Army Alternative Ground Fuels Qualification

PETRO 2012 Conference & Exhibition, National Petroleum Management Association
DOD Alternative Fuels Seminar
31 May 2012
# Army Alternative Ground Fuels Qualification

**Introduction**


**Subject Terms**

- Aluminum-Enhanced Biofuel
- Army Energy Strategy
- Army Alternative Ground Fuels Qualification
- Biofuel
- Bulk Fuel Roadmap
- Candidate Fuels Progressing Through Qualification
- DoD Strategic Guidance
- Energy Alternatives
- Identification of Candidate Fuels
- Qualification Roadmap
- Peripheral Fuel System Design
- Qualification
- TARDEC Evaluations
- Technology Readiness Levels
Agenda

• Introduction
  – Tank Automotive Research, Development, and Engineering Center (TARDEC) Mission and Portfolio
  – Responsibilities as DOD Executive Agent for Ground Fuels & Lubricants

• Why Alternative Fuels?
  – Payback
  – What Army Leaders Are Saying About Energy Alternatives
  – DoD Strategic Guidance
  – Army Energy Strategy

• Army Alternative Ground Fuels Qualification
  – Bulk Fuel Roadmap
  – Qualification – Technology Readiness Levels
  – Identification of Candidate Fuels
  – Evaluating Candidate Fuels
  – Candidate Fuels Progressing Through Qualification
  – Qualification Roadmap
  – Upcoming Demonstrations of Candidate Alternative Fuels
  – Completed TARDEC Evaluations – Reports and Papers Available
- Provides full life-cycle engineering support and is provider-of-first-choice for all DOD ground combat and combat support vehicle systems.

- Develops and integrates the right technology solutions to improve Current Force effectiveness and provide superior capabilities for the Future Force.

**Ground Systems Integrator for the Department of Defense**

Responsible for Research, Development and Engineering Support to 2,800 Army systems and many of the Army’s and DOD’s Top Joint Warfighter Development Programs
Portfolio

Combat Vehicles
- Heavy Brigade Combat Teams
- Strykers
- MRAPs
- Ground Combat Vehicles (Future)

Tactical Vehicles
- HMMWVs
- Trailers
- Heavy, Medium and Light Tactical Vehicles

Force Projection
- Fuel & Water Distribution
- Force Sustainment
- Construction Equipment
- Bridging
- Assured Mobility Systems

Robotics
- Technology Components
- Demonstrators
- Military Relevant Test & Experimentation
- Transition & Requirements Development

TARDEC Engineers Provide Cradle-To-Grave Engineering Support
"The Director of the U.S. Army TARDEC… will execute the RDTE program for fuels and lubricants as the DOD Executive Agent for ground fuels and lubricants. TARDEC is also the single point within the DA for control of all petroleum and petroleum related specification commodities assigned to the Army and DOD and for Army representation to NATO and ABCA forums related to ground fuels and lubricants."
“Clearly, future operations will depend on our ability to . . . use more renewable or alternative sources of energy.”

The Honorable John McHugh, Secretary of the Army¹

• More options, less risk
  – Military acceptance to use more diverse (non-petroleum) fuels
  – Ensure Army operations are not adversely affected by fuel-equipment incompatibilities
  – Addresses growing challenges to energy supply – promotes long-term energy surety

• Important to national security
  – “In long term, alternative fuels have the potential to be an important part of the Nation’s energy landscape”²

¹2012 Budget Request for the Army, testimony before the House Armed Services Committee, 2 March 2011
²DOD Energy for the Warfighter: Operational Energy Strategy
Richard G. Kidd IV, Deputy Assistant Secretary of the Army for Energy and Sustainability (at AUSA, October 2011):

“[There] is a commitment from the Army’s senior most leadership to make energy security a priority. It’s fiscally responsible, operationally necessary, and mission-critical.”

LTG Raymond V. Mason, Deputy Chief of Staff of the Army, G-4 (Logistics):

“One of the issues is, does operational energy just include the battlespace and what’s deployed? Or does it include things back in the generating space, the institutional Army?”

The latter is true, he said. “For example, actions that occur at the National Training Center or the Joint Readiness Training Center [that] prepare units to deploy [are] part of operational energy.”
From the DOD Operational Energy Strategy, May 2011:

The Department also is taking steps to promote long-term surety of supply. The volatility of oil prices will continue to be a budgetary challenge for the Department, and the realities of global oil markets mean a disruption of oil supplies is plausible and increasingly likely in the coming decades. The Services have already taken steps to certify aircraft, ships, tactical vehicles, and support equipment to use alternative liquid fuels, a prudent insurance policy against future oil supply disruptions and high prices.

Although the Department currently procures alternative fuels at a premium for testing purposes, the Department will acquire such fuels for military operations at prices that are competitive with the market price for conventional fuels. The Department also may acquire alternative fuels to meet a mission imperative.
Strategic Energy Security Goal 3
Increased Use of Renewable / Alternative Energy

Objective 3.3
Transition from fossil fuel based tactical mobility/power generation to renewable and alternative energy/sources.

Implementation Plan per AR 5-5 Study:
By 2028, 50% of the fuel requirement in the training base for the tactical mobility fleet (surface and air) is met by alternative fuel blends.

- Intended outcomes focused on integrating the use of alternative fuels in vehicle and aircraft engines in the training base
- Percent of fuel requirement met by alternative fuel blends:
  - 15% by FY18
  - 30% by FY23
  - 50% by FY28
Army Bulk Fuel Roadmap

Fuels must be compatible with existing and future Army/DoD tactical ground systems.

- **Near-Term**
  - Current Fuels (entirely petroleum)

- **Mid-Term**
  - Blended Fuels* (partially synthetic and/or renewable)

- **Far-Term**
  - Drop-in Fuels* (entirely synthetic and/or renewable)

* ‘Drop-in’ fuels:
1. Include blended fuels.
2. Meet requirements in fuel specification.
3. Require no change to vehicles/equipment.
4. Require no change to infrastructure.
5. Can be mixed or alternated with petroleum-derived fuel.

**NOTE:**
Army primarily uses JP-8 (jet fuel). Diesel fuel, regionally sourced, is likely alternate if JP-8 is not available or accessible.
### Alternative Fuels Qualification Technology Readiness Levels

Only a partial representation of TRL tests and evaluations.

**Laboratory Evaluations**

- **TRL 1**: Basic Fuel Properties
  - Distillation
  - Hydrocarbon Range
  - Density

- **TRL 2**: JP-8 Fuel Specification Properties
  - Oxidative Stability
  - Cetane Index (Report Only)

- **TRL 3**: Fit for Purpose
  - Storage Stability
  - Material Compatibility
  - Viscosity vs. Temperature

- **TRL 4**: Extended Lab Fuel Property Test
  - Dermal Irritation Test
  - Cetane No. / Derived Cetane No.

**Component Evaluations**

- **TRL 5**: Component Rig
  - Fuel Injection System Testing (Rotary, Inline, Common Rail, Unit Injectors)

- **TRL 6**: Engine Testing
  - NATO 400-hr test protocol, modified to desert-like conditions
  - 210-hr TWV test cycle

**System Evaluations**

- **TRL 7**: Limited Ground Vehicle/Equipment Demos
  - Vehicle Test Track Evaluation
  - Tactical Gen Set Side-by-Side Operability Evaluation
  - TWV Pilot Field Demo
  - Force Projection Equipment Pilot Field Demo

**Demonstrations**

- **TRL 8**: Validation
  - Ground Equipment Evaluations – Proving Grounds

- **TRL 9**: Field Service Evaluations
  - Ground Equipment Evaluations (typically long duration, at CONUS field locations, wide-in-scope)

**Qualification Report**

- Executive Summary of RDT&E to PEOs-PMs
- Independent Third Party Review

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**Develop data needed to assess fuel’s suitability for use.**

**Build user knowledge of and confidence in use of fuel.**

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**
EMERGING ALTERNATIVE FUELS MARKET

- DOD
- DOE
- Industry
- Academia
- Fuel Producers
- Equipment OEMs
- Other Government Agencies
- Standards Development Organizations

Market Connection
- Manufacturing technology
- Fuel data, samples
- Market drivers

Candidate drop-in alternative fuels for qualification
Evaluating Candidate Alternative Ground Fuels

Candidate drop-in alternative fuels

Fuel / Component Evaluations
- Chemical composition
- Physical properties
- Component performance / durability

Engine Evaluations
- Fuel ignitability
- Fuel combustion
- Performance / durability

System Evaluations
- Operability
- Performance
- Demonstrations

Example:
Poor lubricity fuel may cause increased wear rates in fuel injectors and injection pumps.

Example:
Poor long-term storage stability fuel characteristics could impact readiness.

Example:
Low cetane-rated fuel may cause difficult cold-starts and combustion instability.

Example:
Low fuel viscosity may lead to internal fuel pump leaks resulting in reduced power.

Approval and acceptability of alternative fuels for use in military ground equipment.
Candidate Fuels Progressing Through Qualification

- Two alternative fuels for which evaluations are being completed to assess their impacts on tactical ground systems
  - **Blends** of JP-8 and up to 50% by volume of Synthetic Paraffinic Kerosene (SPK)
    - Fischer-Tropsch Synthetic Paraffinic Kerosene (FT SPK)
    - Hydroprocessed Esters and Fatty Acids (HEFA SPK)
  - Both products (FT SPK and HEFA SPK) are very similar compositionally
    - Resultant properties are very similar
    - Evaluations thus conducted using one of these blends will be representative of evaluations for the other by similarity
- Evaluations are conducted using nominal 50%:50% volumetric blends
- Blends are meant to be “drop-in” fuels
  - Meets fuel performance requirements (in spec)
  - Requires no change to vehicles/equipment
  - Requires no change to infrastructure
  - Can be mixed or alternated with petroleum-derived fuel
## Qualification Roadmap for FT SPK and HEFA SPK Blends (Tactical/Combat Ground Equipment)

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<th>Pre-FY09</th>
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* Gen Set Tests Key

**Technology Driven. Warfighter Focused.**

Unclassified
Upcoming Demonstrations of Candidate Alternative Fuels

- **Camp Grayling Demo**
  - Camp Grayling, located in central northern Michigan, is the nation’s largest National Guard training site
  - Selected Michigan Army National Guard units will operate a variety of tactical/combat ground vehicles on a biofuel during their training exercises
  - Taking place in June 2012, total of 10,000 gals of alternative fuel

- **Fuel and Water Distribution Systems Demo**
  - Will demonstrate pump-engine capabilities (fuel and water), and the Aviation Forward Area Refueling System (AAFARS), while operating on alternative fuel
  - Pump-engine recirculation loop on water, engines on alternative fuel – 400 hrs
  - AAFARS recirculation loop and engine on alternative fuel – 400 hrs at 90°F+
  - Demo starts in summer 2012, Southwest Research Institute campus in Texas

- **Green Warrior Convoy**
  - In Spring 2013, convoy will demonstrate vehicle energy and educate the value of S&T in Army vehicles; to include operation on alternative fuel
  - Vehicles will travel from Warren, Michigan to Washington D.C. as part of the road testing of technologies and systems developed at TARDEC

NOTE: Alternative fuel for these demos is HEFA SPK/JP-8 blend unclassified
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<td>Evaluation of Ball on Three Disks as Lubricity Evaluator for CI/LI in Synthetic JP-5</td>
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<td>Bench Top Lubricity Evaluator Correlation with Military Rotary Fuel Injection Pump Test Rig</td>
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<td>Durability Evaluation of Two New Production Caterpillar C7 Engines Subjected to Elevated Temperature 400 Hour NATO Tests Fueled by JP-8 and 50%/50% Blend of JP-8 and S-8</td>
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<td>Synthetic Fuel Blend Demonstration Program at Fort Bliss, Texas</td>
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<td>Cummins V903 Alternative Fuel Evaluation, NATO Modified Standard Laboratory Test AEP-5</td>
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unclassified
Back-up Slides
FT SPK and HEFA SPK Blendstocks – How They Are Made

**CTL / GTL / BTL / CBTL: All use Fischer-Tropsch Processes**

FT SPK

Coal, NG, Biomass Feedstocks

O₂ / Air

O₂ / Air

Syngas manufacture

O₂ / Air

Fischer-Tropsch Synthesis

Syngas CO + 2H₂

Syngas CO + 2H₂

Selective Hydrocracking

H₂O

Product Separation

Paraffins

Very similar processes also used in traditional petroleum JP-8 Production

HEFA SPK

Biomass Feedstock (renewables)

H₂O CO₂

Deoxygenation & Hydrotreating

Paraffins

Selective Hydrocracking

Product Separation

Because of the similar end-processing, FT SPK and HEFA are chemically similar blendstocks
More Possibilities For Making Alternative Jet Fuels (or Blendstocks)

- Sugarcane
- Switchgrass
- Corn stover
- Forest waste
- Lignocellulose

**Synthetic Biology**
- Genetically Engineered Microbes
- Fermentation

**Alcohol Oligomerization**
- Fermentation
- Dehydration
- Olefins

**Pyrolysis**
- Pyrolysis
- Bio-Crude

**Conventional Refinery Processes**
- Polymerization
- Hydroprocessing
- Jet Fuel-Like Product

Used with permission from Mark Rumizen, FAA
Alternatively Sourced Liquid Hydrocarbons

- **Biomass Feedstock** (renewables)
  - non-food crops
  - algae
  - agri-waste
  - wood waste & by-products
  - tallow, fats, lard

- **Fossil Energy Feedstock** (large U.S. resource)
  - coal
  - natural gas
  - oil shale
  - petcoke

- **Petroleum Crude Oil** (increasingly difficult discovery and unfriendly-nation production)

- Various conversion processes dependent on feedstock
- Product meeting commercial and/or military specifications
- Specs evolving to address alternatively sourced hydrocarbons

**Jet Fuel**
- ASTM D1655: conventional jet fuel
- ASTM D7566: blends of synthetic kerosene with conv. jet fuel
- MIL-DTL-83133: JP-8, also blends of synthetic kerosene with JP-8

**Diesel Fuel**
- ASTM D975: up to 5% v. FAME biodiesel (B100) allowed in diesel fuel
- ASTM D6751: B100 spec
- ASTM D7467: blends of 6%-20% v. FAME biodiesel (B100) with diesel