -5.2671 | -14.0947% |
| TR (°F) | 25.197 | 27.8313 | 2.6343 | 10.4548% |
| TTD (°F) | 10.7745 | 5.6659 | -5.1086 | -47.4137% |
| Condenser Efficiency (%) | 69.4569 | 81.8163 | 12.3594 | 17.7944% |
| LMTD (°F) | 21.3151 | 14.8306 | -6.4845 | -30.4221% |

THERMOPHASE Application at Midwest Facility

Unit 8 Performance

Table 2. Comparison of Unit 8 performance metrics between July 2024 and July 2025 shows negligible differences. Terminal Temperature Difference (TTD) increased slightly by 0.415°F, accompanied by a 1.702% decrease in condenser efficiency, and a 0.686°F increase in LMTD, indicating no enhancement in heat transfer or overall condenser performance.

| Control | July 2024 (Pre-Application) | July 2025 (Post-Application) | Difference | Percent Change |
|--------------------------|--------------------------------|---------------------------------|------------|----------------|
| ITD (°F) | 30.6703 | 29.6563 | -1.014 | -3.3062% |
| TR (°F) | 27.0471 | 22.4992 | -4.5478 | -16.8145% |
| TTD (°F) | 3.848 | 4.2632 | 0.41525 | 10.7915% |
| Condenser Efficiency (%) | 87.0435 | 85.3414 | -1.7021 | -1.9555% |
| LMTD (°F) | 12.8191 | 13.5047 | 0.68565 | 5.3487% |

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

THERMOPHASE Application at Ocean State Power Plant

Terminal Temperature Difference Unit 1 & Unit 2

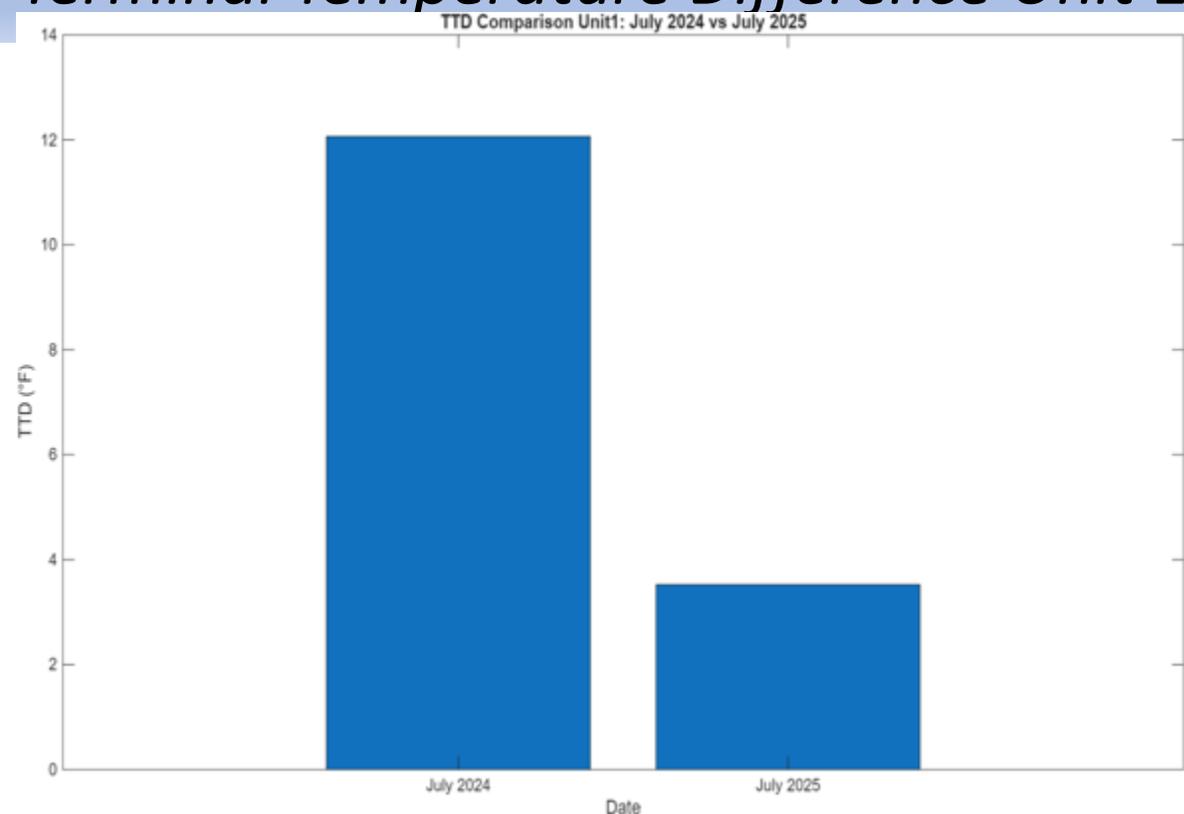


Figure 1. Terminal Temperature Difference (TTD) comparison for Unit 1 between July 2024 and July 2025 shows a reduction from approximately 12°F pre-THERMOPHASE application to about 4°F post-application. This decrease indicates improved condenser heat transfer performance, suggesting a positive impact of THERMOPHASE.

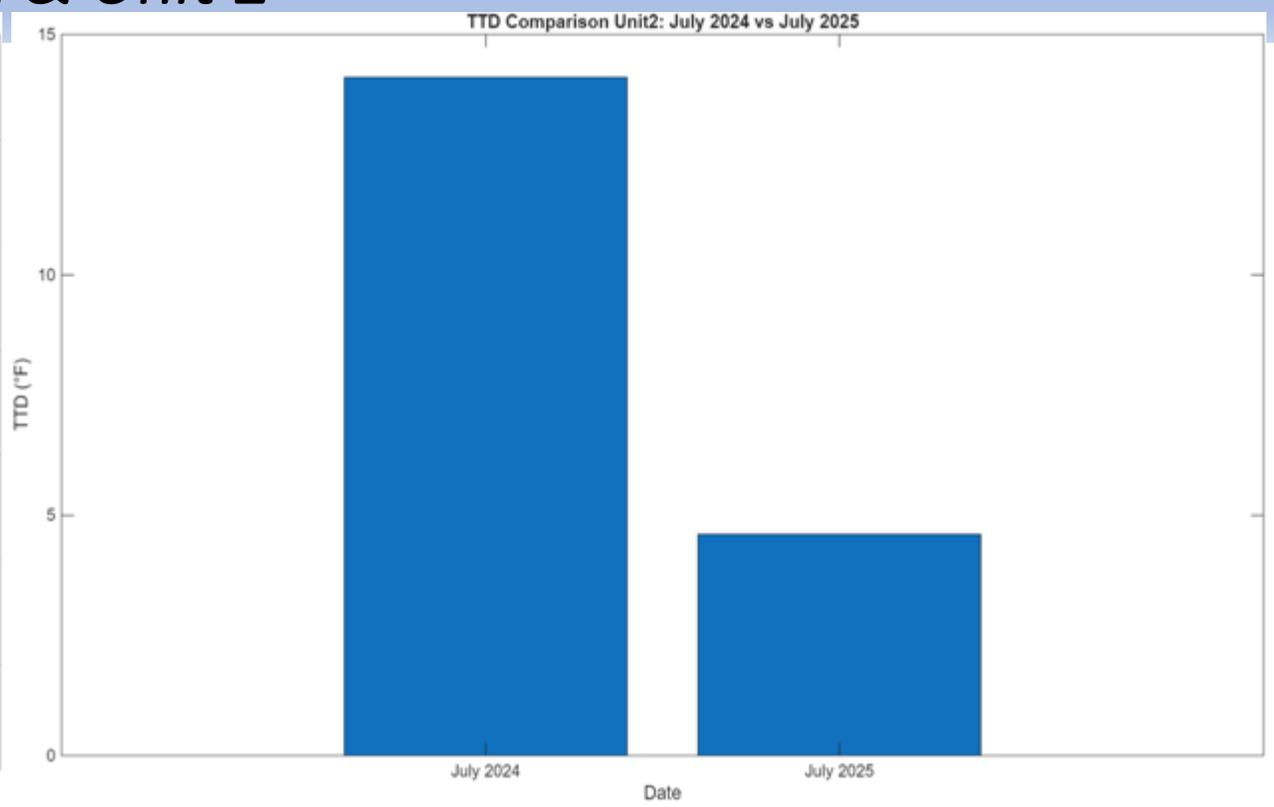


Figure 2. Terminal Temperature Difference (TTD) comparison for Unit 2 between July 2024 and July 2025 shows a reduction from approximately 14°F pre-THERMOPHASE application to about 5°F post-application. This decrease indicates improved condenser heat transfer performance, suggesting a positive impact of THERMOPHASE.

THERMOPHASE Application at Ocean State Power Plant

Terminal Temperature Difference Unit 1

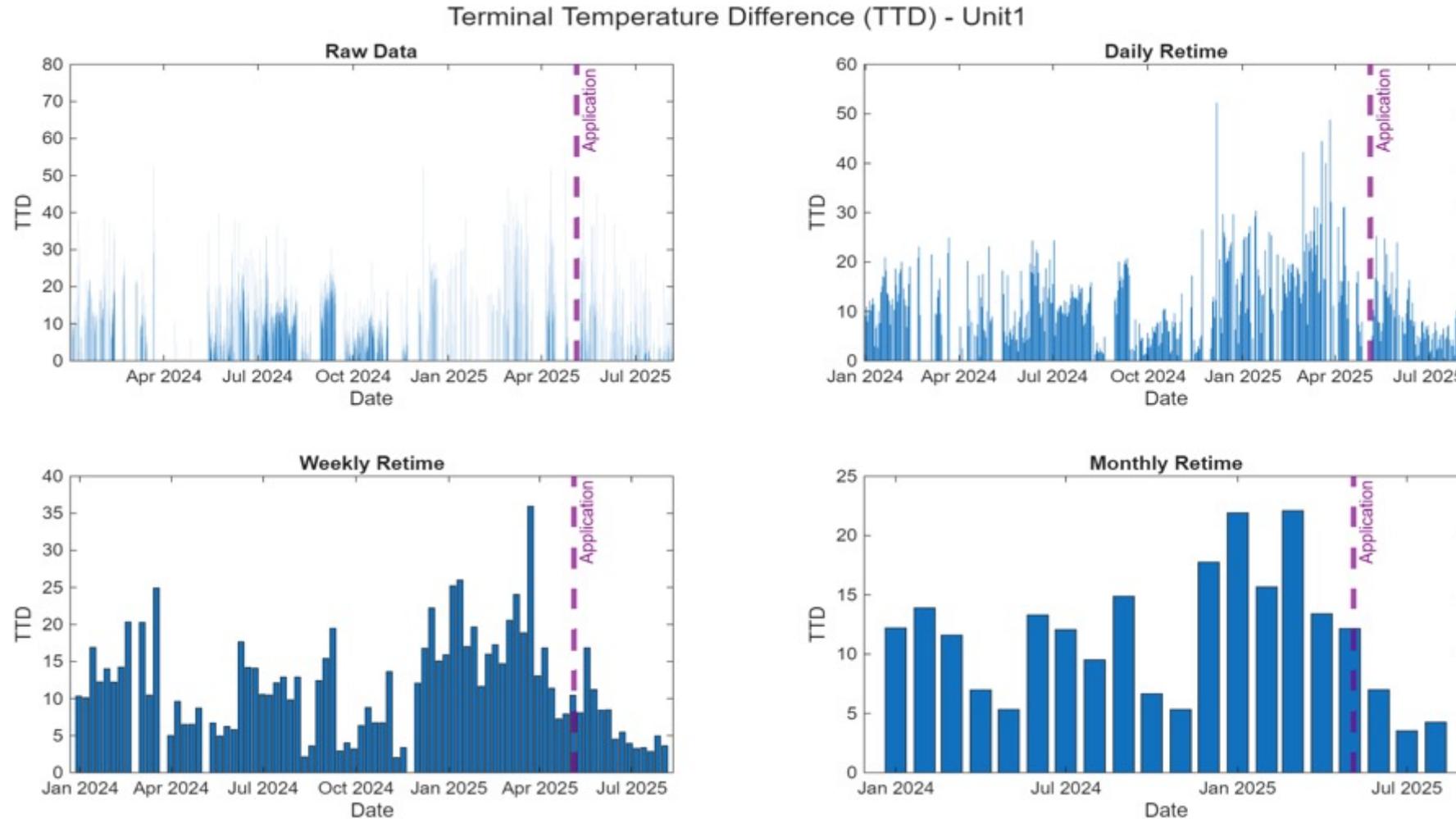


Figure 3. Terminal Temperature Difference (TTD) for Unit 1 from January 2024 through August 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views indicate a clear decrease in TTD after THERMOPHASE application, suggesting improved condenser heat transfer performance.

THERMOPHASE Application at Ocean State Power Plant

Terminal Temperature Difference Unit 2

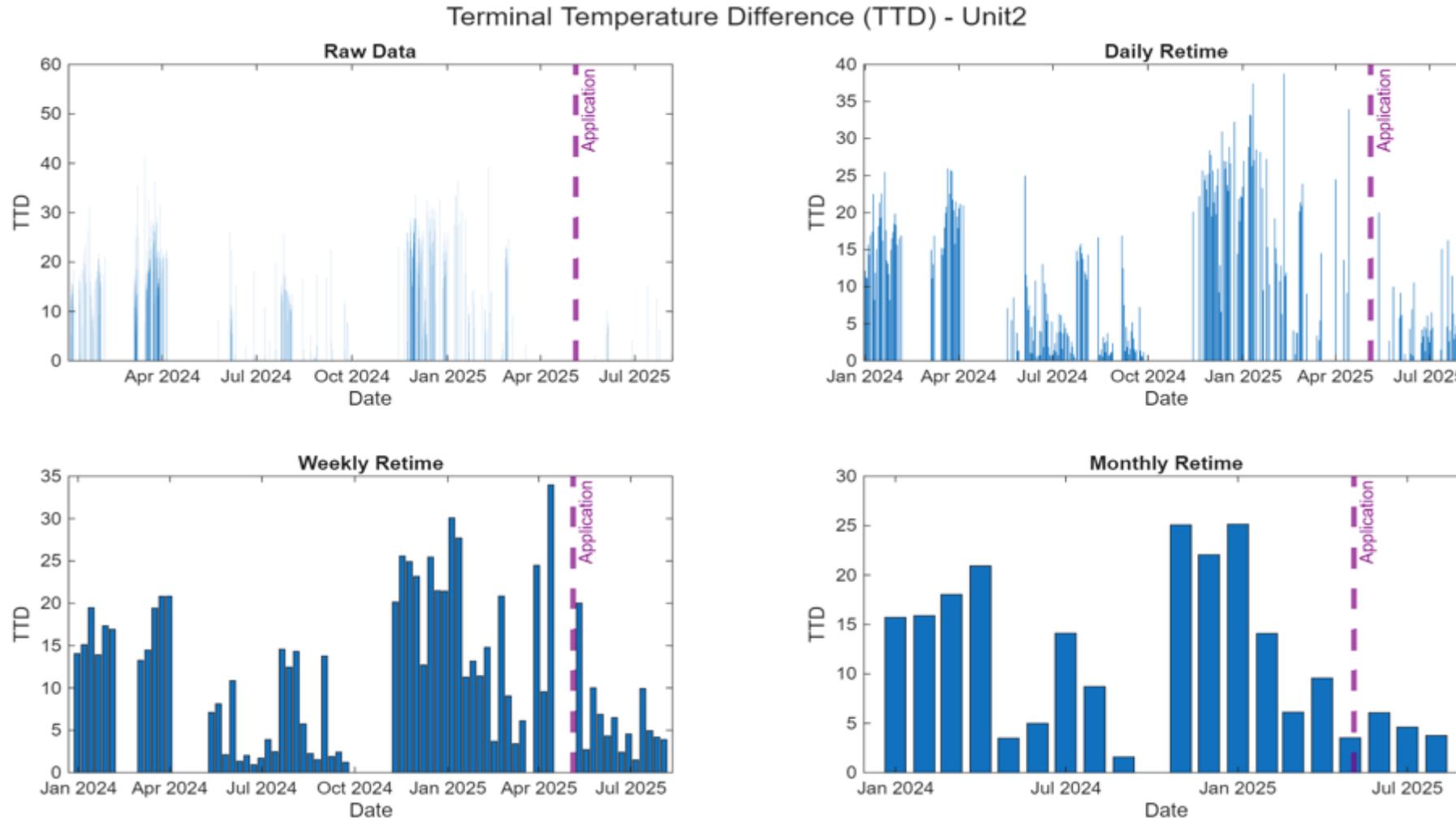


Figure 4. Terminal Temperature Difference (TTD) for Unit 2 from January 2024 through August 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views indicate a clear decrease in TTD after THERMOPHASE application, suggesting improved condenser heat transfer performance.

THERMOPHASE Application at Ocean State Power Plant

Condenser Efficiency Unit 1 & Unit 2

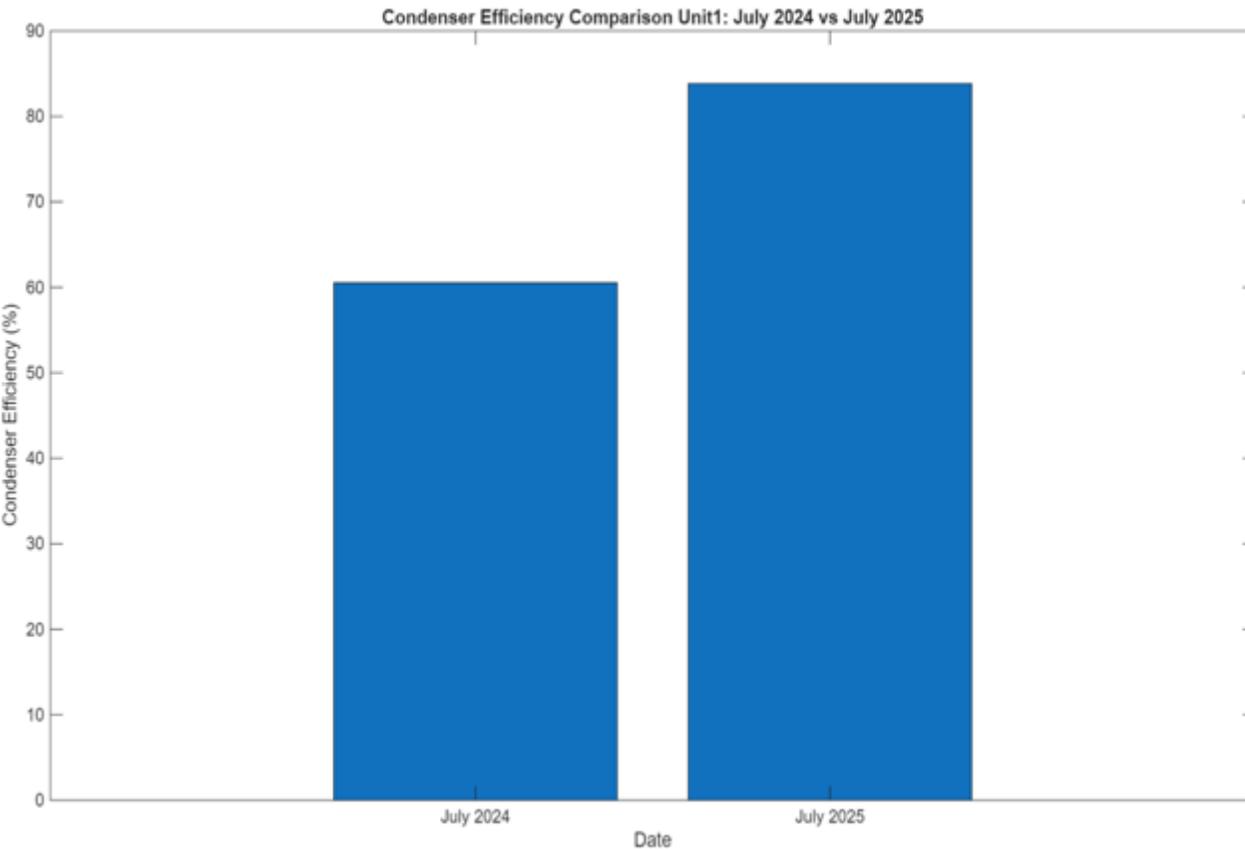


Figure 5. Condenser Efficiency comparison for Unit 1 between July 2024 and July 2025 shows an increase from approximately 60% pre-THERMOPHASE application to about 85% post-application. This increase indicates improved condenser heat transfer performance, suggesting a positive impact of THERMOPHASE.

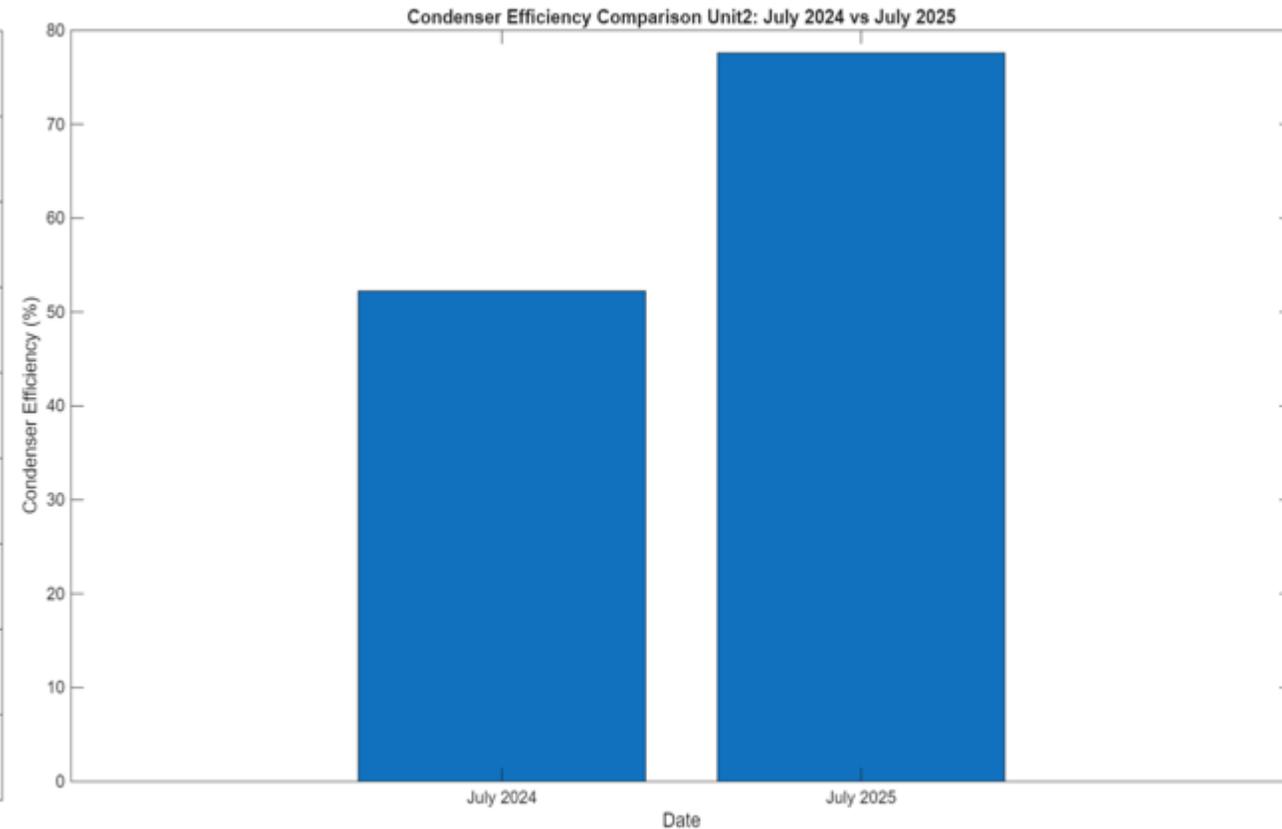


Figure 6. Condenser Efficiency comparison for Unit 2 between July 2024 and July 2025 shows an increase from approximately 55% pre-THERMOPHASE application to about 78% post-application. This increase indicates improved condenser heat transfer performance, suggesting a positive impact of THERMOPHASE.

THERMOPHASE Application at Ocean State Power Plant

Condenser Efficiency Unit 1

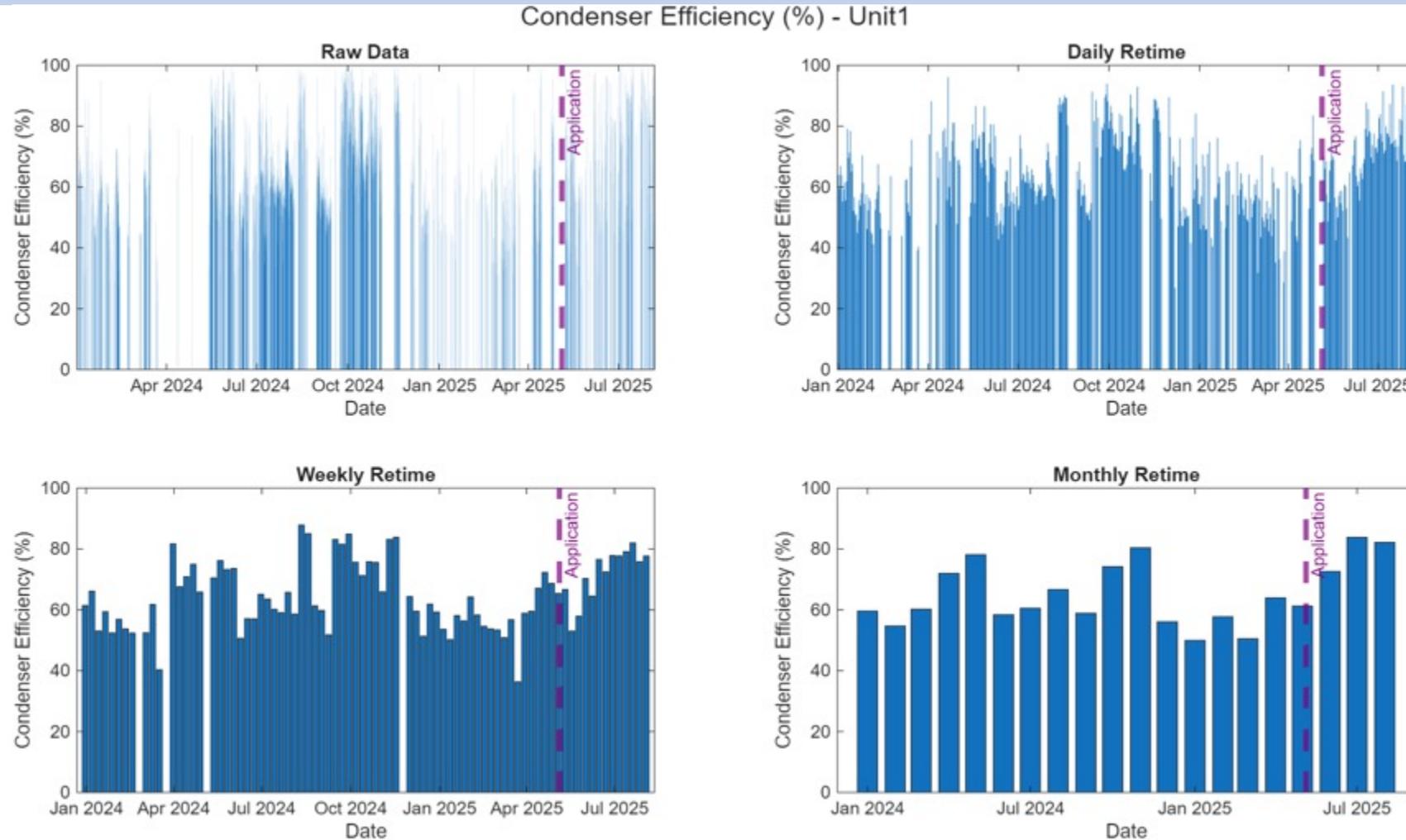


Figure 7. Condenser Efficiency for Unit 1 from January 2024 through August 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views indicate an increase in Condenser Efficiency after THERMOPHASE application, suggesting improved condenser heat transfer performance.

THERMOPHASE Application at Ocean State Power Plant

Condenser Efficiency Unit 2

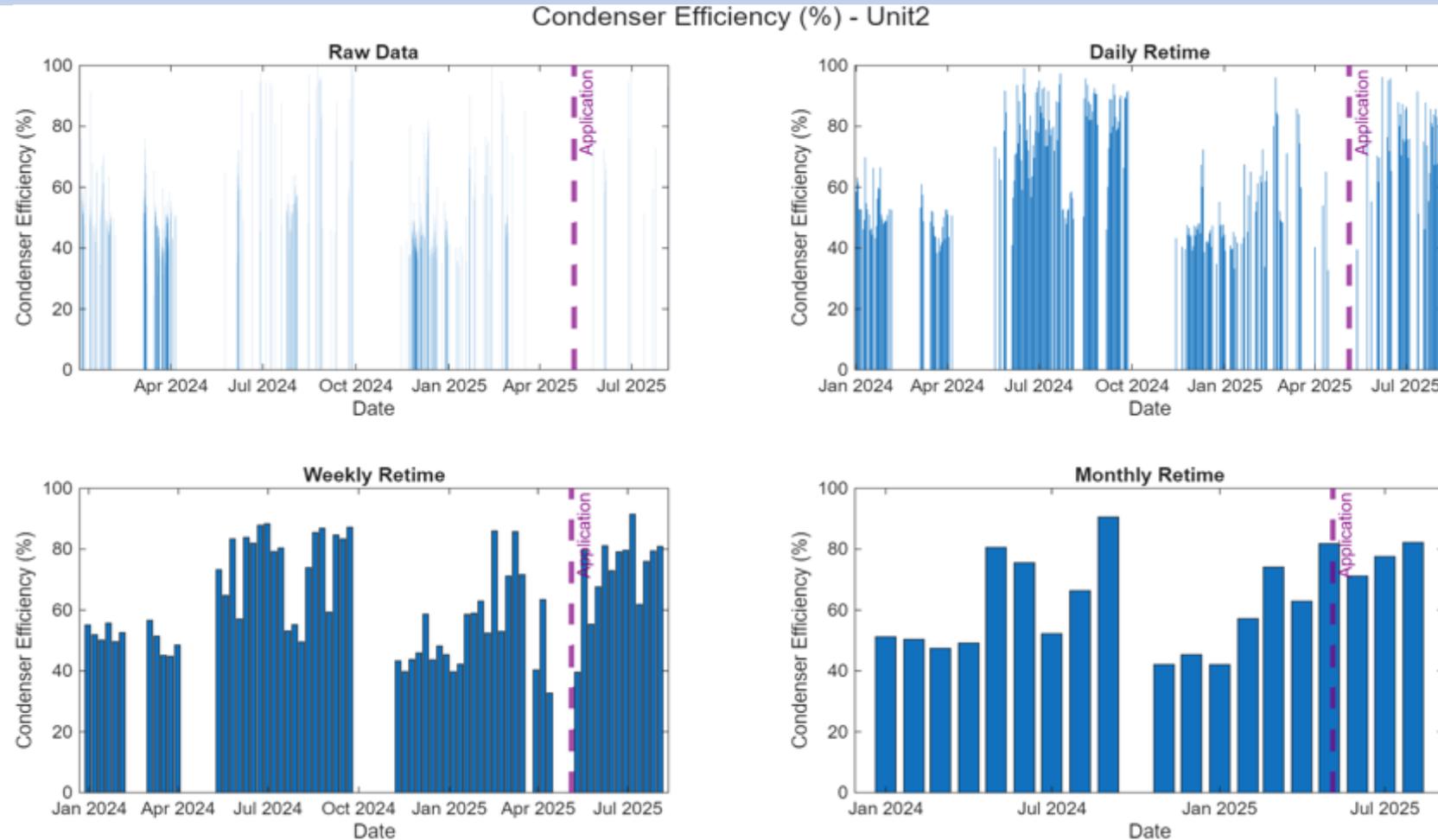


Figure 8. Condenser Efficiency for Unit 2 from January 2024 through August 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views indicate an increase in Condenser Efficiency after THERMOPHASE application, suggesting improved condenser heat transfer performance.

THERMOPHASE Application at Ocean State Power Plant

Condenser Backpressure Unit 1 & Unit 2



Backpressure Comparison Unit1: July 2024 vs July 2025

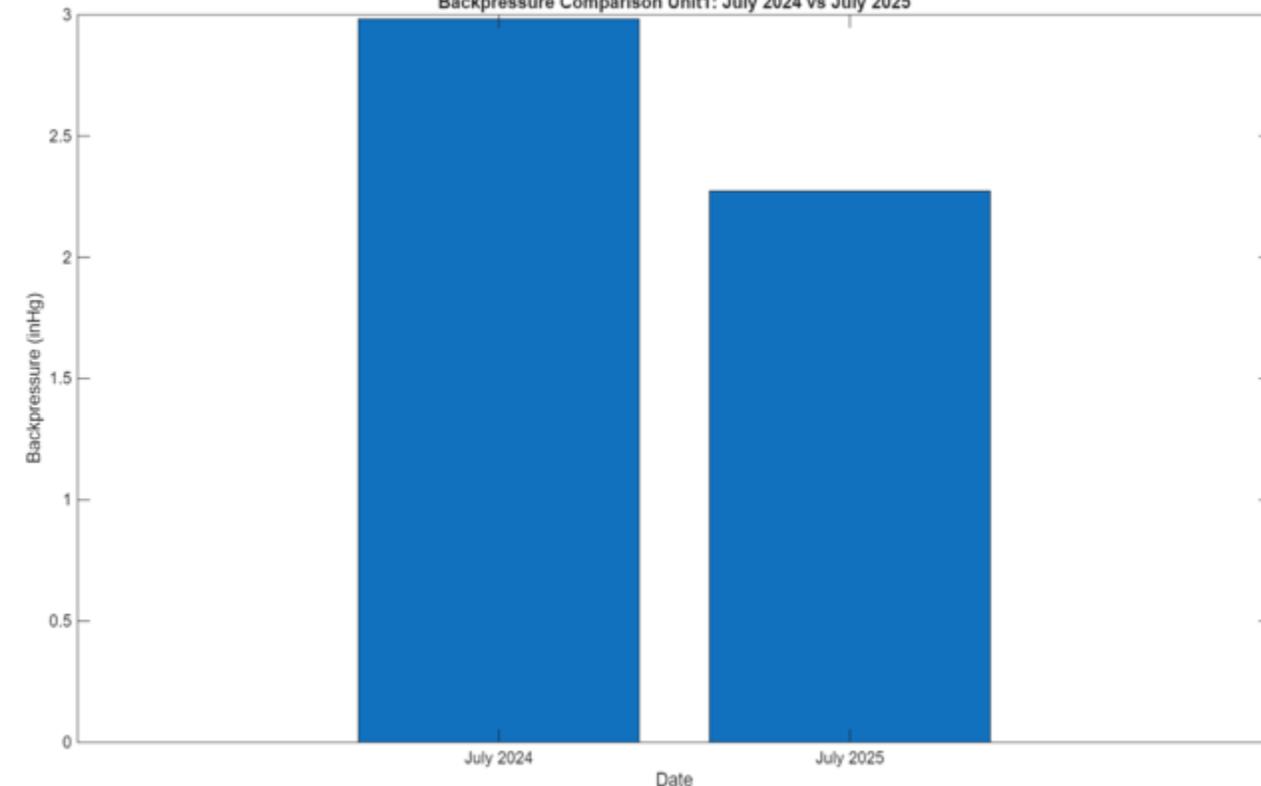


Figure 9. Condenser Backpressure comparison for Unit 1 between July 2024 and July 2025 shows a decrease from approximately 3 inHg pre-THERMOPHASE application to about 2.25 inHg post-application. This decrease indicates improved condenser heat transfer performance, suggesting a positive impact of THERMOPHASE.

Backpressure Comparison Unit2: July 2024 vs July 2025

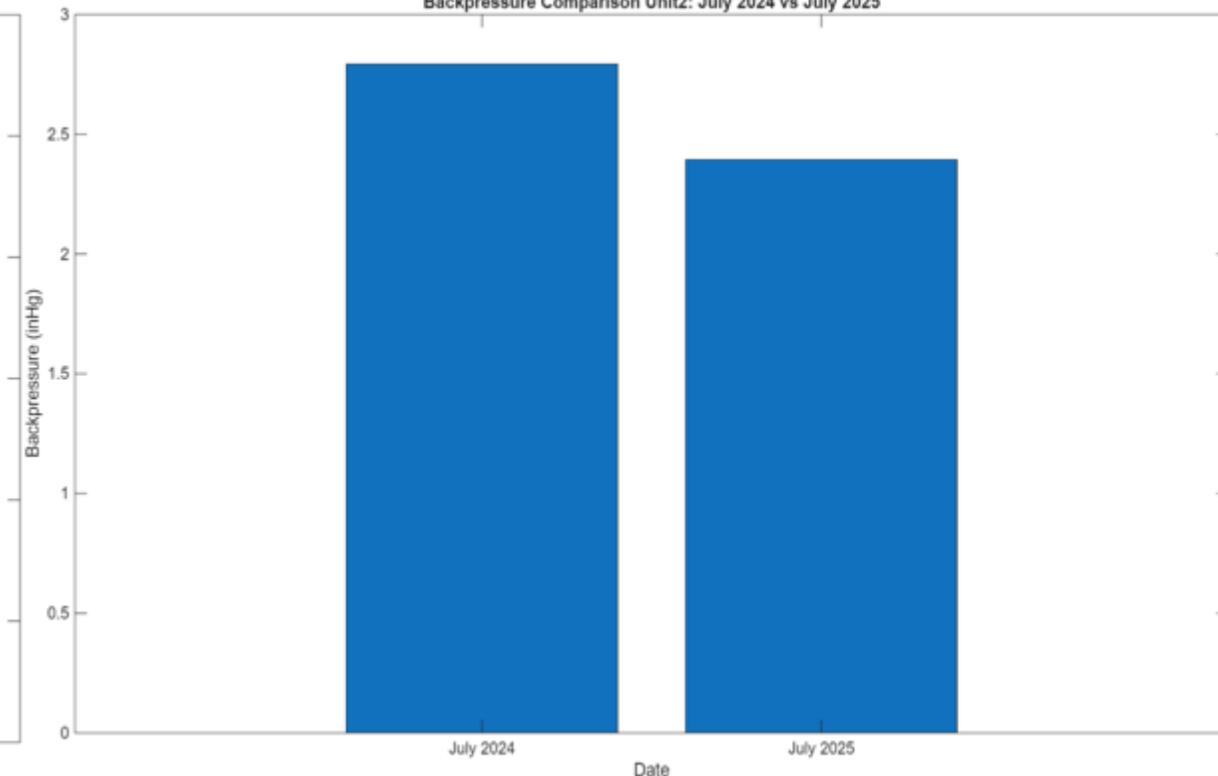


Figure 10. Condenser Backpressure comparison for Unit 2 between July 2024 and July 2025 shows a decrease from approximately 2.75 inHg pre-THERMOPHASE application to about 2.4 inHg post-application. This decrease indicates improved condenser heat transfer performance, suggesting a positive impact of THERMOPHASE.

THERMOPHASE Application at Ocean State Power Plant

Condenser Backpressure Unit 1

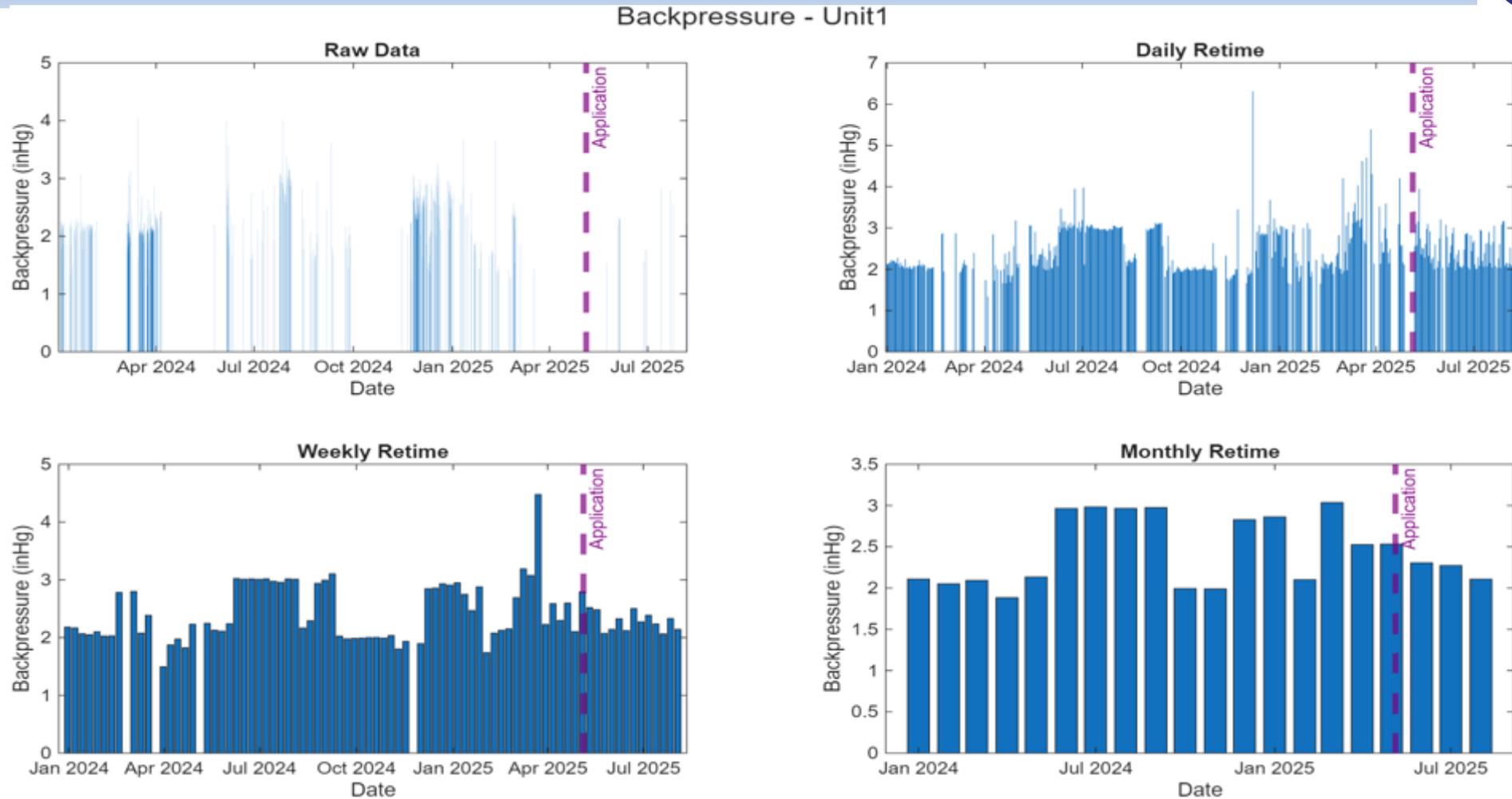


Figure 11. Condenser Backpressure for Unit 1 from January 2024 through August 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views indicate a decrease in Condenser Backpressure after THERMOPHASE application, suggesting improved condenser heat transfer performance.

THERMOPHASE Application at Ocean State Power Plant

Condenser Backpressure Unit 2

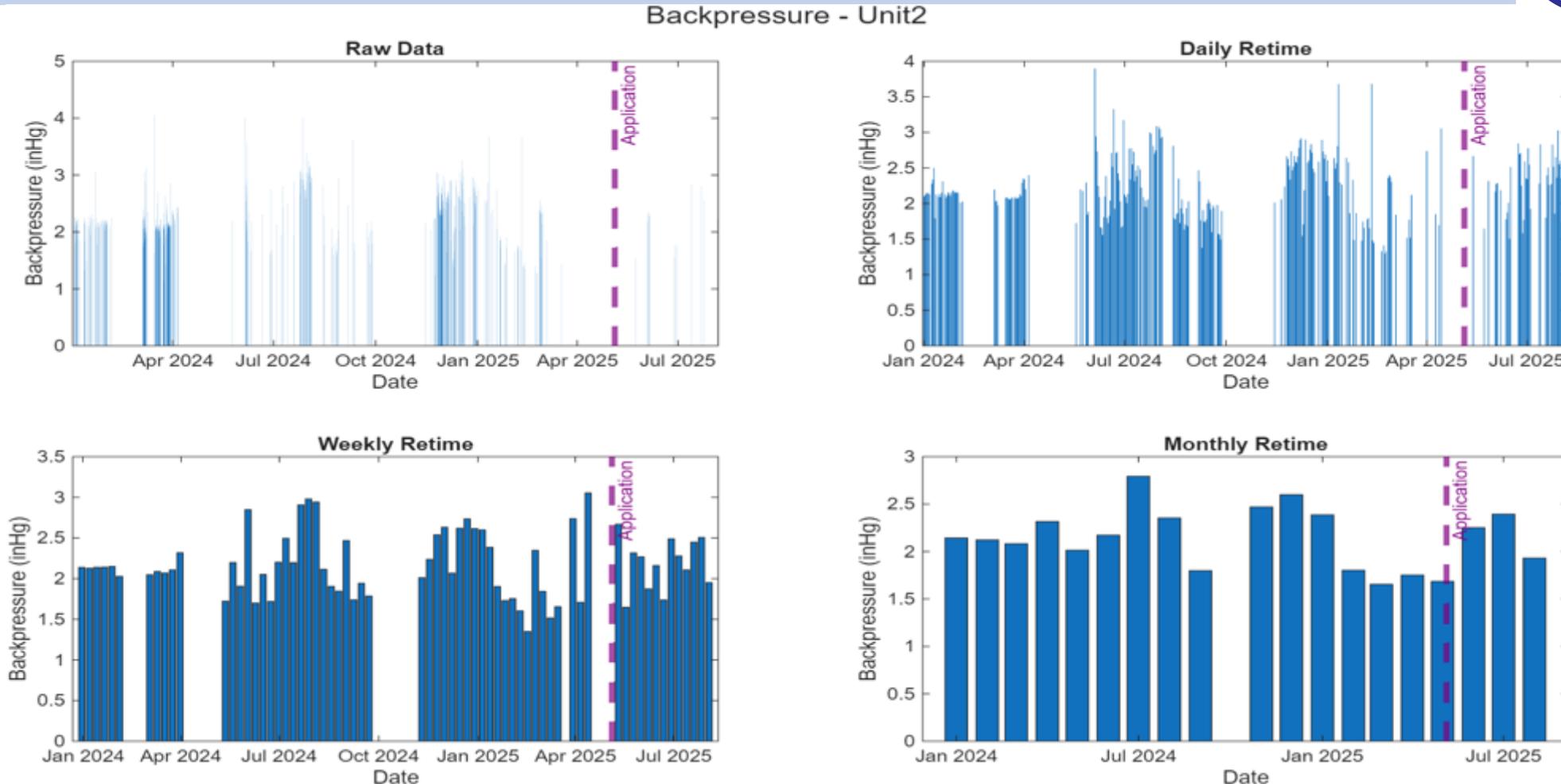


Figure 12. Condenser Backpressure for Unit 2 from January 2024 through August 2025 is shown at multiple retiming intervals: raw, daily, weekly, and monthly. Retimed plots use median values to reduce outlier influence, and all views indicate a decrease in Condenser Backpressure after THERMOPHASE application, suggesting improved condenser heat transfer performance.

ThermopHASE Application at Ocean State Power 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 8.54°F, accompanied by a 23.309% increase in condenser efficiency, a 9.8591°F reduction in LMTD, and a 0.7095 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) | 30.7312 | 22.1180 | -8.6132 | -28.028% |
| TR (°F) | 18.7120 | 17.9853 | -0.72673 | -3.8837% |
| TTD (°F) | 12.0641 | 3.5257 | -8.5385 | -70.776% |
| Condenser Efficiency (%) | 60.5283 | 83.8375 | +23.309 | +38.509% |
| LMTD (°F) | 19.9296 | 10.0705 | -9.8591 | -49.469% |
| Backpressure (inHg) | 2.9829 | 2.2734 | -0.70949 | -23.786% |

ThermopHASE Application at Ocean State Power 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 9.505°F, accompanied by a 25.358% increase in condenser efficiency, a 10.066°F reduction in LMTD, and a 0.39885 inHg drop in backpressure, indicating enhanced heat transfer and overall condenser performance.

| Unit 2 | July 2024 | July 2025 | Difference | Percent Change |
|--------------------------|-----------|-----------|------------|----------------|
| ITD (°F) | 29.2478 | 21.6535 | -7.5943 | -25.965% |
| TR (°F) | 15.2909 | 16.5632 | +1.2723 | +8.3207% |
| TTD (°F) | 14.1082 | 4.6031 | -9.5052 | -67.373% |
| Condenser Efficiency (%) | 52.2348 | 77.5929 | +25.358 | +48.546% |
| LMTD (°F) | 20.7975 | 10.7319 | -10.066 | -48.398% |
| Backpressure (inHg) | 2.7928 | 2.3940 | -0.3988 | -14.28% |

Summary & Thank You

Validation of THERMOPHASE Success Includes:

- 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
- Many Installations
 - Approaching 10,000MW in Power (with expectation to more than double in 2026)
 - Coal, Gas, Nuclear, etc.
 - Industrial Facilities
 - Commercial Facilities

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Scan the QR code to contact us



THANK YOU!