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Bio-Ultimax™ 1000 - Navy ASDS* Hydraulic Fluid ISO 32

The test data below show the *Modified Bio-Ultimax™ 1000 Hydraulic Fluid typical specifications and actual bench tests performed by independent laboratories. These tests were performed in combination by Petro-Lubricant Testing Laboratories, Inc., the Lubrizol Corporation, and Chevron Phillips Chemical. The data was collected for a project for **Northrop Grumman Engineering, Ocean Systems Division** to replace the hydraulic fluids for their Advanced Delivery System. Northrup Grumman was informed by the Navy that the current Castrol-130 Food Grade oil was stopping production and therefore needed replaced. The Navy needed to minimize the hazards of the hydraulic fluids for the US Navy Seals that operate and are transported by the submersible. The requirement for the hydraulic fluid involved a P9290 off-gassing test for toxicity and replacement for MIL-PRF-17672D & Amd. 3 2075 T.H. (Grade 32), that is currently used as the outboard hydraulic oil for the submarines. This is identified as a highly critical area for the military. Patented Product: US Patent 6,383,992, US Patent 6,534,454 with additional Pending and Foreign Patents

Tests Performed	METHOD	ISO 32	Castrol-130	Spec. Requirements
Specific Gravity @ 15.6°C API Gravity @ 15.6°C Viscosity @ 40°C Viscosity @ 100°C Viscosity @ -15°C, Brookfield Viscosity @ -25°C, Brookfield Viscosity @ -30°C MRV TP1 Viscosity @ -35°C MRV TP1	ASTM D-287 ASTM D-287 ASTM D-445 ASTM D-445 ASTM D-2983 ASTM D-2983 ASTM D-4684 ASTM D-4684	0.874 30.4 30.87 6.9 500 cP 1,200 cP 4,500 cP 7,500 cP	0.849 35.17 (FAILED) 25.2 4.8 NC NC NC NC	Report Report ISO 32 Note 1 Note 1 Note 1 10W= <60,000 5W= <60,000
Viscosity Index Flash Point (COC) Fire Point (COC)	ASTM D-2270 ASTM D-92 ASTM D-92	184 236°C 260°C	111 (FAILED) 182°C NC	90 (min) 198°C (min) 218°C (min)
Pour Point	ASTM D-97	-39°C	(FAILED) -21°C	MIL-PRF-17672D (Grade 32 <-29°C)
Hydrolytic Stability, Copper Wt. Loss (mg) Copper Appearance % Change in Viscosity @ 40°C Change in Acid Number, mg KOH/g Total Acidity of Water Layer, mg KOH % Insolubles	ASTM D-2619 ASTM D-445 ASTM D-974	-0.017 1B +0.71% +0.16 5.46 +0.001%	-0.008 2C -0.12% 0.00 0.35 +0.003%	0.2 Report Report Report Denison HF-2 6 (max) Report
Foam Sequence Sequence I Initial Volume, ml Final Volume, ml (after seconds) Sequence II Initial Volume, ml Final Volume, ml (after seconds) Sequence III Initial Volume, ml Final Volume, ml (after minutes seconds)	ASTM D-892	420 0 (305 sec) 35 0 (8 sec) 390 0 (4 min 4 sec)	280 0 (153 sec) 20 0 (6 sec) 250 0 (2 min 11.5 sec)	0 Foam after 10 minutes (min) Denison HF-0 industrial specification does not require initial foam volume
Rust Prevention Distilled Water Syn. Sea Water	ASTM D-665	Pass Pass	NC NC	Pass Pass
Copper Corrosion Strip 3hr @ 100°C	ASTM D-130	1B	NC	DIN 51524 2 (max)
Rotary Bomb Oxidation, (minutes)	ASTM D-2272	264	(FAILED) 30	USS 120 (min)
Filterability A-No Water (s) (Avg) B-2% Water (s) (Avg)	Denison TP 02100 HF-0 Requirement	113 187	NC NC	600 (max) 2xA (max)
Demulsibility, ML Oil/Water/Emulsion	ASTM D-1401	40/ 40/ 0 (10 minutes)	40/ 40/ 0 (5 minutes)	40/ 37/ 3 (30 minutes) (max)
4-Ball Wear, 1h, 167°F, 1200 RPM, 40 kg	ASTM D-4172	0.45mm	(FAILED) 0.78mm	USS 127 0.5 (max)
<u>Biodegradation Classification</u> <u>NC Not Completed</u> <u>Note 1 Viscosity Sufficient for Application</u> <u>Note 2 Not Required</u> * <u>Modified For the Navy Advanced Seal</u> <u>Delivery System (Lower Additive Concentration)</u>	ASTM D-5864	Ultimate PW1	Not PW1 Biodegradable	Ultimate PW1