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EUCOMs POL Capability & Capacity Gaps Single Fuel Concept Follow On

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EUCOM'S POL CAPABILITY & CAPACITY GAPS – SINGLE FUEL CONCEPT FOLLOW ON

EXECUTIVE SUMMARY

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Project Summary

This study analyzed refueling support during Phase II operations in the European theater by comparing the use of JP-5 (a kerosene-based fuel used in naval aircraft) as a single fuel against the current practice of using F-76 (a diesel-like fuel oil) for naval vessels and reserving JP-5 for aircraft. Prior studies focused on the logistical benefit provided by the Single Fuel Concept in the Pacific and on the capability gaps surrounding petroleum, oil, and lubricant (POL) distribution. We evaluated the potential costs and benefits of adopting a single fuel (JP-5) and which policy changes might be necessary to close those gaps. We modified the NPS-developed Fuel Usage Study Extended Demonstration (FUSED) model to compare the two fueling paradigms in a variety of scenarios combining pre-assault, assault, flight operations, and sustain activities during transit between Souda Bay, Greece, and Loch Striven, Scotland. We find that the single fuel concept is the most efficient alternative, enabling greater fuel efficiency, which translates into less time spent refueling, fewer refueling operations, and less fuel consumed.

Keywords: *single fuel concept; United States European Command; USEUCOM; United States Naval Forces Europe; NAVEUR; petroleum, oil, and lubricant; POL; POL supply chains; JP-5; F-76*

Background

In 1986, the United States and its NATO allies adopted a single fuel policy for all land-based operations, selecting the JP-8 as its single fuel for all aircraft. That decision was not extended to maritime operations because of the low flashpoint (100°F) of the JP-8, making it an onboard fire hazard. Just like the JP-8 was standardized as the fuel of choice for all land-based operations, the JP-5 has long been considered the single fuel alternative for maritime operations. The US Navy uses JP-5 as the fuel of choice for all its aircraft because it has a high flashpoint (low propensity for spontaneous ignition) with low risk of shipboard fire. On the other hand, the US Navy uses F-76 in all shipboard propulsion and electric-generation conventional systems. The specifications of jet fuels, such as JP-5 and JP-8, are quite strict to match the engineering requirements of jet turbines. Shipboard propulsion, however, may use most varieties of kerosene or diesel oil. That makes JP-5 the natural choice to become the single fuel concept in naval operations.

The proposal to adopt JP-5 as a single fuel has raised a number of objections: (a) JP-5 contains less energy than the same volume of F-76 (a difference smaller than 3%); (b) JP-5 is usually more expensive than F-76; (c) JP-5 has lower lubricity than F-76, which may affect power plant durability; and (d) JP-5 is available in fewer ports than F-76. This study addresses the first concern, energy density. The second concern, price differential, has lost much of its relevance, considering that the prices of the two fuels have approached parity, but it deserves further study. The third concern, lubricity, has been the subject of several studies by the US Navy (e.g., Giannini et al., 2002; Guimond, 2007), and these studies indicate that JP-5 has no negative impact on naval power plants. The final concern, JP-5 availability, deserves further investigation.

In a limited inventory pooling study, Jimenez et al. (2020) found logistical benefits in the single fuel concept. In our study, we simulated realistic operational scenarios in the European theater to confirm the logistical benefits and to assess the impact of the lower energy efficiency. Our design of experiments considered three variables: battlegroup configurations, JP-5 energy efficiency, and operation duration.

- There were three battlegroup scenarios with two carrier strike groups (CSG), two amphibious ready groups (ARG), and one CSG plus 1 ARG.

- There were four levels of JP-5 energy efficiency varying from 97% to 100% of the content in F-76.
- There were nine sets of exercises, alternating seven, ten, or thirteen days of performing pre-assault, assault, flight operations, and sustain activities.

Considering the fuel consumption levels of the battlegroups in each type of exercise, FUSED was able to estimate when and where each CSG and ARG would need to replenish during their multi-day transit. The simulation with dual fuel operation was repeated four times using JP-5 as a single fuel, once for each energy content assumption. The analysis substantiated JP-5's logistical superiority.

Findings and Conclusions

Our simulations confirmed prior analysis indicating that JP-5 would provide substantial logistical benefits to operations on naval vessels. During a dual fuel operation, it is possible that the battlegroup uses up one type of fuel more than the other; the battlegroup might need to resupply F-76 while there is still JP-5 in the tanks or vice-versa. With the single fuel concept, all tanks have JP-5, and they are used uniformly for flight operations, for shipboard propulsion, or for power generation. Therefore, there is no need to replenish until all tanks have been depleted to the refueling level. This outcome confirms the results in Jimenez et al. (2020) using more complex scenarios.

Specifically, our study verified that the impact of JP-5's lower energy level was trivial. In almost all scenarios, single fuel operation required fewer replenishment at sea (RAS) events, and the combat logistics force (CLF) ships supporting the battlegroups required fewer trips to port to replenish their tanks. In some scenarios with low energy efficiency, single fuel operation required more RAS events than with equal energy content, but the additional RAS did not occur every time. Even with low energy content, it was possible to consume less fuel with the single fuel operation because the CLF ships would require fewer trips to replenish their tanks.

Considering these results, we recommend that the Navy consider switching from a dual fuel operation and instead adopting JP-5 as the single fuel in naval operations, eliminating the use of F-76. To succeed, it would be necessary to design a schedule for converting the fleet to the single fuel. The fuel tanks and the fuel lines would have to be cleaned, the CLF ships would have to be equally converted, and the supply lines would have to be established. In addition, discipline policies would have to be designed to avoid accidental contamination of JP-5 fuel tanks with F-76.

Recommendations for Further Research

Our study evaluated the logistical benefits of adopting JP-5 as the single fuel in naval operations. Switching from F-76 to JP-5 has raised several concerns (technical, financial, supply), which have been addressed in this and other studies. We found that the benefits are very significant, and that the US Navy should seriously consider the single fuel concept as the new standard for fueling its naval platforms.

Our analysis assumed a steady-state environment where all ships are ready to operate exclusively on a single fuel (JP-5), Combat Logistics Force ships are exclusively carrying JP-5, and supply points can provide JP-5 in the necessary quantities. Switching to a single fuel, however, cannot be done overnight. Fuel tanks and fuel lines must be cleaned in all ships, which would take time and money.

Further research should evaluate the conversion costs and timeline, while supporting refineries should agree to gradually convert their production schedule to supply JP-5 in the necessary quantities.

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Acronyms

ARG	amphibious ready group
CSG	carrier strike group
CLF	combat logistics force
FUSED	Fuel Usage Study Extended Demonstration
POL	petroleum, oil, and lubricants
RAS	replenishment at sea