US DEPARTMENT OF THE NAVY
Advanced Biofuels Efforts

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Energy Security Concerns

- In 2012 alone the Department of the Navy faced unplanned expenditures of $500 million simply due to fuel price increases
- Every time oil rises $1/barrel it costs the Navy $30 million+
- Global oil markets convey substantial economic and supply risk
- More energy options allow our operators added flexibility

- SECNAV Goal: By 2020, 50% of our energy will come from alternative sources

Biofuels – Taking Flight

2012 Great Green Fleet Demonstration

USS Princeton (CG 59) refuels from oiler USNS Henry J. Kaiser (T-AO 187) in the Pacific Ocean

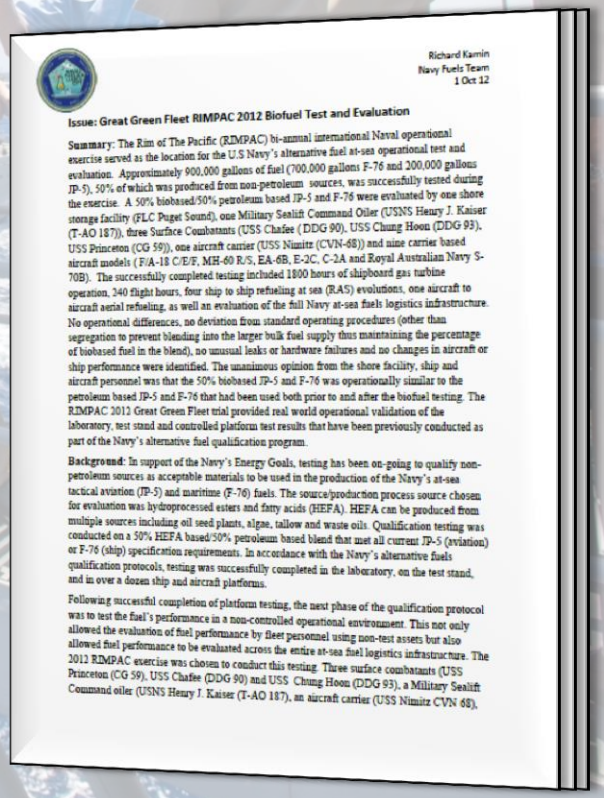
Royal Australian Navy S-70B Sea Hawk helicopter

SECNAV and CNO aboard USS Chafee

USS Nimitz (CVN 68), USS Princeton (CG 59)

GGF After Action Report

- 1,800 hours of shipboard gas turbine operation
- 240 flight hours
- Four ship-to-ship Refueling At Sea evolutions
- One air-to-air refueling
- No operational differences noted:
  - Logistics Infrastructure
  - Ship power plants and aircraft
- Less filter changes



Richard Kamin
Navy Fuels Team
1 Oct 12

Issue: Great Green Fleet RIMPAC 2012 Biofuel Test and Evaluation

Summary: The Rim of The Pacific (RIMPAC) bi-annual international Naval operational exercise served as the location for the U.S Navy's alternative fuel at-sea operational test and evaluation. Approximately 900,000 gallons of fuel (700,000 gallons F-76 and 200,000 gallons JP-5), 50% of which was produced from non-petroleum sources, was successfully tested during the exercise. A 50% biobased/50% petroleum based JP-5 and F-76 were evaluated by one shore storage facility (FLC Puget Sound), one Military Sealift Command Oiler (USNS Henry J. Kaiser (T-AO 187)), three Surface Combatants (USS Chafee (DDG 90), USS Chung Hoon (DDG 93), USS Princeton (CG 59)), one aircraft carrier (USS Nimitz (CVN-68)) and nine carrier based aircraft models (F/A-18 C/E/F, MH-60 R/S, EA-6B, E-2C, C-2A and Royal Australian Navy S-70B). The successfully completed testing included 1800 hours of shipboard gas turbine operation, 240 flight hours, four ship to ship refueling at sea (RAS) evolutions, one aircraft to aircraft aerial refueling, as well an evaluation of the full Navy at-sea fuels logistics infrastructure. No operational differences, no deviation from standard operating procedures (other than segregation to prevent blending into the larger bulk fuel supply thus maintaining the percentage of biobased fuel in the blend), no unusual leaks or hardware failures and no changes in aircraft or ship performance were identified. The unanimous opinion from the shore facility, ship and aircraft personnel was that the 50% biobased JP-5 and F-76 was operationally similar to the petroleum based JP-5 and F-76 that had been used both prior to and after the biofuel testing. The RIMPAC 2012 Great Green Fleet trial provided real world operational validation of the laboratory, test stand and controlled platform test results that have been previously conducted as part of the Navy's alternative fuel qualification program.

Background: In support of the Navy's Energy Goals, testing has been on-going to qualify non-petroleum sources as acceptable materials to be used in the production of the Navy's at-sea tactical aviation (JP-5) and maritime (F-76) fuels. The source/production process source chosen for evaluation was hydroprocessed esters and fatty acids (HEFA). HEFA can be produced from multiple sources including oil seed plants, algae, tallow and waste oils. Qualification testing was conducted on a 50% HEFA based/50% petroleum based blend that met all current JP-5 (aviation) or F-76 (ship) specification requirements. In accordance with the Navy's alternative fuels qualification protocols, testing was successfully completed in the laboratory, on the test stand, and in over a dozen ship and aircraft platforms.

Following successful completion of platform testing, the next phase of the qualification protocol was to test the fuel's performance in a non-controlled operational environment. This not only allowed the evaluation of fuel performance by fleet personnel using non-test assets but also allowed fuel performance to be evaluated across the entire at-sea fuel logistics infrastructure. The 2012 RIMPAC exercise was chosen to conduct this testing. Three surface combatants (USS Princeton (CG 59), USS Chafee (DDG 90) and USS Chung Hoon (DDG 93), a Military Sealift Command oiler (USNS Henry J. Kaiser (T-AO 187), an aircraft carrier (USS Nimitz CVN 68),

Synthesized Hydrocarbons in Bulk Fuels

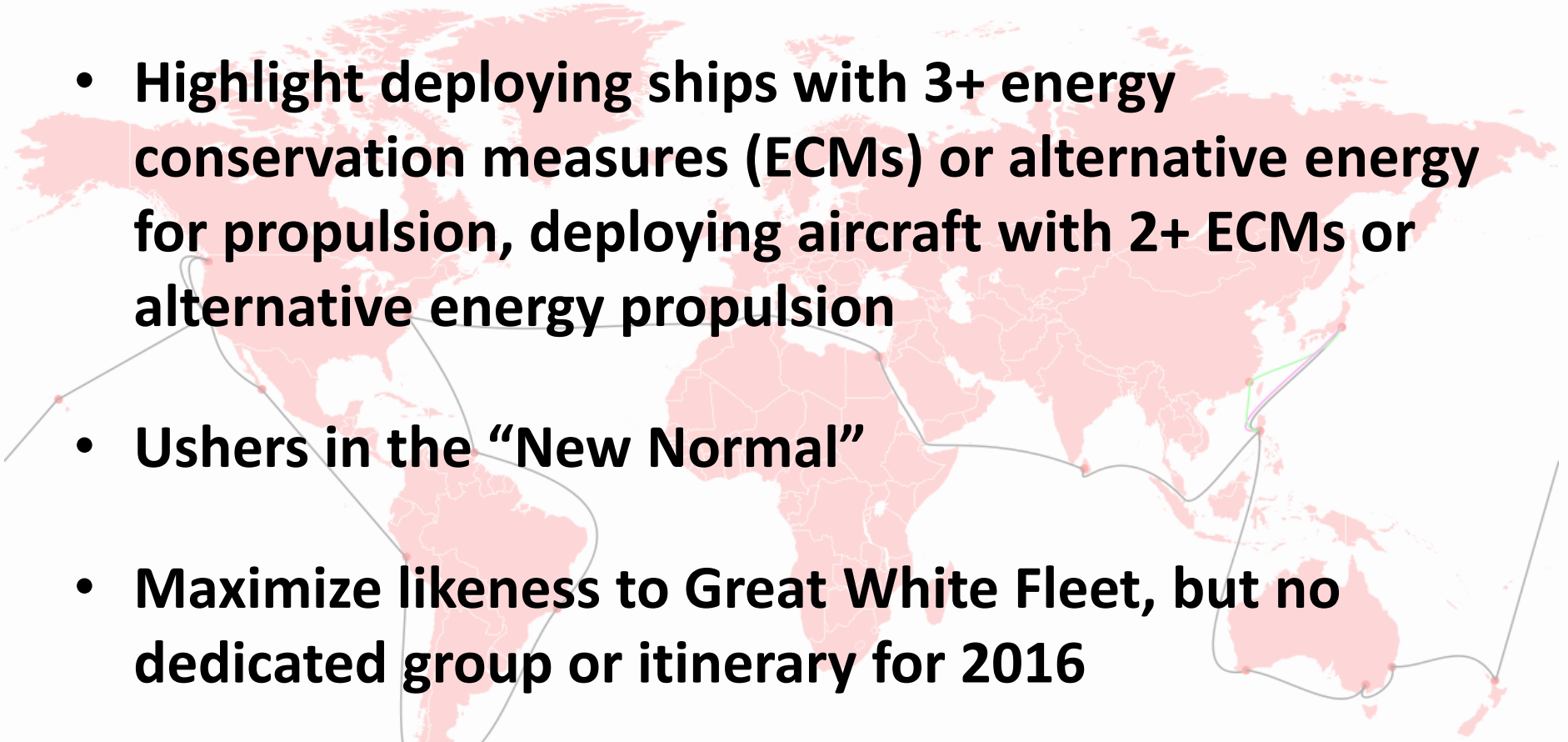
- **Starting April 2015, F-76 and JP-5 in US assets may contain synthesized hydrocarbons**
  - **Hydrotreated Esters and Fatty Acids (HEFA)**
  - **Fischer-Tropsch Synthetic Paraffinic Kerosene (F-T SPK)**
  - **Other pathways added when test and certification completes (Pyrolysis, alcohol to jet, synthesized iso-paraffins, co-processing, catalytic hydrothermolysis, hydrothermal liquefaction, etc.**
  - **Eventual goal is 336 million gallons (neat) of alternative fuels per year by 2020**
- **This means fuels passed by a US tanker or received on a US Naval installation could consist of up to a 50% biofuels blend**
- **Since they were qualified as drop-ins, no attempt will be made to segregate or identify the alternative fuels. They will simply be treated as F-76 or JP-5.**

Synthesized Hydrocarbons in Bulk Fuels

- **Inland/ East/ Gulf Coast fuel delivery starts 1 April 2015**
  - **Covers Norfolk, Mayport, and Jacksonville**
- **Rocky Mountain/ West Coast contract solicitation soon for fuel delivery starting 1 October 2015**
  - **Covers San Diego, Bremerton, Hawaii**
- **Western Pacific bulk fuels contract will have alternative fuels annexes added to F-76 and JP-5 for deliveries starting 1 Jan 2016**
  - **Covers west of Hawaii to the Middle East**
- **Atlantic / European / Mediterranean fuels contract has alternative fuels annexes added to F-76 and JP-5 soon. New delivery contract starts 1 July 2016**

Great Green Fleet 2016

- Year-long event throughout CY 2016
- Highlight deploying ships with 3+ energy conservation measures (ECMs) or alternative energy for propulsion, deploying aircraft with 2+ ECMs or alternative energy propulsion
- Ushers in the “New Normal”
- Maximize likeness to Great White Fleet, but no dedicated group or itinerary for 2016
- Need international biofuel acquisitions



Defense Production Act Advanced Drop-In Biofuels Production Project

- Multiple, Commercial Scale Integrated Biorefineries
- $510M Agency Funding
- No More Than a 50% Cost Share
- Cost-competitive with conventional petroleum w/o subsidies
- Produced domestically

Defense Production Act Advanced Drop-In Biofuels Production Project

Company	Location	Feedstock	Conversion Pathway	Fuels	Capacity (MM gpy)
Emerald Biofuels	US Gulf Coast	Fats, Oils, and Greases	Hydroprocessed Esters and Fatty Acids (HEFA)	F-76	82
Fulcrum BioEnergy	McCarran, NV	Municipal Solid Waste	Gasification – Fischer Tröpsch (FT)	JP-5, 8	10.8
Red Rock Biofuels	Lakeview, OR	Woody Biomass	Gasification – Fischer Tröpsch (FT)	F-76, JP-5,8	12

Current Efforts/Plan Forward

JP-5

- **Alcohol To Jet**
  - Lab testing 95% Complete
  - Component/ Engine Testing In Process
  - Flight Tests Planned Fall 2014
- **Direct Sugar To Hydrocarbon**
  - Lab testing 90% complete
  - Similarity analysis on-going to determine component/engine req'ts
  - Flight Tests completed Sept 2014
- **Hydroprocessed Depolymerized Cellulosic**
  - Lab testing 70% complete
  - F414 combustor test planned 2014
- **Catalytic Hydrothermolysis**
  - Lab testing 60% complete
  - Component/Engine testing planned 2015

F-76

- **Direct Sugar To Hydrocarbon**
  - Laboratory testing 95% Complete
  - Component /Engine Testing in Process
  - Platform trials planned 2014/15
- **Hydroprocessed Depolymerized Cellulosic**
  - Laboratory Testing 90% Complete
  - Component/Engine Testing in process
  - Platform trials planned 2015
- **Catalytic Hydrothermolysis**
  - Lab testing 60% complete
  - Component/Engine testing planned 2015

F/A-18E , Pacific Ocean
USS Nimitz (CVN-68)