August 2008

BULLETIN

ILSAC GF-5 Update

Where are we on the timing of **ILSAC GF-5?**
The entire process started in……..

- **2Q2006** : Test for ILSAC GF-5 category development started
- **1Q2007** : Preliminary test were short listed and **Matrix** testing commenced
- **4Q2008**: - ASTM Test acceptance begins
  - ACC registrations for Fluid developers are allowed to use
- **2Q2009**: **Technology demonstration** - **6 months allowed**
- **3Q2009**: **ILSAC / Oil approval** – After all of the test development & demonstration of technology
- **3Q2010: API 1st License Date**

Sequence IIIG Engine Test:

The **Sequence IIIG** is a fired engine test designed to evaluate the candidate oil's performance in three areas:

- **Viscosity Increase**
- **High Temperature Piston Deposits**
- **Valve Train Wear**

For **GF-5** the **rated performance parameters proposed** are:

- **Viscosity Increase as a percentage of new oil Viscosity**
- **Weighted Piston Deposits**
- **Cam and Lifter wear**
- **Hot Stuck Rings**

The **weighted piston deposit** requirement proposed for **GF-5 is 5.0 minimum** is a **significant upgrade** compared to the **GF-4 limit of 3.5 minimum**.

Sequence IIG Test Conditions:

Engine	**GM 3.8L (3800 cc) V-6**
Test Length (h)	100
Speed (RPM)	3600
Load (Nm)	250

Oil Temperature (°C)	155
Coolant Temperature (°C)	115
Intake Air Temp (°C)	35
Valve Spring Load (lbs)	205 @ 0.375 inch deflection
Air/Fuel Ratio	15:1
Initial Oil Charge (ml)	5500
Oil Check and samples (h)	0,20, 40, 60, 80 and 100
Materials	
Camshaft	Nodular Cast Iron (**Phosphated**)
Cam Bushing	Babbitt
Lifters	Alloy Cast Iron
Fuel	**Haltermann Fuel unleaded**

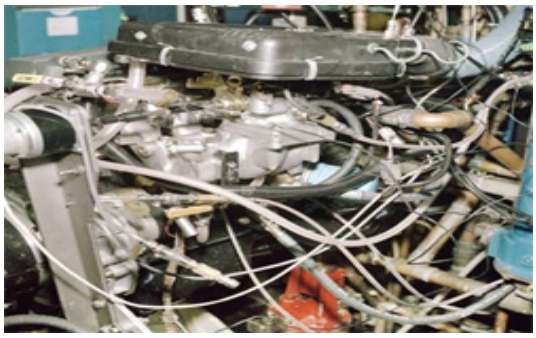
Sequence VG Engine Test:

The **Sequence VG** is a fired engine test designed to evaluate the candidate oil's ability to prevent **sludge** and **varnish deposits** in short trip low temperature operation.

The test cycles between **low and high temperature** operation, simulating the **short trip driving conditions** which promote the **generation of acids** and **fuel dilution** in the crankcase. A **special fuel** is used which is **prone** to **sludge** and **varnish generation**.

The rated performance parameters for the **Sequence VG** are:

- **Average Engine Sludge (AES)**
- **Rocker Arm Cover Sludge (RACS)**
- **Average Engine Varnish (AEV)**
- **Average Piston Skirt Varnish (APV)**
- **Oil Screen Clogging (Screen Clogging, %)**
- **Ring Sticking (RS)**



Proposed Performance Limits for **AES, RACS** and **Oil Screen Clogging** will be **more demanding** for **GF-5** compared to the **limits for GF-4**.

Sequence VG Test Conditions:

Engine	**Ford 4.6L SOHC V-8**
Test Length (h)	216
Operating Cycles	54 Cycles, 4 hours/Cycle 3 Stages / Cycle
Time (Minutes)	120/75/45
Speed (RPM)	1200/2900/700
Manifold Pressure (KPa absolute)	269/66/Record
Oil Temperature (°C)	68/100/45
Rocker Cover Coolant Temperature (°C)	29/85/29
Engine Coolant Temperature (°C)	57/85/45
Intake Air Temp (°C)	35
Fuel	**Haltermann Fuel unleaded**

Sequence IVA Engine Test:

The **Sequence IVA** is a fired engine test designed to measure the **crankcase oil's ability** to prevent **valve train wear** encountered during "**Stop and Go**" or **short trip driving conditions** and **extended idling**. The test evaluates **cam lobe wear** at **low temperature and low speed conditions**.

The rated parameter is the average **Cam Lobe Wear** and is measured at **seven locations** on each of the **twelve cam lobes**.

Sequence IVA Test Conditions:

Engine	**Nissan 2.4L inline 4 cylinder**
Test Length (h)	100
Stages	2 (Low and High speed)
Stage Duration (minutes)	50/10
Speed (RPM)	800/1500
Manifold Pressure (KPa absolute)	60/65
Oil Temperature	50/60
Coolant Temperature (°C)	50/55
Fuel	**Haltermann Fuel unleaded (Dyed Green)**

Sequence VIII Engine Test:

The **Sequence VIII** is a fired engine test used to evaluate candidate oil's ability to prevent **Copper /Lead bearing corrosion**. In addition this test is used to evaluate lubricant's **resistance** to **viscosity loss** due to **mechanical shearing**.

Test performance Parameters are **Bearing Weight Loss** after **40 hours** and the viscosity @ 100°C of the "vacuum stripped" oil sample taken after **10 hours** of operation.

Sequence VIII Test Conditions:

Engine	**LABECO Single Cylinder**
Test Length (h)	40
Speed (RPM)	3150 ± 25
Oil Temperature (°C)	143.5 ± 1
Coolant Temperature (°C)	93.5 ± 1
Fuel Consumption (kg/h)	2.15 ± 0.11
Air/Fuel Ratio	14.0 ± 0.5
Fuel	**Haltermann Unleaded Fuel (Dyed Green)**

Engine Oil Aeration Test (ASTM D6894) {New}

ASTM D6894, **Engine Oil Aeration Test**, is a standard test method for evaluation of the **oils resistance to Oil Aeration**. Commonly referred to as **HEUI** or **EOAT**, the test was originally developed in 1994 to measure the aeration tendencies of heavy duty diesel engine oils. It was intended to replace the ASTM high temperature foam test D6082 in API CG-4 requirements, API CG-4 was implemented and it was discovered that the **ASTM foam tests did not correlate with engine oil aeration in field service**. The Engine Oil Aeration test is run in a fired engine for 20 hours and the aeration is measured as a **% volume of the oil.**

This **test has not been used for PCMO specification** and it is **not know if this test would be suitable** for the **proposed GF-5** application.

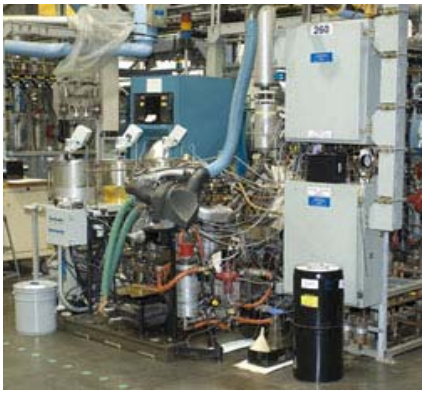
Sequence VID Engine Test:{New}

The **Sequence VID** is currently under development. This new test is intended to replace the **Sequence VIB as the Fuel Economy test for ILSAC GF-5**. As an outcome of discussions within **ILSAC / OIL** a **Consortium** was formed to oversee and fund the **Sequence VID development**.

The members are:

Automotive Companies	Oil Companies	Additive Companies
General Motors Corp.	Chevron	Lubrizol
Ford Motor Co.	ExxonMobil	Afton Chemical
	Shell	Infineum
		Oronite
		R. T. Vanderbilt

VID Development Program Status: {New}



The **Sequence VID Development Consortium** has been very active. Listed below are some of the activities that are underway:

- **Test Engine - GM 3.6L High Feature V6 Engine**
- **Engine mapping has been determined**
- **A preliminary test procedure is in place**
- **A test Precision Matrix is under development**
- **Test oils for the Precision Matrix have been solicited**

The preliminary testing as of **May 2008** has indicated that the three criteria for adoption can be met by the proposed procedure

- **Discriminate between oils of differing viscosity grade**
- **Discriminate between oils with and without friction modifiers**
- **Discriminate between "New" and "Aged" or used oils**

Updates will be posted when information is publicly released by the Consortium.

HTHS Bench Test: {New}

New to GF-5: 0W, 5W, 10W-40 **changed from 2.9** to **3.5 cSt maximum at 150°C**

D4951 Bench Test:

Sequence IIIGB (EOT) Bench Test:{New}

Emissions System Durability

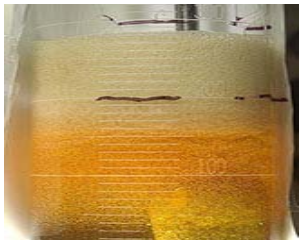
An ASTM committee, **Emissions System Compatibility Improvement Team (ESCIT)** is working to develop a process that will identify the **amount of Phosphorous** that escapes the engine and finds its way into the emissions systems (catalytic converter and other **aftertreatment** devices). It is known that **volatilized Phosphorous** will impair catalyst efficiency and thus **Phosphorous volatility is of concern**.

A considerable amount of effort has been put forward by this team and they have made a recommendation to **ILSAC/OIL**. The **ESCIT** recommendation is to measure the **% Phosphorous Retention** in the **EOT (100 hour)** sample from the **Sequence IIIG test**.

D5800 Bench Test: Volatility

D6417 Bench Test: Volatility

D892 (Option A Modified) Bench Test: FOAM (Tendency / Stability)



D6082 (Option A) Bench Test: Static Foam or Sequence IV

MHT- 4 TEOST Bench Test:

The **MHT- 4 TEOST (ASTM D7097)** is a bench test used to evaluate oil performance relative to forming **Moderately High Temperature Piston Deposits** when subjected to **high power** and **temperature** operating conditions.

The performance parameter is the **weight of deposits** on a **heated metal rod**.

MHT- 4 TEOST Test Conditions

Equipment	**SAVANT TEOST**
Test Length, hours	**24**
Oil Sample volume, g	8.50
Depositor rod Temperature, °C	**285**
Air Flow, ml/minute	10
Depositor Oil Flow, g/minute	0.25
Catalyst	**Liquid Napthenates (Pb/Fe/Sn)**
Catalyst Concentration	0.114g/g oil

The **TEOST 33C** and **TEOST MHT-4** tests are designed to measure **high temperature deposit** forming tendencies of lubricating oils but the procedures are quite different. The **TEOST 33C** version cycles between **200°C** and **480°C** for two hours and is primarily designed to **protect turbochargers**. The **MHT-4** is run at a constant temperature of **285°C for 24 hours** and is to evaluate **piston deposits**.

Together the test results from both versions paint a picture of the **candidate oil's high temperature deposit forming tendency.**

TEOST 33C (ASTM 6335) Bench Test: {New}

The **Thermo-Oxidation Engine Oil Simulation Test (TEOST®) 33C** was originally developed for and made **part of GF-2** to evaluate **Turbocharger deposit** formation. **This test was not included in GF-3 or GF-4** but this test, **TEOST 33C** has been **included** in the draft specification proposed for **GF-5**. The **GF-2**

Performance limit was **60 mg maximum** and the **GF-5 proposal weighs in at 25 mg maximum**. This test is meant to evaluate the **high temperature deposit** forming tendencies of crankcase oil.

This test simulates the cyclic temperatures encountered by lubricating oil in a turbocharged gasoline fueled engine. About 100 ml of test oil is used in a 12 cycle / 2 hour test. The test piece is a hollow heated rod (**TEOST® Depositor Rod**) that will accumulate deposits over the 2 hour test period. The test oil flows over the rod ant about 0.5g/minute while the test piece is cycled 12 times over a temperature range of **200°C to 480°C**. The increase in the weight of the rod is the performance parameter measured for this procedure. The greater the weight gain, the poorer the performance.

TEOST 33C Test Conditions: { New }

Equipment	SAVANT TEOST
Test Length, hours	2
Number of Cycles	12
Cycle Duration, minutes	9.5
Depositor Rod Temperature, °C	**200 to 480**
Depositor Oil Flow, g/minute	0.45
Oil Sample volume, ml	100
Catalyst	**Ferric Napthenate**

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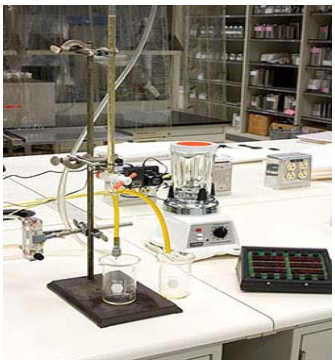
Together the test results from both versions paint a picture of the candidate oil's **high temperature deposit forming tendency.**

EOWTT & EOFT Bench Tests & ASTM D6922 Bench Test:(H & M)



ROBO Bench Test: {New}

The **ROBO test** is a proposed bench test for evaluation of the **used oil low temperature viscosity performance** of engine oils. This test was developed by

Degussa Rhomax Additives and has been accepted by **ILSAC / OIL** for evaluation as a **Sequence IIIGA replacement**.

Test Procedure

Test oil is combined with **Iron Ferrocene catalyst** is placed in a reaction vessel. The mixture is reacted under vacuum with **Nitrogen Dioxide** and air for **40 hours at 170°C**, while being stirred with a paddle stirrer. The performance parameter to be evaluated is **low temperature viscosity** as measured by the **ASTM D4684 MRV-TP1.**

ROBO Bench Test Conditions (New - Proposed)

Test Length, h	**40**
Temperature, °C	**170**
Test Oil charge, g	197
Stirrer speed, RPM	200
Catalyst, Iron Ferrocene, ppm	**15**
Airflow, ml/minute	185
Nitrogen Dioxide (Liquid Phase)	**2ml/h for 12 h**
Vacuum for test vessel, mm Hg	18
Volatility (Loss) %	**35-45**

The **ROBO test** has been proposed as an **ASTM standard** and the test is being considered inclusion in **GF- 5.**

Ball Rust Test ASTM D6557 Bench Test

The **BRT (Ball Rust Test) ASTM D6557** is a bench test developed to replace the **Sequence IID** engine test for measuring **rust of iron** or **steel parts** in an engine. It is used to measure a candidate oils ability to **prevent corrosion** of the internal engine parts in service where water and acid build-up occur.

The **BRT is an 18 hour procedure** during which the actual Lifter Ball from a hydraulic tappet is exposed to an **acid/water** solution in air. The performance parameter in this procedure is called the Gray Value Rating. The **Gray Value Rating** is obtained from an instrument that measures reflective intensity which is an indicator of surface area corrosion.

Ball Rust Test Conditions

Equipment	Hydraulic Lifter Ball in a 20cc glass containers with 10 ml of test oil on a shaker table
Test Length	18 hours
Temperature	48°C

Shaker Speed	300 RPM
Air Flow	40 cc / minute
Acid Solution	Acetic/Hydrobromic/Hydrochloric Acids in deionized water
Acid Add Rate	0.19 ml/hour

Humidity Cabinet Rust Test (ASTM D1748)

ASTM D1748 is a standard procedure for evaluating **corrosion protection** capacity of lubricating oil under **high humidity conditions**. Testing is conducted in a sealed chamber called a **Humidity Cabinet** that provides a moisture saturated environment causing continuous condensation and evaporation. Test panels are suspended from a rotating stage and air temperature is maintained at **48.9 ± 1.1°C.**

Performance parameter is the degree of rusting that occurs and is a visual assessment. Proposed limit has been "**No Rust**". **This test has been officially dropped by ILSAC / OIL**.

Seal Compatibility (ASTM D7216-05) Bench Test { New }

ASTM D7216 is a standard procedure for evaluating **oil compatibility with typical seal materials** used in automotive applications.

The **HDEO categories** have had seal compatibility included since the **API CH-4** service category and **GM** has had a requirement for a few years for their passenger car engine oils. Seal compatibility has been proposed for **GF-5** in order to provide a leak free engine which is good for the environment.

The current proposal is to evaluate the seal materials after **336 hours of immersion** in the candidate oil. The **seal material proposed** and the test temperature are listed below: **Seal Compatibility Test Conditions**

Seal Material	Temperature, °C
Polyacrlate Rubber - (ACM-1)	150
Hydrogenated Nitrile Rubber - (HNBR-1)	100
Silicone Rubber - (VMQ-1)	150
Fluorocarbon Rubber (FKM-1)	150
Ethylene Acrylic Rubber - (AEM)	150

The properties measured for each material are:

1. **Volume Change, % Δ**
2. **Hardness Change, Points**
3. **Tensile Strength, % Δ**
4. **Elongation at Break, % Δ**
5. **Tensile Stress at 50% Elongation, % Δ**

Emulsion Retention Bench Test: {New}

Emulsion Retention is an **ILSAC GF-5** issue due to the increasing use of **BioFuels** such as **E-85** in **Flexible Fuel Vehicles**. **Chrysler** has proposed a bench test to evaluate emulsion retention in the **presence of water** and **ethanol** in gasoline. The procedure uses the candidate oil blended* with **10% water** and **10% E-85 fuel**. The expectation is to have the following occur:

Emulsion Retention Test Conditions

24 hours @ 0°C	No water separation
24 hours @ 25°C	No water separation

*blended using a Waring blender or equivalent for 1 minute at room Temperature.
E-85 fuel is 85% Ethanol and 15% gasoline.