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Fire Resistant Fuel Program Update

13 Sep 2011
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Fire Resistant Fuel (FRF) Background



- Fire Resistant Fuel program ran from 1970 -1987
- Diesel 2 fuel used as base stock
 - 52° F Flashpoint
- Program ended due to logistical and operational challenges associated with the water requirements
 - Low temperature usage
 - High water purity requirements
 - 12% additive solution
- IEDs were not a threat



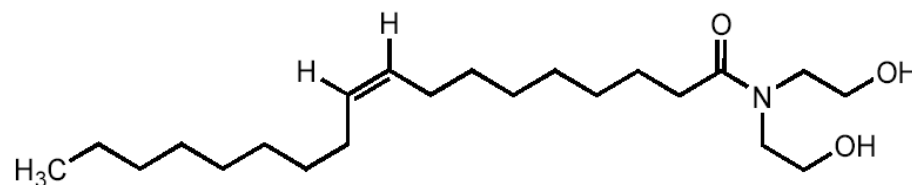
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FRF Development Project



- JP-8 used as battlefield fuel
 - 38° F Flashpoint
- Objectives
 - developing new emulsified fuel formulations;
 - investigating anti-mist additives to diminish the fuel fireball;
 - determining the effect of FRF on vehicle and equipment;
 - designing field blending system for producing the FRF;
 - determining overall effectiveness of the FRF based on JP-8.

- FRF formulation:
 - Emulsifier (Schercomid ODA) keeps water in suspension (5-6 vol. %)



Oleamide DEA – a fatty acid amide

- Schercomid ODA also contains up to 8% of the free oleic acid and up to 25% of the unreacted diethanolamine.



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Current FRF Formulation



- Mist Control Additive (MCA) – (125-250 ppm) reduces initial fireball, essential in JP-8
 - Flo MXC from Baker Petrolite
 - 20-25% polymer in solvent
 - High molecular weight polymers between 5-20 million MW
 - mixture of molecular weights 20 million down to 200,000.
 - majority of the polymers are in the range of 12-16 million MW.
 - shear from blending reduces largest molecules down to 8-10 million molecular weight.
 - Vehicle fuel system shearing causes further reduced down to 4-6 million MW.
- Additive's tensile strength imparts non-Newtonian properties into fuel, decreasing surface to volume ratio, increasing droplet size which results in reduced fireball size



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Current FRF Formulation



- Water reduces or extinguishes pool fuel fires (10 vol. %)
 - heat sink provided by the water
 - emulsified water on the surface prevents fuel vaporization
 - released water vapor concentrating at the surface of the fuel eliminates oxygen from the fuel



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Sample DF-2 Viscosities



Sample	Surfactant	Water	MC Polymer	Viscosity
1	6%	10%	0 ppm	4.52 CST
2	6%	10%	125 ppm	4.83 CST
3	6%	10%	250 ppm	5.13 CST

Kinematic viscosity at 40°C



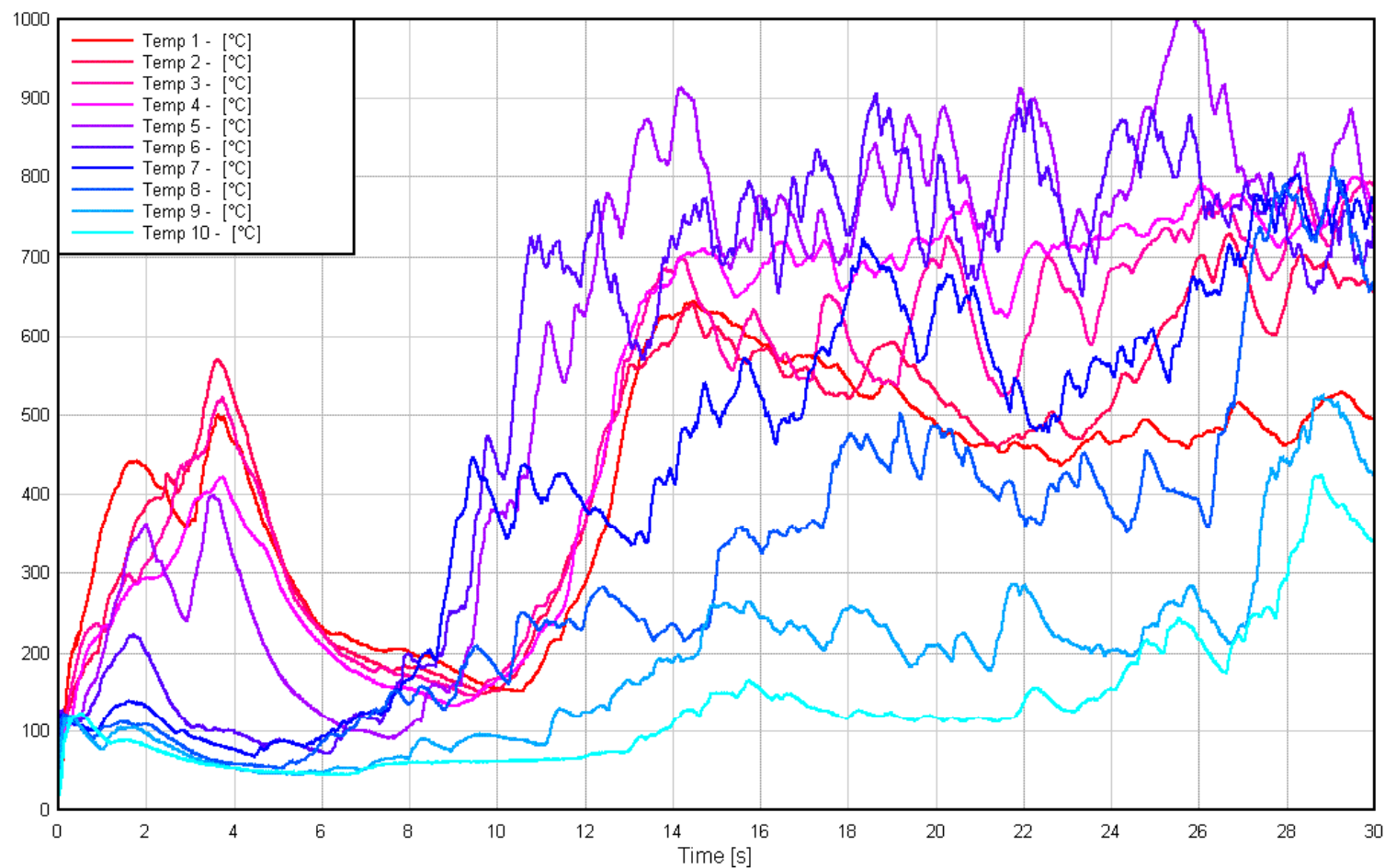
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Fire Resistance





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Fire Resistance Temperature Profile



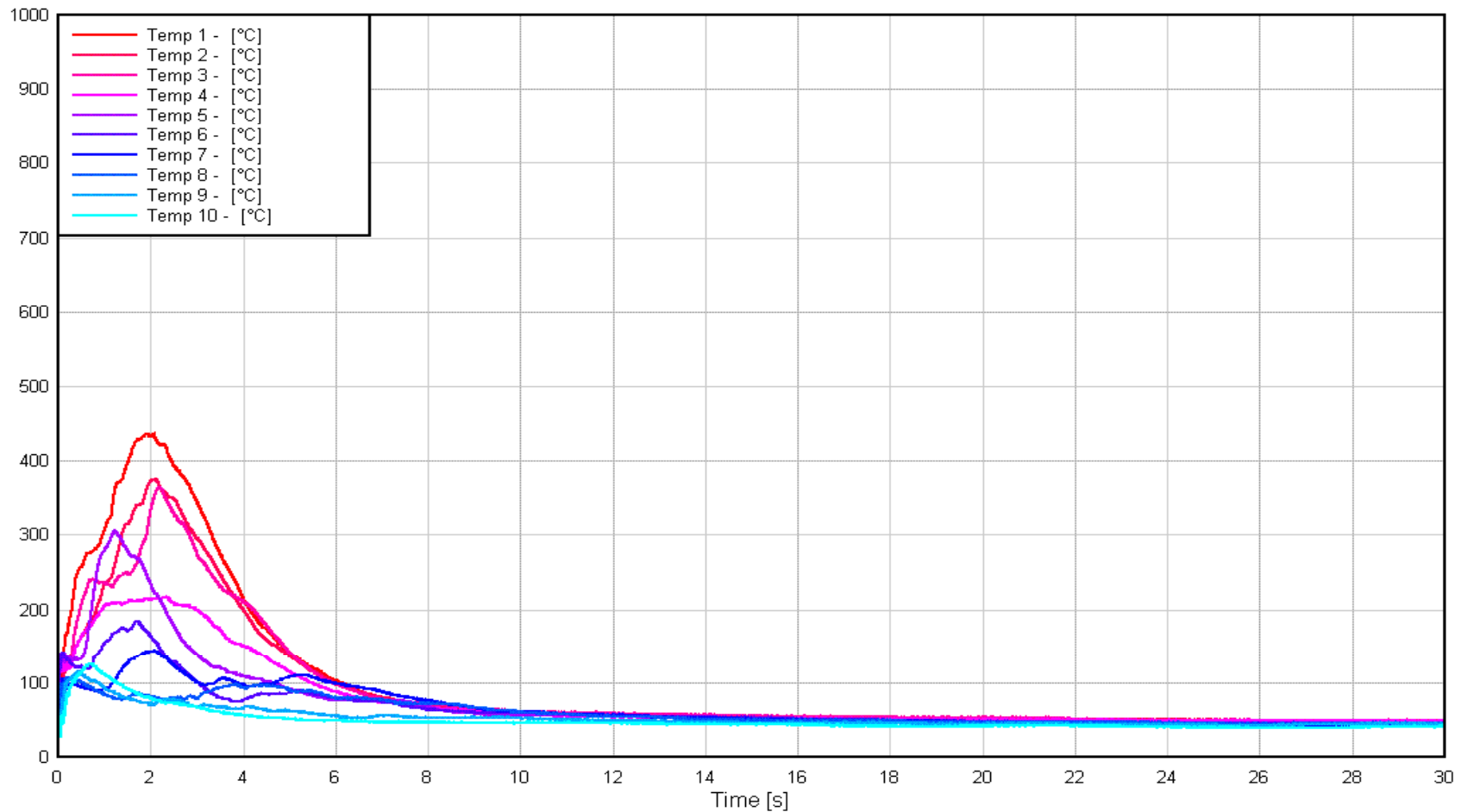
JP-8 Ballistic Test – Uncontrolled Burn

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Fire Resistance Temperature Profile



(U) Diesel 2 FRF Ballistic Test – Controlled Burn



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Pegasus Vehicle Live Fire



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Pegasus Video



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- Mist control “strings”





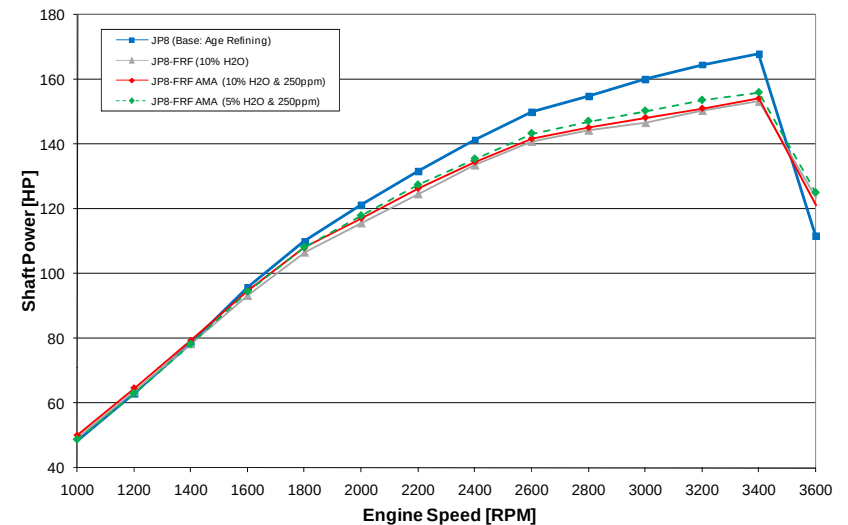
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Equipment Performance Impacts

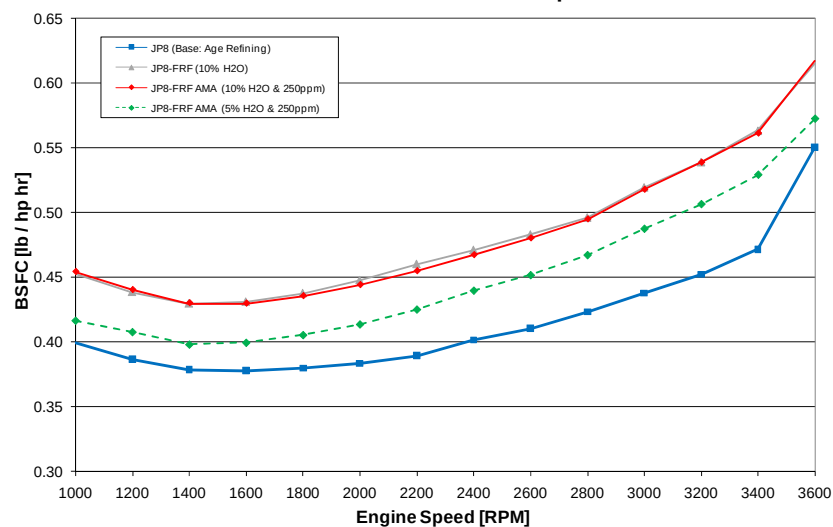


- FRF-JP8 fuel reduces power, torque, and fuel economy by 8-9%
(Charts depict 6.5L Turbo Diesel)

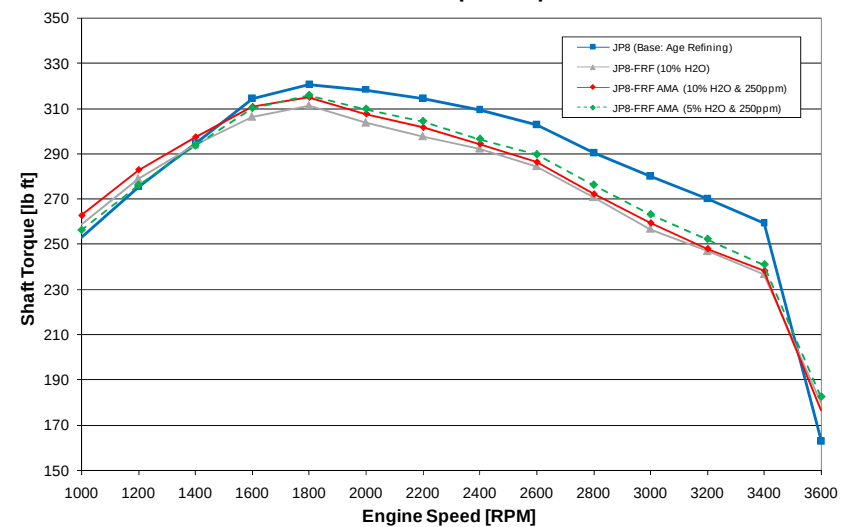
Maximum Power Output



Maximum Load Fuel Consumption



Maximum Torque Output



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Up-Armored HMMWV Performance

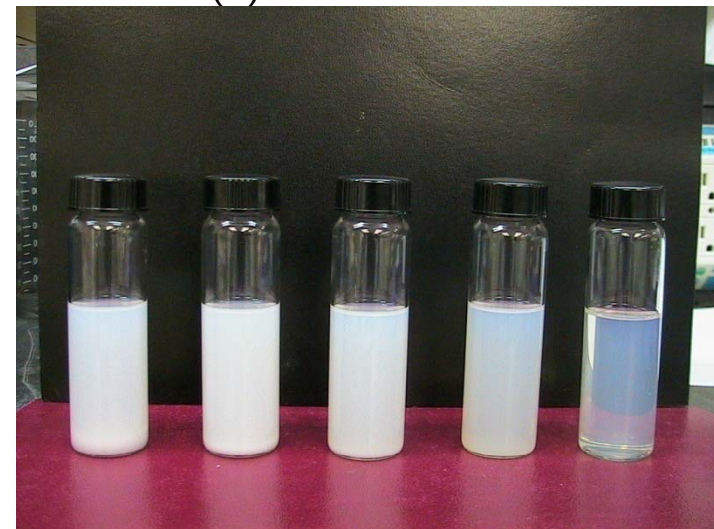


	JP8	JP8 FRF	% change
0-30 mph (s)	11.5	12.52	8.9
0-50 mph (s)	32.24	37.87	17.5
Top Speed (mph)	67	61	9.8
Speed on Grade			
5% grade (mph)	40	37	8.1
20% grade (mph)	11	10	10.0
40% grade (mph)	8	7	14.3
60% grade (mph)	5	4	25.0

- Indefinite stability desired
- Stability affected by
 - Temperature
 - Time
 - Agitation



(U) FRF Mixtures - Clear



(U) FRF Mixtures - Cloudy

FRF field blending concept diagram

