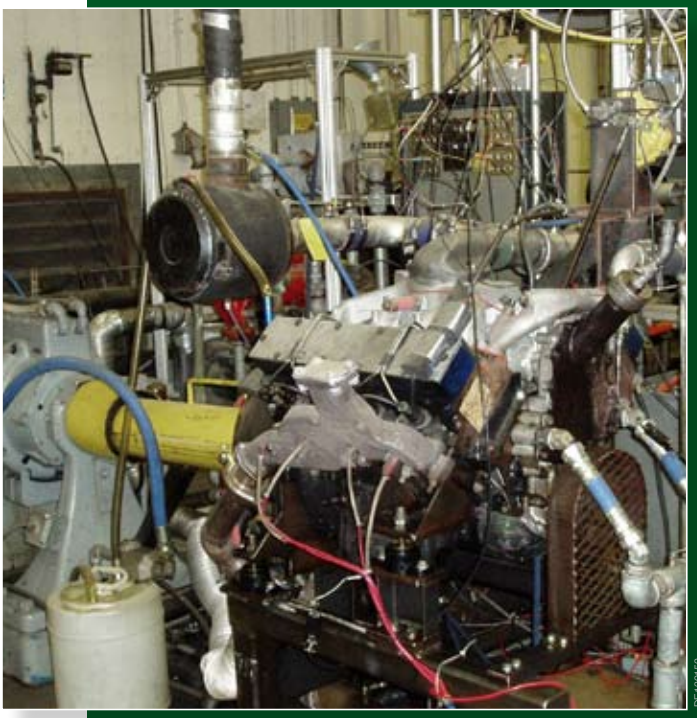
6.5L Diesel Fuel Economy Improvement Test

The 6.5L Diesel Fuel Economy Improvement Test was developed to measure the effects of engine oils on the fuel economy (FE) of diesel engines. This dynamometer test is used to measure the fuel efficiency performance of engine oils under conditions analogous to a typical driving cycle during operation of a 6.5L diesel engine in a High Mobility Multipurpose Wheeled Vehicle (HMMWV).

A 10-stage test protocol was developed following analysis of a military cycle recorded during field HMMWV operation. This data was a subset of data in Interim Report 377, "HMMWV Field Operation Data Collection and Analysis," published by the U.S. Army TARDEC Fuels and Lubricants Research Facility at Southwest Research Institute® (SwRI®). The time-weight factors for the stages were determined by SwRI and represent the percentage of time the engine operates in the speed-torque-oil temperature range.



Summary of Test Method

A 1994 GM 6.5L diesel, V-8, 4-cycle engine is used as the test apparatus. The engine incorporates roller followers, two valves per cylinder, and mechanical fuel injection. Fuel used is a single batch of PC-9.

The 6.5L FE test incorporates a flush-and-run procedure. Each test consists of two 10-stage fuel economy measurements on a baseline oil, one at the beginning of the test and one at the end. The test oil is evaluated in between the two baseline runs and aged during 16 hours of operation at 1600 r/min and 85°C oil temperature. After aging, a 10-stage fuel economy measurement is taken. The two measurements on the baseline oil are used to calculate fuel economy improvement for the test oil.

Test Conditions

Condition	Stage									
	1	2	3	4	5	6	7	8	9	10
Speed, rpm	600	1100	1600	2100	1100	1600	1600	2100	2600	3100
Torque, Nm	27	81	27	81	135	81	135	135	13	135
Nominal Power, kW	1.7	9.3	4.5	17.8	15.6	13.6	22.6	29.7	36.8	43.8
Oil Temp Gallery, °C	65	75	75	75	85	85	85	85	85	95
Intake Air, °C	30									
Fuel Temp, °C	35									
Weighting	21%	2%	2%	7%	1%	7%	6%	19%	26%	9%
Aging is at 1600 rpm, 135 Nm, 85°C oil for 16 hours. Flushing is at 1600 rpm, 81 Nm, 85°C oil.										

Test Results

% FEI Test Oil =	(Average (baseline before + baseline after) – Test oil)/ Average (baseline before + baseline after) x 100

Test Cycles

Cycle*	Oil	Purpose	Approximate Test Hours
1	Flush		2
	Baseline	BSFC Measurement	6.7
2	Flush		2
		Aging	16
	Candidate 1	BSFC Measurement	6.7
3	Flush		2
	Baseline	BSFC Measurement	6.7
*The test can be extended for multiple candidate oils.			

Operational Data Analysis

Oil	Stage	Average BSFC (kg/kWh)		Nominal Power (kW)		Weighting		Fuel Consumed (kg)
Cycle 1 BC	1	BSFC	x	1.7	x	21%	=	
	2	BSFC	x	9.3	x	2%	=	
	3	BSFC	x	4.5	x	2%	=	
	4	BSFC	x	17.8	x	7%	=	
	5	BSFC	x	15.6	x	1%	=	
	6	BSFC	x	13.6	x	7%	=	
	7	BSFC	x	22.6	x	6%	=	
	8	BSFC	x	29.7	x	19%	=	
	9	BSFC	x	36.8	x	26%	=	
	10	BSFC	x	43.8	x	9%	=	
Total Fuel Consumed for All 10 Stages								

Quality Accomplishments

The Office of Automotive Engineering (OAE) at SwRI is certified to ISO 9001:2008, "Quality Management Systems – Requirements," accredited to ISO/IEC 17025:2005, "General Requirements for the Competence of Testing and Calibration Laboratories," and certified to ISO 14001:2004, "Environmental Management Systems." The OAE has also achieved Ford Tier 1 status for providing engineering services and the Engine, Emissions and Vehicle Research Division has received the Ford Q1 Quality Award. In addition, the Petroleum Products Research Department is a Nuclear Procurement Issues Committee (NUPIC)-approved laboratory and the Fuels and Lubricants Research Division has maintained its status as an American Chemistry Council (ACC)-approved laboratory.

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