Evaluating the Impact of Wash Methods on Jet Engine Longevity

AT49700 Applied Research Project

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Table of Contents:

Executive Summary

This study presents a comparative evaluation of AeroCore's Nucleated Foam wash technology and traditional water wash methods for turbine engine maintenance. Jet engines naturally accumulate fouling over time, which can degrade fuel efficiency, increase exhaust gas temperatures, and shorten operational lifespan. While water washes have served as the industry standard for decades and continue to provide measurable recovery, the analysis indicates that foam washes consistently offer enhanced performance across a range of operating environments, not only in harsh conditions.

Performance data from over 100 engines revealed that **water washes** deliver a **32% lower recovery in exhaust gas temperature margin (EGTM)** compared to foam washes. Additionally, accumulation of consistent **foam-washed** engines demonstrated **lower fuel burn during takeoff and cruise**, and **significantly longer time on wing (TOW)**, contributing to reduced maintenance frequency and driving the lowest lifecycle cost without component upgrades. These benefits were observed across both high-debris regions and more temperate operating environments, suggesting that foam wash advantages are broadly applicable.

The study also supports the hypothesis that cleaner engines degrade more slowly, as fouling accumulation is mitigated with each wash cycle. While water washes remain a viable option, particularly where foam wash implementation may be limited, the data support further exploration of wash strategies, including no wash, water wash, and foam wash, based on performance outcomes and depot-level cost comparisons.

Introduction

Jet turbine engines are an investment for every buyer, whether that be a private company, a public airline, or a public organization - military or civilian. A similar goal, regardless of who is utilizing the engine, is to keep the engine on the wing for as long as possible before having to replace it entirely. From the beginning of turbine engine use, a main problem area has been the efficiency of the engine deteriorating over time. These engines accumulate fouling, the buildup of contaminants, which lowers the airflow into the engine. Due to the decrease in airflow, negative effects such as an increase in exhaust gas temperatures or reduced fuel efficiency begin to occur.

In attempts to increase the longevity and time-on-wing of a turbine engine, airlines began washing the engines to remove the fouling. Starting with a simple water wash, then progressing into detergent washes, airlines saw mild results. These washes removed some fouling but not as much as was desired. However, AeroCore introduced into the market a Nucleated Foam Wash that gets injected into the compressor stage of the engine to clean out the entire core of the engine more effectively.

In addition to engine washing, increasing longevity and time-on-wing for turbine engines, washing also acts as a form of preventative maintenance. When an engine is washed adequately throughout its lifecycle, it extends the time between major maintenance overhauls, leading to less downtime of the engine (Pratt & Whitney 2024). Less downtime also means the engine is operating for more hours, which in turn makes the engine more profitable.

Not only do turbine engines become more profitable with higher operating times when they are consistently and adequately cleaned, but they also avoid higher long-term maintenance costs overall. High factor costs include part repairs and full engine part replacements. For example, fouling left on engine blades starts to cause corrosion and erosion, which can lead to blade failure (AGARD 1994). Removing the harmful contaminants from the engine and engine blades prevents corrosion from progressing to the point of blade failure.

The goal for this semester is to utilize data shared from an AeroCore Technologies customer to provide an independent analysis on engine wash performance across a fleet of engines. During the review of performance, data analysis will be created to accurately surface charts, graphs, and tables, and explain the conclusions and results yielded.

Problem Statement:

Jet turbine engines accumulate large amounts of buildup, carbon, and debris in their core throughout their lifespan. This debris was cleaned initially using only a water wash; however, a problem exists in that the water wash was not effective enough to remove and flush out a majority of the buildup. Additionally, the water wash failed to clean the entire engine, only partial of the compressor section. When this buildup throughout the core of the engine is not addressed, it leads to more unscheduled engine removals and decreases the longevity of the engine.

AeroCore collects metrics such as EGT, Delta Fuel Flow, and TDS after each foam wash, comparing engine performance with traditional water-based washes. Due to the large volume of data, an independent review has been requested to evaluate wash effectiveness.

Purpose Statement:

The objective of this project is to identify and evaluate the most critical data points and influencing factors associated with pre- and post-engine wash procedures. By leveraging advanced engine data capture systems, the analysis will focus on extracting meaningful insights and establishing reliable metrics to assess performance variations resulting from different wash methodologies, specifically water-wash and foam-wash programs. The findings aim to support engineering teams in understanding comparative performance outcomes and informing sustainment strategies for modern engine systems.

Literature Review:

There are many methods used to maintain the cleanliness of engines, such as water washes, foam washes, and detergent washes. Previously, in the aviation industry, the primary method for cleaning the engine was water washing. The world has mostly done water washing for the last 30 years (GE Aerospace, 2021). After years of research and study, the aviation industry in recent years has moved towards foam and detergent washes, which have been determined to be more beneficial than water washes.

A water wash is simply spraying water into the intake of the engine while motoring the engine. This will rinse the engine of contaminants. A foam wash is a wash designed with the application of detergent foam used to help remove contaminants within the engine, using the foam as both a chemical cleaner and as a structural scrubber due to its unique chemical makeup. Detergent rinses use a material-surface compatible soap sprayed into the inlet to attempt to clean the compressor. All of these wash types are designed to help restore efficiency, extend engine life, increase time on wing, cut operating costs, and clean the engine.

Cleaning Techniques:

While the ingredients of the washes themselves have been evolving, the cleaning techniques of these washes have also been evolving. Off-wing washing and on-wing washing are the two main cleaning techniques. Off-wing requires the disassembly of the turbine engine, which bears a significantly cost and is extremely time-consuming (Casari et al. 2021). Off-wing washing is used with the basic objective being “to clean a dirty compressor and to ‘restore power and efficiency to virtually ‘new & clean’ values.” (Meher-Homji et al. 2013) Off-wing washing uses a soak and rinse method; however, the engine must be apart to adequately clean the components.

On-wing washing, completed while the engine is installed on the aircraft, intends to maintain the cleanliness level of a compressor. On-wing washing extends the engine's operating period between the off-wing washing shutdowns. While off-wing washing is performed with the engine removed and disassembled, on-wing washing is performed while the engine is still installed and uses engine crank procedures to move the cleaning solution through the engine. A primary difference to note between washing techniques is that while demineralized water for rinsing is typically not specified for off-wing washing, since the engine is off, for on-wing washing, it is mandatory to use demineralized water. This is due to the fact that during on-wing washing, the engine is operating, and if sodium or other metal contaminants enter the combustion path it could cause high temperature corrosion damage to the engine and blades.

Positive Effects of Engine Cleaning:

Engine cleaning is one of the most critical procedures in increasing the longevity of an engine and preventing further maintenance issues. Not only does engine washing restore airflow, reduce EGT, and increase fuel efficiency, but it also prevents or delays corrosion on the engine blades. “Corrosion will result in roughening and pitting of blade surfaces, which will again cause a loss of aerodynamic efficiency.” (AGARD 1994) In addition, if corrosion begins on engine blades and is left untreated, it can start the initiation of cracking, which can in turn eventually lead to blade failure.

Aside from positive effects on the engine directly, engine washing can help lower CO2 emissions into the atmosphere. Fouling that is left in the engine will eventually be burned in flight, producing more CO2. Engine washing helps to remove the fouling, meaning it is then not burned and entered into the atmosphere. Additionally, “cleaner engines burn fuel more efficiently” (Pratt & Whitney 2024,) which also leads to lower emissions since engines aren’t burning as much fuel during flight.

Engine Design Importance:

The compressor of a turbine engine is one essential component of the engine. The compressor’s goal is to maximize the air inlet to be properly ignited with fuel in the combustion chamber for power generation at the turbine. “Compressor blades are the heart of gas turbines, playing a crucial role in the overall efficiency and performance of these power generation systems” (Karkhana.io, 2023). The design of the compressor blades dates back to the 1930s. The profile is specifically designed to create a high-pressure region on one side of the blade and a low-pressure region on the other. The blades are carefully designed using numerous methods, each to prevent a different issue within the compressor and the engine itself. The stall prediction method, a ratio efficiency potential prediction method, a vector diagram design, and a detailed blade design are all steps or procedures used to make the most efficient compressor and compressor blades. With so much research focusing solely on the compressor and its blades, it is no argument that it plays a significant role in the engine.

Not only is the compressor one of the first stages in turbine operation, but it is also the entry point for the process of an engine foam wash. The remainder of the core is cleaned with the nucleated foam as it follows the engine's designed internal gas path to enhance the combustion chamber, injectors, and the turbine section cooling holes.

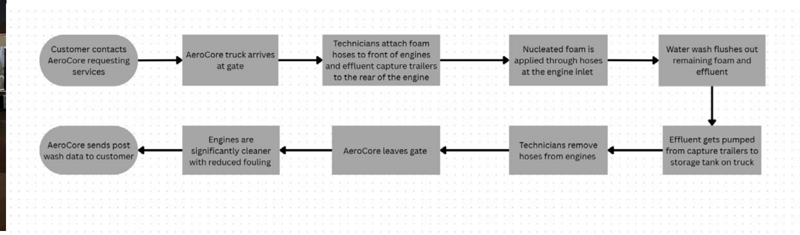
Concept Evaluation:

The current proposed analysis software that may be used to visualize and compare data is Excel and SPSS. Graphs and charts will be created to compare data and draw conclusions. Some of the metrics that will be taken into consideration are engine recovery, engine life, and fuel flow.

Process Map:

Figure 1. *Equipment*

Figure 2. *AeroCore and Customer Process Map*



A high-level process, shown in Figure 2, begins with the customer reaching out to AeroCore to contract and schedule engine cleaning. For on-wing cleaning, the AeroCore truck is scheduled to arrive at the customer's designated arrival gate. Technicians attach foam hoses to the front of the engines and effluent capture trailers to the rear of the engines. Nucleated foam is applied through the hoses at the engine inlet and ingested through the core of the engine, following the engine's designed internal gas path. A water wash is then applied and flushes out the remaining foam and effluent in a similar manner. The flushed out effluent gets pumped from the capture trailers into a storage tank on AeroCore's truck to be used for measuring the contaminant levels. Technicians then remove the hoses from the engines, and the truck departs from the gate. AeroCore sends post-wash field engine performance data back to the customer for review.

Data Analysis:

The AeroCore provided dataset was extensive. Once configured, engine performance data points were identified as primary performance targets for the project:

- Exhaust Gas Temperature Margin (EGTM) - Difference between projected hot day exhaust gas temperature and engine red line limit temperature
- GWFM Smoothed (Delta Fuel Flow for Cruise) - percentage fuel flow differential from baseline for cruise point
- GWFR Smoothed (Delta Fuel Flow for Takeoff) - percentage fuel flow differential from baseline for takeoff point
- TOW - Time on wing
- FF - Fuel Flow
- LLP - Limited Life Parts
- TDS - Total Dissolved Solids

Objective:

A comparison of wash methods: water wash data to AeroCore's innovative foam wash method was the primary basis of evaluation for this report. Three key research questions were expressed by the customer, framed as hypotheses:

Hypothesis 1:

Engines that are only washed with water trend towards higher takeoff and cruise fuel burn than engines that only receive foam washes

Hypothesis 2:

Engines only washed with water have lower EGTM recovery from the wash than engines washed with foam.

Hypothesis 3:

Engines only washed with water will have shorter Time On Wing (TOW) than engines receiving only a foam wash.

In the following sections, the reader will walk through the supporting analysis for the above hypotheses.

Data Set:

The data consists of flight data for 311 unique serial number engines. A quality of data assessment was performed to eliminate engines that do not meet these requirements:

- if data has gaps in time or missing parameters for EGTM, FF, N-speeds.
- if data does not have wash dates
- if data does not have cruise fuel flow (only available on some engines)

This reduced the available data to 102 engines for the analysis.

Hypothesis 1

Hypothesis 1: Engines that are only washed with water trend towards higher takeoff and cruise fuel burn than engines that only receive foam washes.

A selection of engines was determined from the dataset, looking for particular serial numbers that had only received either water washes or foam washes from the onset of the foam wash program that Aerocore had provided to the customer.

The following figures represent engines receiving a specific type of wash and a running average of the provided parameter, Fuel Flow, in two types of settings, at cruise and takeoff.

- Cruise Fuel Flow - Cruise is essential because it represents a stable parameter under similar conditions and a larger operational time. (see Figures 3, 4, and 5)
- Takeoff Fuel Flow - this fuel flow parameter represents the maximum demand, and the small changes created by the effects of foam vs water wash are magnified (see Figures 6, 7, and 8)

Figure 3. *Foam Wash Only, Engine Cruise Fuel Flow w/ Wash Dates*

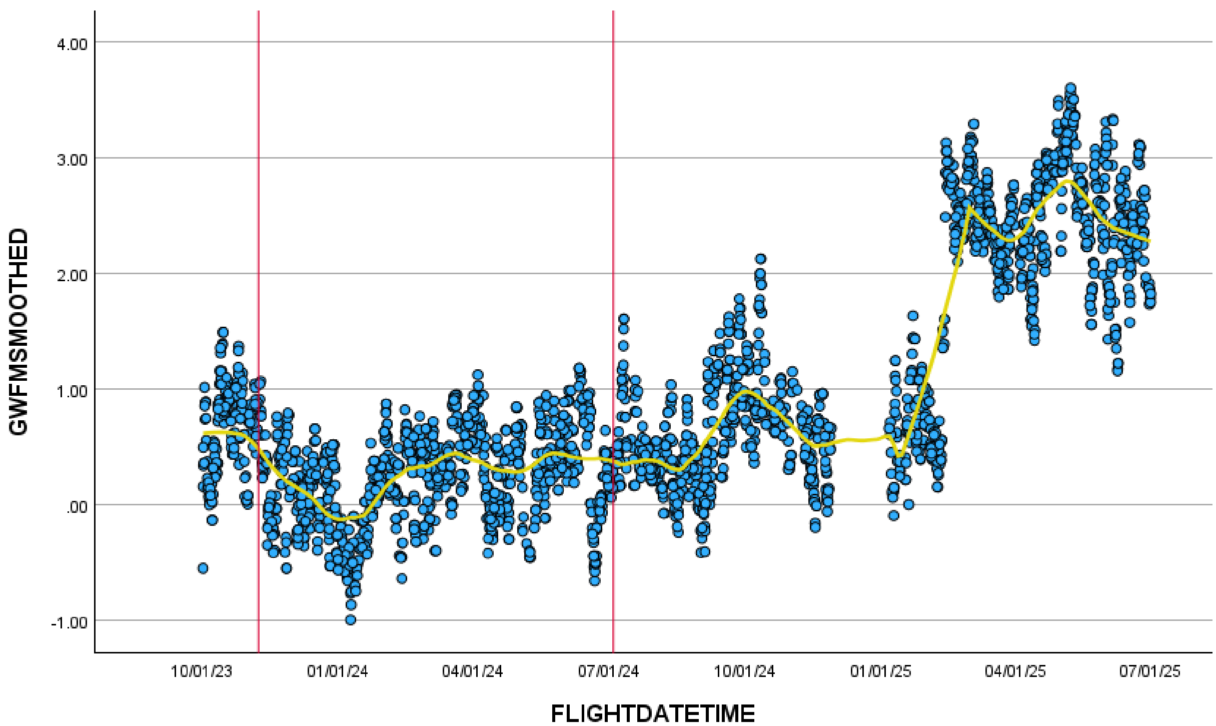
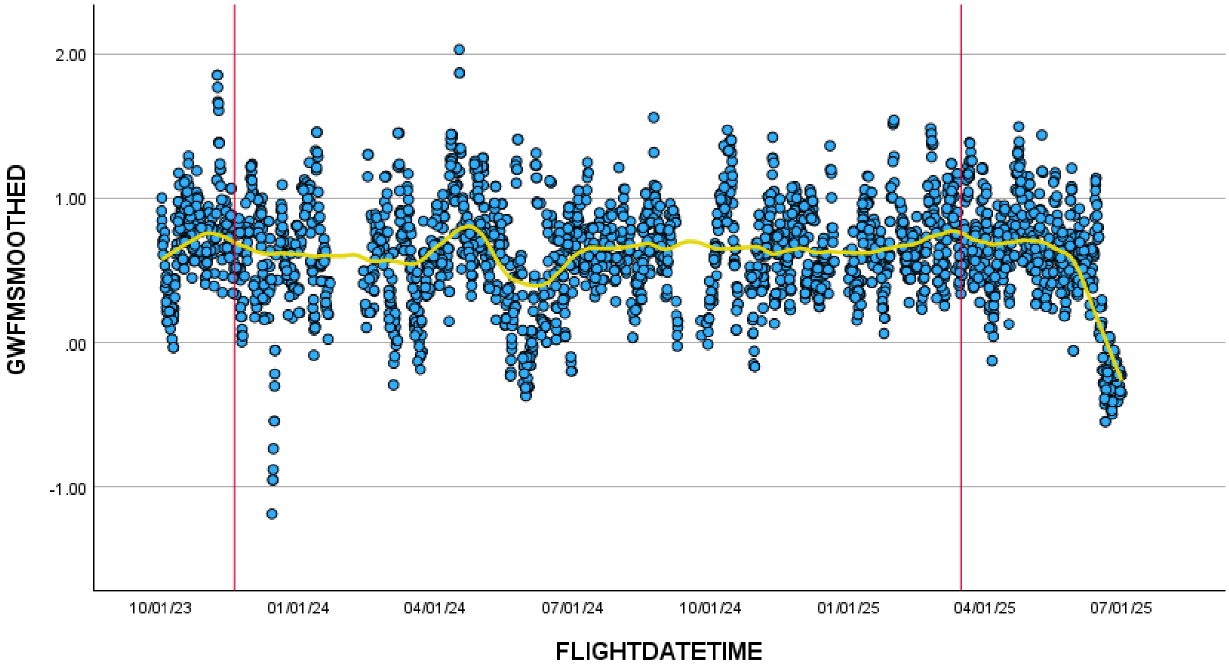


Figure 3 represents a single-engine scatter of data points from October 2023 through May 2025. Foam washes are defined by the red line and were performed in November 2023 and July 2024. Each wash date results in a sharp and immediate drop in fuel flow. The post-wash periods show lower and more stable fuel flow, indicating effective restoration of engine efficiency. The smoothed trend line (yellow) reflects a cyclical pattern of degradation and recovery.

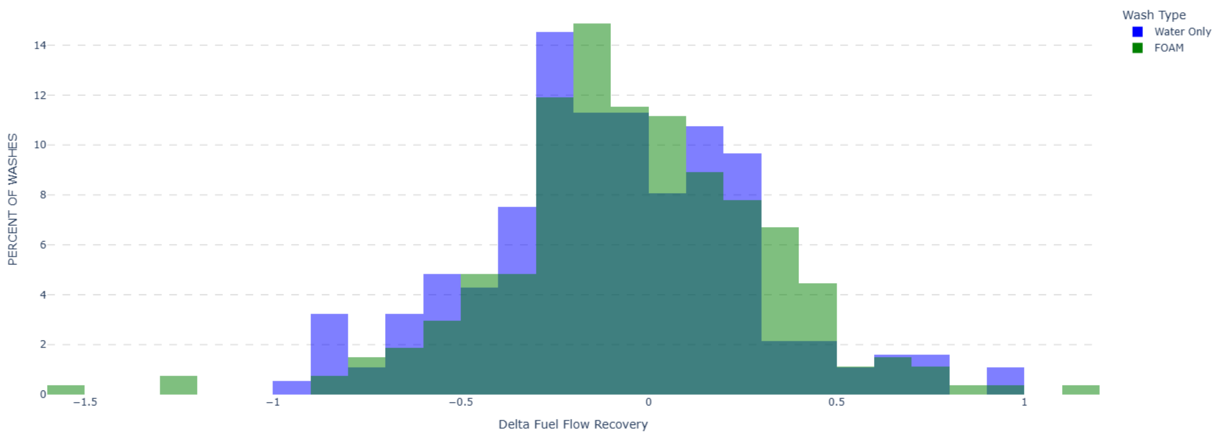
Figure 4. *Water Wash Only Engine Cruise Fuel Flow w/ Wash Dates*



In contrast, Figure 4 represents a different engine that received only water washes during this same interval as Figure 3. The washes demonstrate little change in the before and after averages for the individual washes when the rolling average is applied. The fuel flow reduction after each wash is less pronounced compared to the foam wash. Post-wash periods show modest stabilization, but the overall trend is less dramatic compared to foam wash.

This process was repeated for all engines in the dataset that contained both EGTM and fuel flow information to gather an overall distribution of fuel flow gains from each wash event. That distribution is represented in Figure 5.

Figure 5. *Distribution of Fuel Flow Recoveries in Cruise*



Average Cruise Delta Fuel Flow Recovery Foam: -.043

Average Cruise Delta Fuel Flow Recovery Water: -.097

When comparing all of the washes, the difference in fuel flow recoveries between water washes and foam washes at cruise is negligible when compared at scale. When projecting the distributions out, it would appear as though the same returns were garnered from foam and water wash when comparing cruise fuel flow. Negative numbers in this case represent a decrease in the delta fuel flow for the washes, which is a positive effect.

However, to better assess fuel consumption, takeoff fuel flow was assessed to identify wash effects during peak fuel demand. Figure 6 demonstrates a particular serial number and the response of the engine's takeoff fuel flow to the foam wash. As seen below, there is an increase in takeoff fuel flow from the first wash, but the second wash yields a decrease in takeoff fuel flow for this particular serial number. Foam washes cause a brief spike in the takeoff fuel flow, and then a period of increasing performance that lasts between 2-4 months.

Figure 7 exhibits an engine only receiving water washes over the same date range. This engine also demonstrates an increase in takeoff fuel flow from the first wash, followed by an additional increase in the second wash, with the overall trend having a slight increase over time. Water washes help to keep takeoff fuel consumption stable, but do not increase performance notably.

In the charts that depict take-off fuel flow and cruise fuel flow, there is a gradual decline in the fuel flow consumption of the engine compared to the manufacturer's baseline. This indicates improvement in fuel flow over time when associated with consistent washing.

When taking a closer look at the foam wash data, a pattern can be established from the foam wash events. At the specific wash events for the particular engine serial number demonstrated below, it can be seen that there is an initial recovery or spike, then it will continue to decline. What is essential to notice is the difference in recovery. It is important to note that washing with water does have that same initial spike nearly right after the wash event, but it does not bring it up to the same level of recovery.

Figure 6. *Foam Wash Only Engine Takeoff Fuel Flow w/ Wash Dates Overlay*

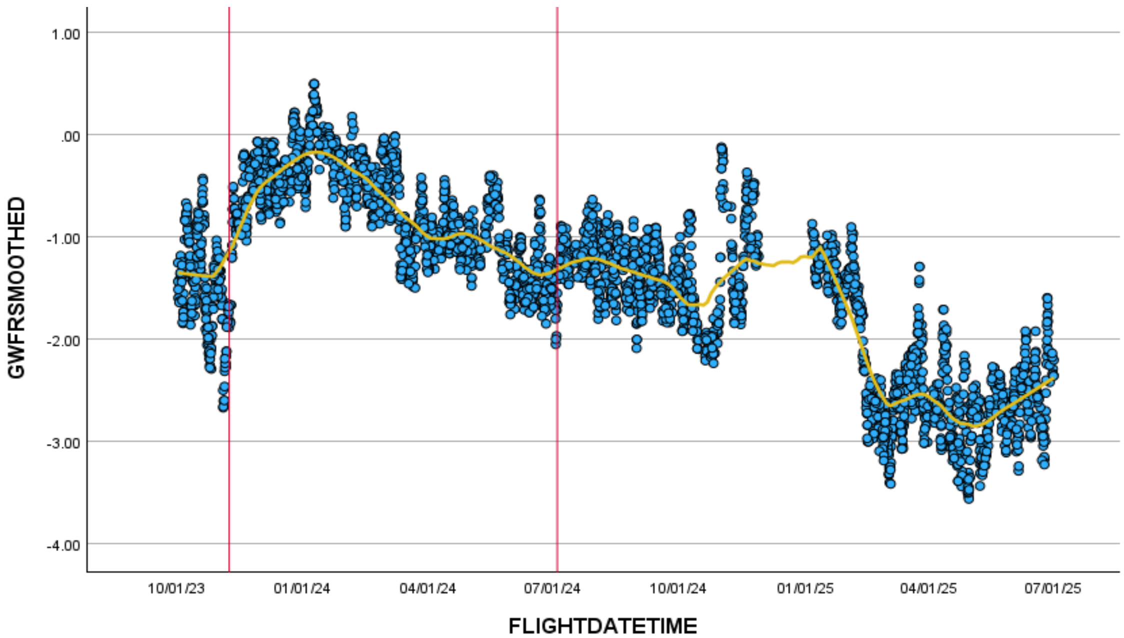
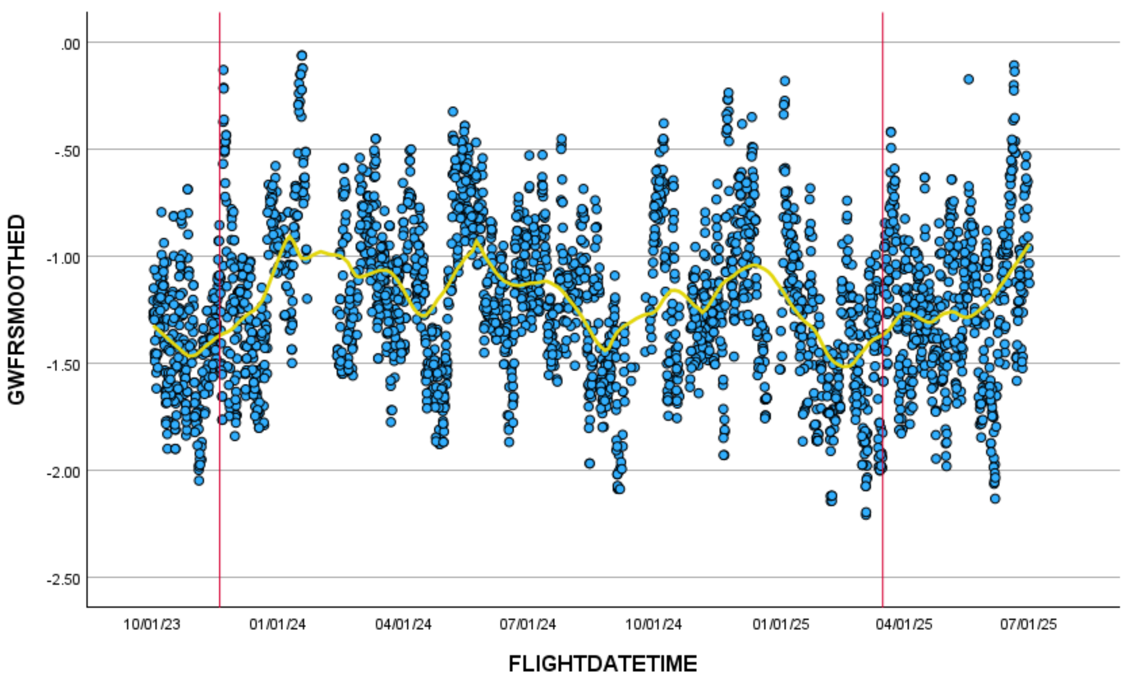
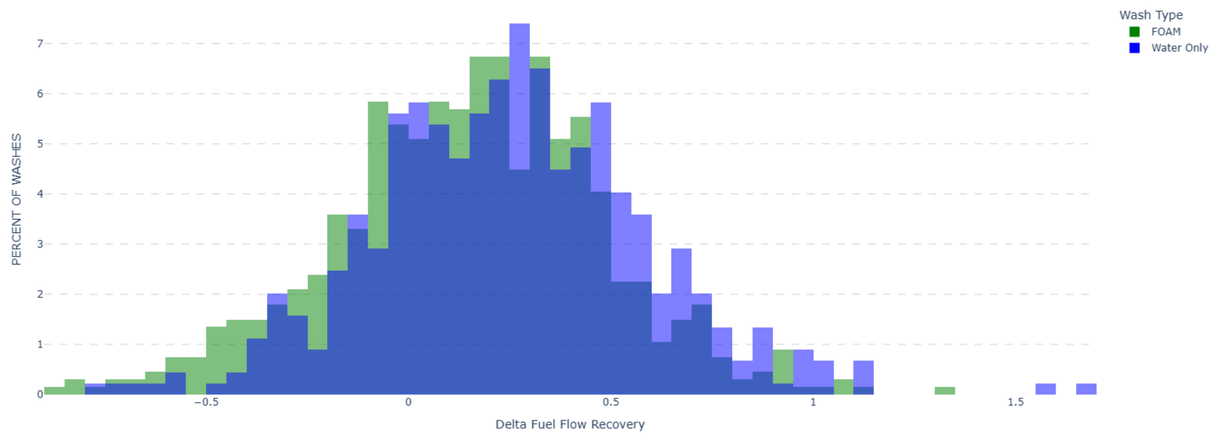


Figure 7. *Water Wash Only Engine Takeoff Fuel Flow w/ Wash Dates Overlay*



When applying the same analysis to all aircraft with the EGTM and fuel flow data available, the following distributions of fuel flow recoveries are determined in Figure 8.

Figure 8. *Distribution of Takeoff Delta Fuel Flow Recoveries for Water and Foam Wash*



Average Takeoff Delta Fuel Flow Recovery Foam: .121

Average Takeoff Delta Fuel Flow Recovery Water: .271

While both foam washes and water washes present an overall increase in delta fuel flow from the washes, foam washes present significantly less increase than water washes by more than 50%. Based on the theoretical normal distribution, foam washes also show a much higher percentage of washes where the takeoff delta fuel flow has decreased as a result of the wash.

Hypothesis 1 Conclusion

The proposed hypothesis that *engines that are only washed with water tend to have higher takeoff and cruise fuel burn than engines that only receive foam washes* **is shown to be true** based on the data presented. The overall distribution shows a better recovery of delta fuel flow from foam washes than water washes at takeoff, while showing negligible differences in recoveries at cruise. The detriment of the higher increase in delta fuel flow from water washes is magnified in this high fuel demand phase of flight. This proves that engines that are only washed with water tend towards higher takeoff and cruise fuel burn than engines that only receive foam washes (or a mix of foam/water).

Hypothesis 2:

Engines only washed with water have lower EGTM recovery from the wash than engines washed with foam.

A similar analysis was completed for these engines as was completed for fuel flow, but instead of evaluating the exhaust gas temperature margin. The EGTM is calculated on the aircraft or in the OEM dashboard by taking the takeoff engine specifications for temperature, extrapolating that to a hot day temperature, and then comparing that extrapolated value to the engine red line. The difference between the extrapolated EGT and the red line is the EGT margin.

Figure 9. *Foam Wash Only Engine EGT Margin w/ Wash Dates Overlay*

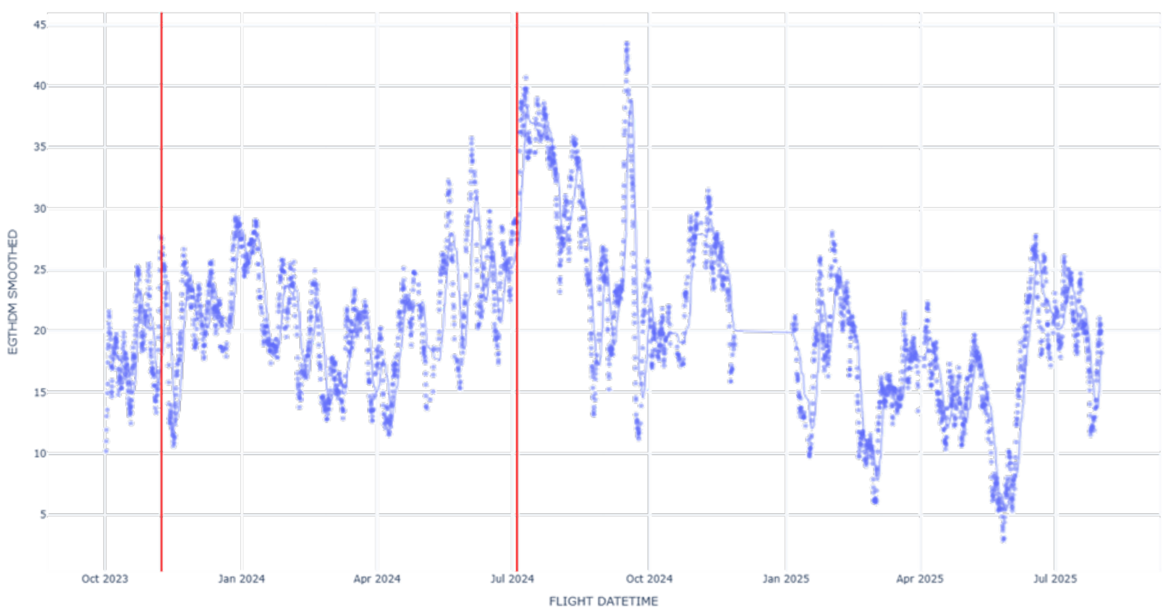
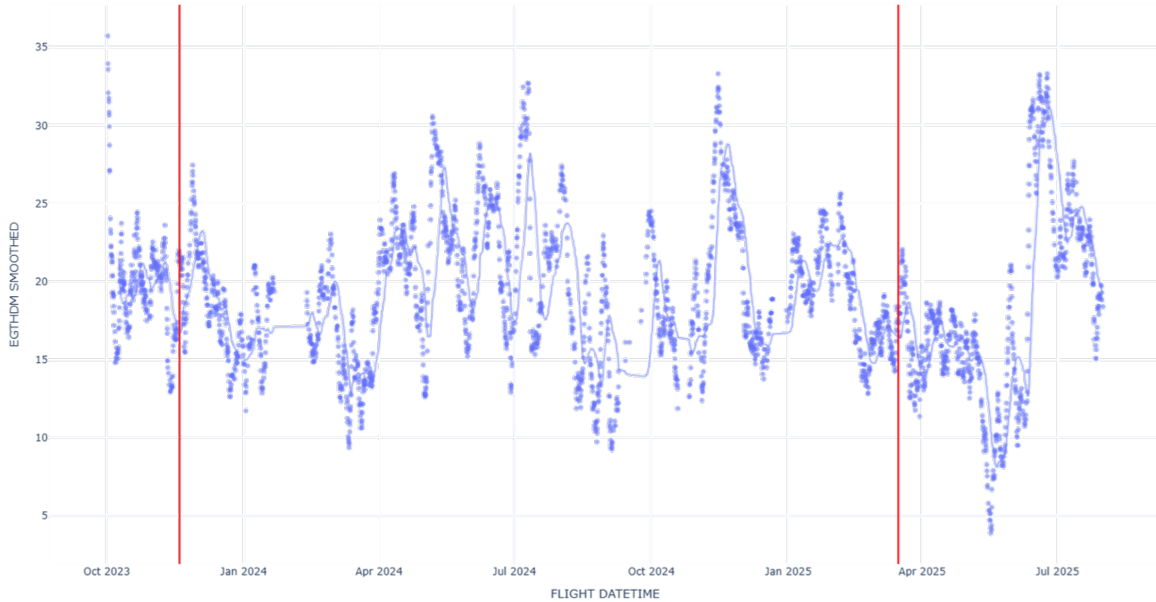
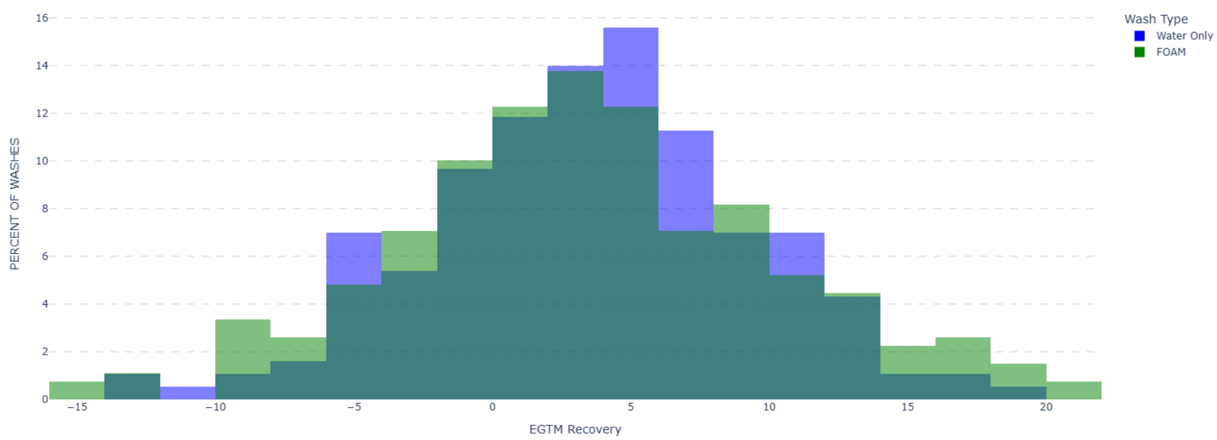


Figure 10. *Water Wash Only Single Engine EGT Margin w/ Wash Dates Overlay*



The analysis then looked at the average EGTM before and after each wash for all engines used in hypothesis 1. The distribution of EGTM recovery from each wash is then shown in Figure 11.

Figure 11. *EGTM Recovery from Foam and Water Washes*



Average EGTM Recovery Foam: 3.57 °C

Average EGTM Recovery Water: 2.7 °C

By comparing the previous data points to the data points after the wash, it is shown that foam washes recover 3.57℃ on average, while water washes only recover 2.7℃ EGTM. This indicates that water washes are 32% less effective on EGTM recovery than foam washes.

Hypothesis 2 Conclusion

From the data shown in Figure 11, it is clear that *engines washed only with water have lower EGTM recovery than engines washed with foam.* The EGTM recovery of these engines that have been foam washed is higher than that of engines that have only been water washed. While they both provide recovery of the EGTM , over time, the recovery of an engine under a foam wash routine program will be greater and hold longer than a water-washed engine. Water washes only recovered 2.7℃ EGTM, while foam washes recovered 3.57℃ EGTM. The data reveals that **water washes are 32% less effective on EGTM recovery than foam washes** on the engines within this data set.

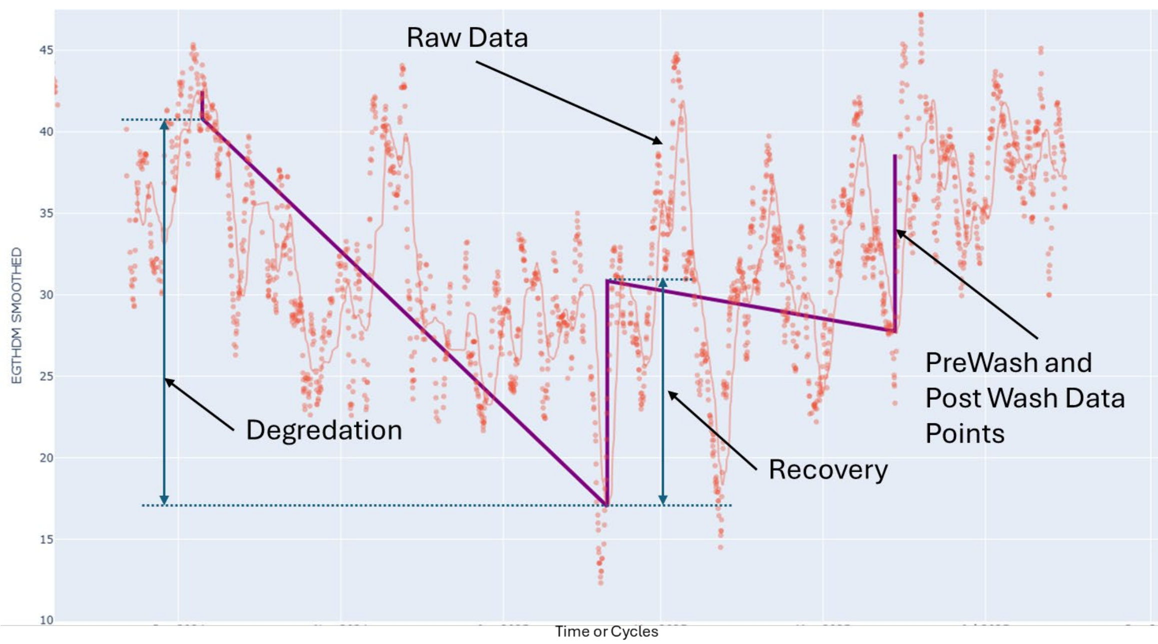
Hypothesis 3

Engines only washed with water will have shorter TOW than engines receiving only a foam wash.

In the evaluation of Hypothesis 1 and Hypothesis 2, water washes and foam washes were compared absolutely, without regard for different levels of fouling in each engine. Engine recoveries in both EGTM and Delta Fuel Flow could be subject to the amount of fouling or deterioration that is in the engines themselves. A dirtier engine could allow for a higher recovery than an already clean engine.

To compare the degradation and recovery, it is essential to gauge the impact of the fouling against the expected hardware degradation of the engine. For instance, an unwashed or engine without a routine wash program may show a higher level of recovery than an engine washed at regular or optimized intervals. Thus, inadvertently, the journey of each engine will bias the performance gain. For this reason, the approach of using both degradation and recovery to assess the different wash types is used herein.

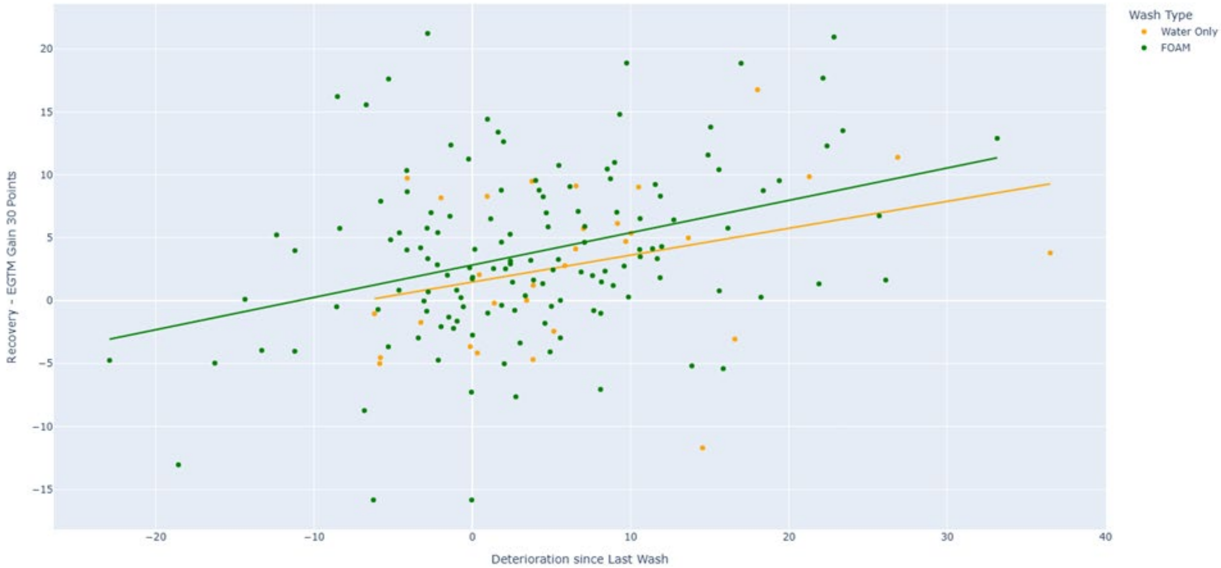
Figure 12. *Demonstration of Degradation/Fouling vs Recovery Example*



The figure above shows the raw data from a particular engine, where each point is a takeoff EGTM. The degradation is measured as the difference between the previous wash post-wash EGTM value and the current wash pre-wash EGTM value. The recovery is then calculated as described for Hypotheses 1 and 2 and plotted against the degradation. The purple line represents the change of the pre- and post-wash EGTM averages together to present a summary of the degradation and recovery for each engine. Each purple vertical line represents the engine wash, whether it be foam or water.

Applying this evaluation for each engine wash by serial number, the plotted recovery will result in the deterioration and is shown in Figure 13.

Figure 13. *Degradation vs Recovery of Engine Washes by Wash Type)*



The linear fit represents the projected EGTM recovery for each wash, considering the deterioration of EGTM since the previous wash. The equations for those fits are as follows:

$$(1)\ EGTM\ Recovery_{FOAM}\ (℃) = 0.257 * Deterioration + 2.82$$

$$(2)\ EGTM\ Recovery_{WATER}\ (℃) = 0.21 * Deterioration + 1.48$$

Using these equations across the life of an engine, a projection of the respective time on wing can be generated.

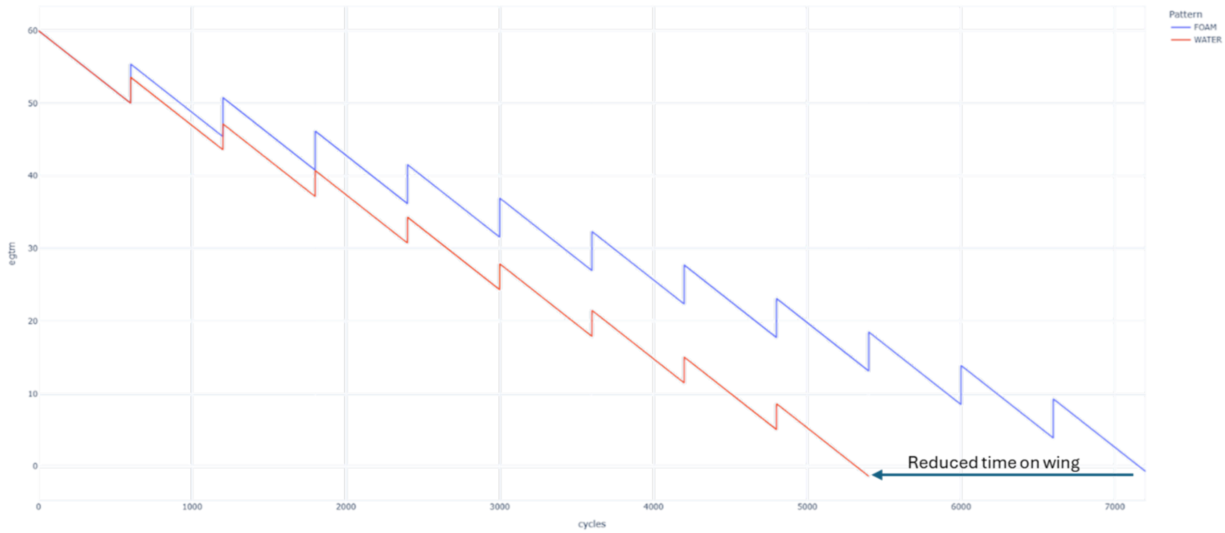
For this projection, the following assumptions are applied:

- Engine starts at 60 ℃ EGTM at zero cycles
- Engine washes happen every 600 cycles
- Engine deterioration is 10 ℃ between each wash cycle

Using those assumptions and tracking out until the EGTM reaches zero, it is shown in Figure 14 that the water-washed engine reaches zero well before the foam-washed engine does. Therefore, the water-washed engine has a shorter time on wing than the foam-washed engine.

The quantity of this TOW increase will change with many factors, including the starting conditions, engine hours, routes and other environmental factors. It is, however, clearly demonstrated that a water-washed engine will have less TOW than a foam-washed engine when it comes to exhaust gas temperature margin.

Figure 14. *Projection of Time on Wing for Engines with Foam or Water Wash (from degradation vs recovery metrics)*



Hypothesis 3 Conclusion

Considering the extracted data from Figure 13 projected into the Time on Wing prediction results illustrated in Figure 14, engines maintained exclusively with water washes reach end-of-life at approximately 5,400 cycles, whereas foam-washed engines extend to 7,300 cycles. A difference of 1,900 cycles. This substantial gap underscores the long-term impact of wash method selection. The enhanced EGTM recovery from **foam washes initiates a compounding effect that slows degradation and extends operational life**. Over time, consistent foam washing significantly improves time on wing, reduces unscheduled removals, and lowers lifecycle maintenance costs. This truth is relevant to all engines and would be variable based on the age of the engine and robustness of the wash program optimized interval. Therefore, *Engines only washed with water will have shorter TOW than engines receiving only a foam wash* **is true.**

Summary & Conclusion:

The goal of this project was to assess and attempt to quantify AeroCore's foam wash performance data compared to other engine wash methods.

Turbine engines ingest particles and debris, whether it be sand, ash, salt, or other solid particles, during every flight, varying by the region of the world where they operate. These particles lead to erosion, surface roughness of the blade, change in airflow, blocked cooling holes, reduced the capacity of nozzle vanes, etc. The effect these particles can have on the compressor is drastic. Suppose the debris is left sitting on the compressor blades for extended periods. In that case, it will eventually lead to blade erosion, reducing the lifespan of the compressor blades and potentially the compressor. If the particles simply stick to the compressor blades, they negatively modify the airfoil shape and reduce its effectiveness. Meaning, less air is being correctly compressed and directed into the engine, which increases the risk of a stall. "The application of a coated layer of a thickness of 0.025 mm on suction and pressure sides leads to a decrease of 9% of the pressure ratio and 6% of efficiency" (Casari et al. 2021).

Engine fouling is not an unsolvable issue. Engine cleaning is the main way to reduce fouling buildup effectively; however, depending on the cleaning method, compounding effects have better or worse outcomes for time on wing.

Review of past literature alongside current engine wash data received from end customers - AeroCore continues to demonstrate engine cleaning as a key aspect of overall preventative maintenance. Removing the fouling that can lead to erosion or engine part failure reduces the risk of higher depot maintenance costs and engine limit exceedances before engineered times are reached, thus increasing the time on wing/service life of the engine.

Time on-wing directly correlates to maintaining each part within the engine for its estimated lifespan. These parts are called limited lifetime parts (LLP's). These components have an expected lifespan operating within the engine. However, not maintaining the individual LLP's results in a greater frequency of pulling the engine off the wing to perform repairs and replacements, thus reducing the engine's time on wing. Reduced time on the wing means higher maintenance, repair, and replacement costs for the owner/operator. Review of past and current research data shows that the most successful method of maintaining LLPs in the engine is by engine cleaning, reducing unscheduled removals and maintenance costs.

In conclusion, clear evidence was observed that failure to adopt AeroCore's nucleated foam wash system leads to significant operational drawbacks for turbine engine operators. Engines maintained solely with traditional water washes exhibit higher fuel consumption during critical flight phases, reduced recovery in exhaust gas temperature margins, and shorter time on wing—all of which contribute to increased maintenance frequency and elevated operating costs. Over time, these inefficiencies compound, resulting in more frequent unscheduled removals, accelerated wear of limited-life parts, and diminished fleet reliability. By neglecting the advantages of foam wash technology, operators risk undermining engine performance, profitability, and long-term sustainability.

Appendix A:

Design Standards Review:

Table 1

National and International Design Standards Review

Standard	Annotation
Code of Federal Regulations (CFR) Title 14 Chapter 1 Subchapter F Part 91 Subpart E	Describes Federal Regulations for maintenance and preventive maintenance on aircraft.
Code of Federal Regulations (CFR) Title 14 Chapter 1 Subchapter C Part 33	Describes Federal airworthiness standards for aircraft engines.
Advisory Circular 120-17B	Guides creating and maintaining reliability programs as part of a Continuous Airworthiness Maintenance Program
IATA - Aircraft Operational Availability 2nd Edition - 2022	International guidelines for the measurement of Aircraft Availabilities

Table 2

Customer Requirements (VOC)	Project Primary Sponsor	Students or other end user	Technical/Design Requirements
Engineering assessment/quantification of Nucleated Foam versus alternate technologies (data review)	AeroCore		Data analysis software (Excel, SPSS)
Long-term benefits of Nucleated Foam Wash	AeroCore		Data analysis software (Excel, SPSS)
Analysis of all Nucleated Foam Wash, considering the current engine margin and engine age	AeroCore		Data analysis software (Excel, SPSS)
Does this Analysis apply to other engine types?	AeroCore		Data analysis software (Excel, SPSS)

Quality Functional Deployment

References:

14 CFR Part 33 -- Airworthiness Standards: Aircraft Engines. (n.d.). https://www.ecfr.gov/current/title-14/part-33

14 CFR Part 91 subpart E -- Maintenance, preventive maintenance, and alterations. (n.d.). https://www.ecfr.gov/current/title-14/chapter-I/subchapter-F/part-91/subpart-E

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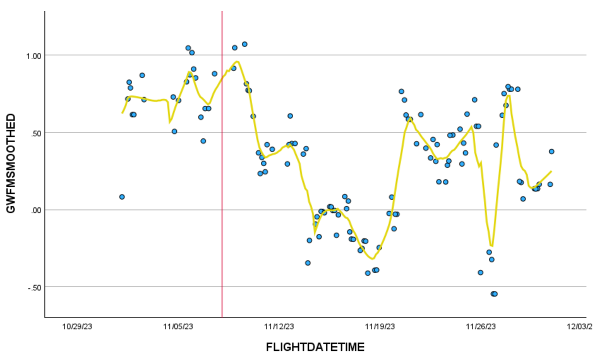
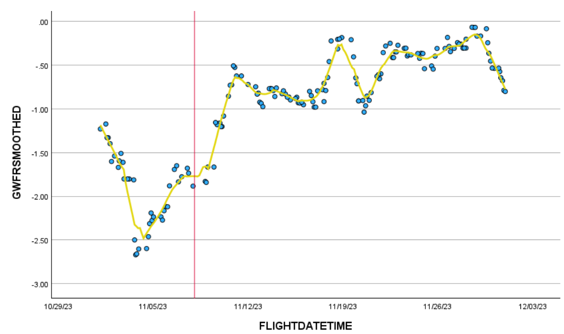
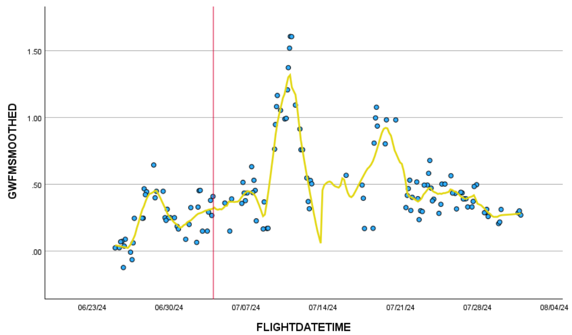
Additional Charts for Reference



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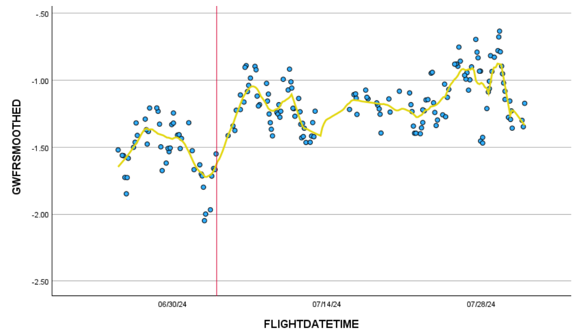
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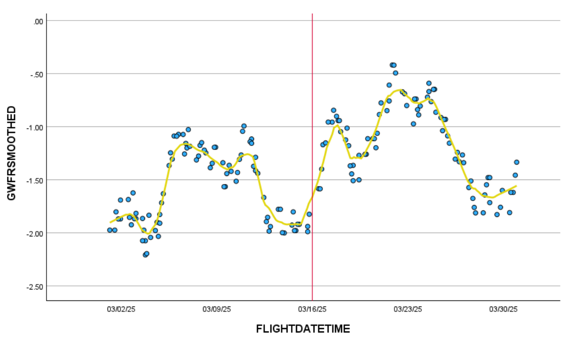
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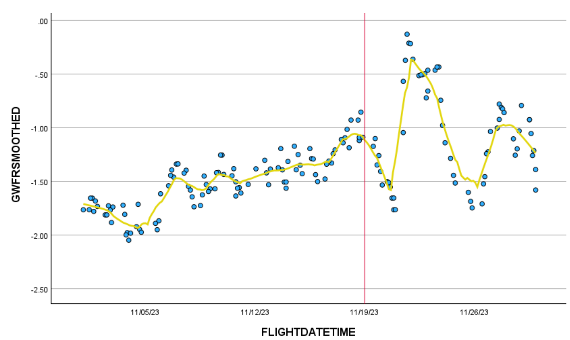
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