(NAVY) NAVAIR 17-15-50.2
(ARMY) TM 38-301-2
(AIR FORCE) T.O. 33-1-37-2
(COAST GUARD) CGTO 33-1-37-2

15 March 2021
Change 1 – 15 June 2022

TECHNICAL MANUAL

JOINT OIL ANALYSIS PROGRAM MANUAL

VOLUME 2

SPECTROMETRIC AND PHYSICAL TEST LABORATORY OPERATING REQUIREMENTS AND PROCEDURES

The latest change information, change 1 dated 15 June 2022, has been incorporated in this issue and makes this a complete manual.

This manual is incomplete without NAVAIR-17-15-50.1, NAVAIR-17-15-50.3 and NAVAIR-17-15-50.4

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NUMERICAL INDEX OF EFFECTIVE WORK PACKAGES/PAGES

List of Current Changes

Change #	*Date*		*Change #*	*Date*
Original 0	15 March 2021		Change 1	15 June 2022

Only those work packages/pages assigned to the manual are listed in this index. Dispose of the superseded issues of the technical manuals. Superseded classified technical information shall be destroyed in accordance with applicable regulations. The portion of text affected in a changed or revised work package is indicated by change bars in the outer margin of each column of text. Changes to illustrations are indicated by pointing hands or change bars, as applicable.

Total number of pages in Volume 2 of this manual is 382.

Note: the HMWS WP for this manual is located in Volume 2

15 March 2021
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003 02	NAVY OAP – LABORATORY EQUIPMENT AND CONFIGURATION REQUIREMENTS	1 thru 4	1	1
003 03	NAVY OAP - LUBRICANTS ANALYSIS AND RESEARCH APPLICATION (LARA) SYSTEM REQUIREMENTS AND RESOURCES	1 thru 2	0	0
003 04	NAVY OAP – DATA UPLOAD GUIDE AND REQUIREMENTS	1 thru 2	0	0
003 05	NAVY OAP – TEST EQUIPMENT MAINTENANCE AND INSPECTIONS	1 thru 8	0	1
004 00	AIR FORCE OIL ANALYSIS PROGRAM LABORATORIES OPERATING REQUIREMENTS AND PROCEDURES	1 thru 2	1	1
004 01	AIR FORCE OAP – GENERAL LABORATORY OPERATING PROCEDURES	1 thru 10	1	1
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015 00	SETAFLASH LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 4	1	0
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NAVAL AIR SYSTEMS COMMAND TECHNICAL MANUAL PROGRAM

LIST OF TECHNICAL PUBLICATIONS DEFICIENCY REPORTS INCORPORATED

1. The TPDR listed below has been incorporated in this issue

Activity	Report Control Number	Location
FRC West Lemoore	N44321-22-0113	Lemoore CA

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15 March 2021

WARNINGS APPLICABLE TO HAZARDOUS MATERIALS

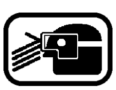
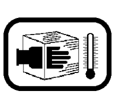
Warnings in this manual alert personnel to hazards associated with the use of hazardous materials. Additional information related to hazardous materials is provided in OPNAVINST 5100.23, Navy Hazardous Material Control Program, and the DOD 6050.5, Hazardous Materials Information System (HMIS) series publications. For each hazardous material used within the Navy, a Material Safety Data Sheet (MSDS) must be provided and available for review by users.

Consult your local safety and health staff concerning any questions regarding hazardous materials, MSDS, personal protective equipment requirements, appropriate handling and emergency procedures, and disposal guidance.

Under the heading “HAZARDOUS MATERIALS WARNINGS”, complete warnings, including related icon(s) and numeric identifier, are provided for hazardous materials used in this manual.

In the text of the manual, the caption “WARNING” is not used for hazardous material warnings. Hazards are cited with appropriate icon(s), the nomenclature of the hazardous material, and the numeric identifier that relates to the complete warnings. Users of hazardous materials shall refer to the complete warnings.

EXPLANATION OF HAZARDOUS MATERIAL ICONS

	**Biological**	The abstract symbol bug shows that a material may contain bacterial or viruses that present a danger to life or health.
	**Chemical**	The symbol of a liquid dripping onto a hand shows that the material will cause burns or irritation to human skin or tissue.
	**Explosion**	This rapidly expanding symbol shows that the material may explode if subjected to high temperature, sources of ignition, or high pressure.
	**Eye Protection**	The symbol of a person wearing goggles shows that the material will injure the eyes.
	**Fire**	The symbol of a fire shows that the material may ignite and cause burns.
	**Poison**	The symbol of a skull and crossbones shows that the material is poisonous or is a danger to life.
	**Radiation**	The symbol of three circular wedges shows that the material emits radioactive energy and can injure human tissue or organs.
	**Vapor**	The symbol of a human figure in a cloud shows that material vapors present a danger to life or health.
	**Cryogenic**	The symbol of a hand in a block of ice shows that the material is extremely cold and can injure human skin or tissue.

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SAE-J1899 (lube Oil)	3	6
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SAE-J2360 (Lube Oil)	7	8
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MIL-PRF-7808	12	11
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HAZARDOUS MATERIALS WARNINGS

Index	Material	Warning
1	Specification TT-T-656, Tricresyl Phosphate 	TT-T-656, FEDERAL SPECIFICATION: TRICRESYL PHOSPHATE. This specification covers tricresyl phosphate, a reaction product of cresylic acid and a phosphorus compound. Cresylic acid derived from petroleum or coal tar is acceptable. Overview and First Aid: Tricresyl Phosphate is a POISON material. It is also a skin, eye, digestive and respiratory tract irritant. May cause irritation of the digestive tract. May cause headache. May cause muscle paralysis, respiratory failure, and possible death. Toxic if swallowed. Overexposure to this product by ingestion, inhalation, or skin absorption may cause cholinesterase inhibition. Symptoms of cholinesterase inhibition may include: headache, nausea, sweating, numbness and tingling of the hands and feet, salivation, muscle twitching, tremors, incoordination, blurred vision, tears, abdominal cramps, diarrhea, and chest discomfort. Avoid contact with skin and eyes. Wash hands thoroughly after each use. Launder contaminated clothing before reuse. If swallowed, get medical aid immediately. Only induce vomiting if directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, get medical aid immediately. Remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Protection: Wear chemical goggles and rubber gloves; half-mask respirator with organic vapor cartridge may be required in poorly ventilated areas, especially when misting occurs. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid. Do not breathe dust, mist, or vapor. Do not get in eyes, on skin, or on clothing. Keep container tightly closed. Do not ingest or inhale. Use only in a chemical fume hood. Storage: Store in a cool, dry place, away from heat, flames, and oxidizing agents.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
2	MIL-PRF-680, Degreasing Solvent 	MIL-PRF-680, PERFORMANCE SPECIFICATION: DEGREASING SOLVENT. This specification covers degreasing solvent that consists of four types of petroleum distillates. The different types are referred to as "Stoddard solvent", "141 degrees Fahrenheit (degrees F) (60.6 degrees Celsius (degrees C)) solvent", "200 degrees F (93.3 degrees C) solvent", and "141 degrees F d-limonene blended solvent". They are used for degreasing of machine parts in equipment maintenance. MIL-PRF-680, degreasing solvent is not classified as dangerous. Good general ventilation should be sufficient to control worker exposure to airborne contaminants. If this product contains ingredients with exposure limits, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure below any recommended or statutory limits. Hygiene Measures: Wash hands, forearms and face thoroughly after handling compounds and before eating, smoking and using the lavatory and at the end of the day. During formulation, follow good industrial hygiene practice. Eye and Hand Protection: Safety glasses with side shields. Natural rubber (latex) gloves. . In case of contact with eyes, rinse immediately with plenty of water. Check for and remove any contact lenses Obtain medical attention if symptoms occur. If ingested do not induce vomiting. Never give anything by mouth to an unconscious person. Get medical attention if symptoms appear. If inhaled, remove to fresh air. If not breathing, give artificial respiration. Get medical attention if symptoms appear. Wash with soap and water. Obtain medical attention if symptoms occur.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
3	SAE-J1899, Lubricating Oil 	OIL, LUBRICATING, AIRCRAFT PISTON ENGINE (ASHLESS DISPERSANT) SAE-J1899, ADOPTION NOTICE; OIL, LUBRICATING AIRCRAFT PISTON ENGINE (ASHLESS DISPERSANT). This SAE Standard establishes the requirements for lubricating oils containing ashless dispersant additives to be used in four-stroke cycle, reciprocating piston aircraft engines. This document covers the same lubricating oil requirements as the former military specification MIL-L-22851. Users should consult their airframe or engine manufacturer's manuals for the latest listing of acceptable lubricants. SAE-J1899 Grades: W65 W80 W100 W120 Lubricating oil, SAE-J1899, is a skin, eye, and respiratory tract irritant. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Avoid contact with skin and eyes. Wash hands thoroughly after each use. Launder contaminated clothing before reuse. If ingested do not induce vomiting. Never give anything by mouth to an unconscious person. Get medical attention if symptoms appear. Store in a cool, dry place, away from heat, flames, and oxidizing agents. Protection: Wear chemical goggles and rubber gloves; half-mask respirator with organic vapor cartridge may be required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water, remove contaminated clothing and shoes. If inhalation occurs, remove from area to fresh air.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
4	SAE-J1966, Lubricating Oil, Aircraft Piston Engine, Mineral Oil, Refer to MIL-PRF-6082 	SAE-J1966, ADOPTION NOTICE; OILS, LUBRICATING, AIRCRAFT PISTON ENGINE (NONDISPERSANT MINERAL OIL). SAE-J1966, "Lubricating Oils, Aircraft Piston Engine (Nondispersant Mineral Oil)", was adopted on 01-NOV-95 for use by the Department of Defense (DoD). This SAE Standard establishes the requirements for nondispersant, mineral lubricating oils to be used in four-stroke cycle piston aircraft engines. This document covers the same lubricating oil requirements as the former military specification MIL-L-6082. Users should consult their airframe or engine manufacturer's manuals for the latest listing of acceptable lubricants. Aircraft lubricating oil, SAE-J1966, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.
5	MIL-PRF-2104 Lubricating Oil, Internal Combustion Engine, 	MIL-PRF-2104, PERFORMANCE SPECIFICATION: LUBRICATING OIL, INTERNAL COMBUSTION ENGINE, COMBAT/TACTICAL SERVICE. This performance specification covers engine oils suitable for lubrication of reciprocating compression-ignition internal combustion engines and for power transmission fluid applications in combat/tactical service equipment. Aircraft lubricating oil, MIL-PRF-2104, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.

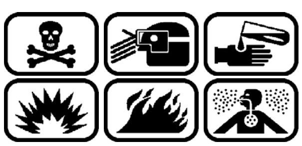
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
6	MIL-PRF-2105, Lubricating Oil, Gear Multipurpose Refer to SAE-J2360 	MIL-PRF-2105, PERFORMANCE SPECIFICATION: LUBRICATING OIL, GEAR, MULTIPURPOSE [S/S BY SAE-J2360]. Aircraft lubricating oil, SAE-J2360, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.
7	SAE-J2360 Lubricating Oil 	This SAE Standard covers multipurpose gear lubricating military oils. This standard is equivalent to MIL-PRF-2105 when all requirements are met. API Category GL-5 designates the type of service characteristic of gears, particularly hypoids in automotive axles under high-speed and/or low-speed, high-torque conditions. SAE-J2360 grades: 75W 80W-90 85W-140 Aircraft lubricating oil, SAE-J2360, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
8	MIL-PRF-5606, Hydraulic Fluid, Aircraft, Missile and Ordinance, Petroleum Base, 	MIL-PRF-5606, PERFORMANCE SPECIFICATION: HYDRAULIC FLUID, PETROLEUM BASE; AIRCRAFT, MISSILE, AND ORDNANCE., This specification describes the characteristics and provides the requirements for a petroleum base hydraulic fluid for use in the -54 Deg. C to +135 Deg. C temperature range. This fluid is identified by military symbol OHA and NATO Code No. H-515. Hydraulic fluid, MIL-PRF-5606, is flammable, toxic and an irritant. Keep away from heat, sparks, open flames and static electricity. Use in well-ventilated area, especially when exposure to hot oil or oil mist is possible. Eye contact: Flush with water for 15 minutes; get medical attention. Skin contact: Wash with soap and water. Ingestion: Do not induce vomiting; get medical attention. Wash hands with soap and water after use and before eating, drinking or smoking. If Swallowed: drink plenty of water, DO NOT induce vomiting. Immediately call a doctor.
9	MIL-PRF-6081, Lubricating Oil, Jet Engine, Petroleum Base 	MIL-PRF-6081, PERFORMANCE SPECIFICATION: LUBRICATING OIL, JET ENGINE., This specification covers the requirements for two grades of jet engine lubricating oil, grades 1010 and 1005. Lubricating oil, MIL-PRF-6081 Grade 1010, is a skin, eye, and respiratory tract irritant. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Avoid contact with skin and eyes. Use with adequate ventilation. Avoid breathing vapor. If heated and ventilation is inadequate, use NIOSH certified respirator, which will protect against organic vapor. Safety glasses, chemical goggles, or face shields recommended to prevent contact. Wear clothing and gloves that cannot be penetrated by chemicals or oil. Wash hands thoroughly after each use. Launder contaminated clothing before reuse. Store in a cool, dry place, away from heat, flames, and oxidizing agents. Protection: Wear chemical goggles and rubber gloves; half-mask respirator with organic vapor cartridge may be required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water, remove contaminated clothing and shoes. If inhalation occurs, remove from area to fresh air.

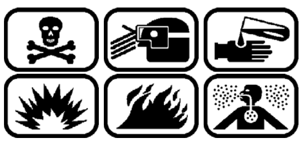
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
10	MIL-L-6082, Lubricating Oil, Aircraft Piston Engine, Mineral Oil, Refer to SAE-J1966 	MIL-L-6082, MILITARY SPECIFICATION: LUBRICATING OIL, AIRCRAFT PISTON ENGINE (NON-DISPERSANT MINERAL OIL) [S/S BY SAE-J1966]. Aircraft lubricating oil, MIL-L-6082, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.
11	MIL-PRF-6083, Hydraulic Fluid, Petroleum Base, 	MIL-PRF-6083, PERFORMANCE SPECIFICATION: HYDRAULIC FLUID, PETROLEUM BASE, FOR PRESERVATION AND OPERATION., This specification describes the characteristics and provides the requirements for one grade of petroleum base hydraulic fluid for use in the -54 DEG C to +135 DEG C temperature range (see 6.1). This fluid is rust inhibited and used both as a preservative for hydraulic systems and components as well as being an operational fluid. This hydraulic fluid will not be used for aircraft systems, aircraft ground support equipment, or the preservation of aircraft components. The hydraulic fluid is identified by Military Symbol OHT and NATO Symbol C-635. Hydraulic fluid, MIL-H-6083, is flammable, toxic and an irritant. Keep away from heat, sparks, open flames and static electricity. Use in well-ventilated area, especially when exposure to hot oil or oil mist is possible. Eye contact: Flush with water for 15 minutes; get medical attention. Skin contact: Wash with soap and water. Ingestion: Do not induce vomiting; get medical attention. Wash hands with soap and water after use and before eating, drinking or smoking.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
12	MIL-PRF-7808, Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, 	MIL-PRF-7808, PERFORMANCE SPECIFICATION; LUBRICATING OIL, AIRCRAFT TURBINE ENGINE, SYNTHETIC BASE., This specification covers the requirements for two grades of aircraft turbine engine lubricating oil, grade 3 and 4. Aircraft lubricating oil, MIL-PRF-7808, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.
13	MIL-PRF-8188, Lubricating Oil, Aircraft Turbine Engine, Synthetic Base 	MIL-PRF-8188, PERFORMANCE SPECIFICATION: CORROSION-PREVENTIVE, AIRCRAFT TURBINE ENGINE, SYNTHETIC BASE., This specification covers the requirements for one type of corrosion-preventive oil for preservation of engines which normally operate on synthetic base oils. This oil is identified by NATO Code Number C-638. Aircraft lubricating oil, MIL-PRF-8188, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
14	MIL-PRF-83282, Hydraulic Fluid, Fire Resistant 	MIL-PRF-83282, PERFORMANCE SPECIFICATION: HYDRAULIC FLUID, FIRE RESISTANT, SYNTHETIC HYDROCARBON BASE, NATO CODE NUMBER H-537., This specification covers the requirements for a synthetic hydrocarbon-base hydraulic fluid for use in the temperature range of -40 deg to +205 deg C. This hydraulic fluid is identified by NATO Code Number H-537. Hydraulic fluid, MIL-PRF-83282, is a skin, eye, and respiratory tract irritant. May contain small quantities of tricresyl-phosphate, a toxic substance. There is a slight fire/explosive hazard when fluid is exposed to heat and flames. Use in well ventilated area. Keep container tightly closed when not in use. Keep away from heat sparks, open flames, and oxidizing agents. Avoid contact with clothing, eyes and skin. Wash hands thoroughly with soap and water after use. Protection: Wear chemical goggles, butyl gloves, and face shield; half-mask respirator with organic vapor cartridge may be required in poorly ventilated areas. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water, remove contaminated clothing and shoes. If inhalation occurs, remove from area to fresh air.
15	MIL-PRF-9000, Lubricating Oil, Shipboard Combustion Engine 	MIL-PRF-9000, PERFORMANCE SPECIFICATION: LUBRICATING OIL, SHIPBOARD INTERNAL COMBUSTION ENGINE, HIGH OUTPUT DIESEL ., This specification covers two grades (SAE 40 and SAE 15W40) of lubricating oil for use in advanced design high-output shipboard main propulsion and auxiliary diesel engines using fuel conforming to MIL-DTL-16884 and MIL-DTL-5624. Military Symbol 9250, NATO Code 0-278 is the designation used for the SAE 40 Grade product. There is not a Military Symbol or NATO designation for the 15W40 Grade product. Aircraft lubricating oil, MIL-PRF-9000, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
16	MS-9250, Lubricating Oil, Refer to MIL-PRF-9000 	MILITARY SYMBOL, MS-9250 is identified as MIL-PRF-9000 (NAVSEA) and NATO Code 0-278. Aircraft lubricating oil, MS-9250, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.
17	MIL-L-15019, Lubricating Oil, Marine Engine Oil, 	MIL-L-15019, Lubricating Oil, Compounded - Symbols 4065 & 6135, Marine Engine Oils, can be used as marine stern tube lubricants where oils complying with MIL-L-15019 Symbols 4065 an 6135 are required. MIL-L-15019 specifies emulsifying type lubricants are formulated using a blend of high grade, medium viscosity index base oils and carefully balanced additive package to meet the crankcase need of marine steam engines. Aircraft lubricating oil, MIL-L-15019, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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18	MIL-DTL-17111, Transmission Fluid, 	MIL-DTL-17111, DETAIL SPECIFICATION: FLUID, POWER TRANSMISSION. This specification covers a class of fluid for use in the hydraulic transmission of power. This fluid is identified by NATO Code No. H-575. Transmission fluid, MIL-DTL-17111, is a skin, eye, and respiratory tract irritant. May contain small quantities of tricresyl-phosphate, a toxic substance. There is a slight fire/explosive hazard when fluid is exposed to heat and flames. Use in well ventilated area. Keep container tightly closed when not in use. Keep away from heat sparks, open flames, and oxidizing agents. Avoid contact with clothing, eyes and skin. Wash hands thoroughly with soap and water after use. Protection: Wear chemical goggles, butyl gloves, and face shield; half-mask respirator with organic vapor cartridge may be required in poorly ventilated areas. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water, remove contaminated clothing and shoes. If inhalation occurs, remove from area to fresh air.
19	MIL-PRF-17331, Lubricating Oil, Petroleum Base, Steam Turbine, 1 	MIL-PRF-17331, PERFORMANCE SPECIFICATION: LUBRICATING OIL, STEAM TURBINE AND GEAR, MODERATE SERVICE ., This specification covers a single classification of steam turbine and gear lubricating oil, moderate service, for use in main and auxiliary turbines and gears, air compressors, and certain hydraulic equipment, as well as for general mechanical lubrication. The lubricating oil will be identified as follows: Military symbol 2190 TEP NATO symbol O-250. Aircraft lubricating oil, MIL-PRF-17331, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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20	MIL-PRF-17672, Hydraulic Fluid, Petroleum Base, 	MIL-PRF-17672, PERFORMANCE SPECIFICATION: HYDRAULIC FLUID, PETROLEUM, INHIBITED. Symbols 2075TH, 2110TH & 2135TH. This specification covers petroleum base hydraulic fluids for use in hydraulic systems and in other applications where a high grade hydraulic fluid having anti-corrosion and anti-oxidation properties are required. This hydraulic fluid is not an extreme pressure (EP) or anti-wear (AW) fluid. This hydraulic fluid should not be used in systems where a fire-resistant fluid is required. Hydraulic fluid, MIL-PRF-17672, is flammable, toxic and an irritant. Keep away from heat, sparks, open flames and static electricity. Use in well-ventilated area, especially when exposure to hot oil or oil mist is possible. Eye contact: Flush with water for 15 minutes; get medical attention. Skin contact: Wash with soap and water. Ingestion: Do not induce vomiting; get medical attention. Wash hands with soap and water after use and before eating, drinking or smoking.
21	MIL-H-19457, Hydraulic Fluid, Fire Resistant, 	MIL-H-19457, MILITARY SPECIFICATION: HYDRAULIC FLUID, FIRE-RESISTANT, NON-NEUROTOXIC., This specification covers the requirements of fire-resistant hydraulic fluid for hydraulic systems which are accumulator loaded and operate above 600 pounds per square inch gauge. Hydraulic fluid, MIL-PRF-19457, is a skin, eye, and respiratory tract irritant. May contain small quantities of tricresyl-phosphate, a toxic substance. There is a slight fire/explosive hazard when fluid is exposed to heat and flames. Use in well ventilated area. Keep container tightly closed when not in use. Keep away from heat sparks, open flames, and oxidizing agents. Avoid contact with clothing, eyes and skin. Wash hands thoroughly with soap and water after use. Protection: Wear chemical goggles, butyl gloves, and face shield; half-mask respirator with organic vapor cartridge may be required in poorly ventilated areas. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water, remove contaminated clothing and shoes. If inhalation occurs, remove from area to fresh air.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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22	MIL-PRF-21260, Lubricating Oil, Internal Combustion, 	MIL-PRF-21260, PERFORMANCE SPECIFICATION: LUBRICATING OIL, INTERNAL COMBUSTION ENGINE, PRESERVATIVE BREAK-IN. This performance specification covers engine oils suitable for preservation, break-in, and lubrication of reciprocating internal combustion engines of both spark-ignition and compression-ignition types, and of power transmission fluid applications in equipment used in combat/tactical service. Aircraft lubricating oil, MIL-PRF-21260, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.
23	MIL-H-22072 Hydraulic Fluid, Catapult, 	MIL-H-22072, MILITARY SPECIFICATION: HYDRAULIC FLUID, CATAPULT, NATO CODE NUMBER H-579 . MIL-H-22072 has been reviewed and determined to be valid for use in acquisition. Hydraulic fluid, MIL-H-22072, is flammable, toxic and an irritant. Keep away from heat, sparks, open flames and static electricity. Use in well-ventilated area, especially when exposure to hot oil or oil mist is possible. Eye contact: Flush with water for 15 minutes; get medical attention. Skin contact: Wash with soap and water. Ingestion: Do not induce vomiting; get medical attention. Wash hands with soap and water after use and before eating, drinking or smoking.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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24	MIL-L-22851, Lubricating Oil, Aircraft Piston Engine, 	MIL-L-22851, MILITARY SPECIFICATION: LUBRICATING OIL, AIRCRAFT PISTON ENGINE (ASHLESS DISPERSENT) [S/S BY SAE-J1899]. This SAE Standard establishes the requirements for lubricating oils containing ashless dispersant additives. SAE-J1899 Grades: W65 W80 W100 W120 Aircraft lubricating oil, MIL-L-22851, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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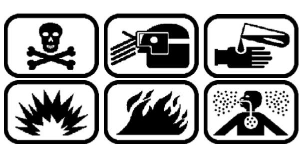
25	MIL-PRF-23699, Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, 	MIL-PRF-23699, MILITARY STANDARD, LUBRICATING OIL, AIRCRAFT TURBINE ENGINE, SYNTHETIC BASE, NATO CODE NUMBER O-156., This specification covers three classes of gas turbine engine lubricating oils, primarily used for aircraft engines, which have a nominal viscosity of 5 centistokes at 100 Deg. C and which are typically made with neopentyl polyol ester base stocks. Aircraft lubricating oil, MIL-PRF-23699, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full- face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.
26	MIL-L-27502, Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, 	MIL-L-27502, MILITARY STANDARD, LUBRICATING OIL, AIRCRAFT TURBINE ENGINE, ESTER BASE., This specification covers the requirements for one grade of aircraft gas turbine engine lubricating oil. Aircraft lubricating oil, MIL-L-27502, is toxic, and a skin, eye, and respiratory tract irritant. If lubricating oil is decomposed by heat, toxic gases are released. Keep away from open flame, sparks, or heat. Use in a well ventilated area, especially when exposure to hot oil or mist is possible. Wash hands thoroughly after use. Launder contaminated clothing before re-use; discard contaminated boots or shoes if oil soaked. Keep containers closed when not in use. Avoid strong oxidizing agents. Protection: Wear chemical goggles, rubber gloves, and protective clothing; full-face piece continuous supplied air respirator required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water; remove contaminated clothing and shoes. If ingested, do not induce vomiting, seek medical attention. If inhalation occurs, remove from area to fresh air.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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27	MIL-PRF-46170, Hydraulic Fluid, Fire Resistant, Synthetic Base 	MIL-PRF-46170, PERFORMANCE SPECIFICATION: HYDRAULIC FLUID, RUST INHIBITED, FIRE RESISTANT, SYNTHETIC HYDROCARBON BASE, NATO CODE NO. H-544, This specification covers the requirements for one type of synthetic hydrocarbon base hydraulic fluid. Hydraulic fluid, MIL-PRF-46170, is a skin, eye, and respiratory tract irritant. May contain small quantities of tricresyl-phosphate, a toxic substance. There is a slight fire/explosive hazard when fluid is exposed to heat and flames. Use in well ventilated area. Keep container tightly closed when not in use. Keep away from heat sparks, open flames, and oxidizing agents. Avoid contact with clothing, eyes and skin. Wash hands thoroughly with soap and water after use. Protection: Wear chemical goggles, butyl gloves, and face shield; half-mask respirator with organic vapor cartridge may be required in poorly ventilated areas. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water, remove contaminated clothing and shoes. If inhalation occurs, remove from area to fresh air.
28	DOD-PRF-85734, Lubricating Oil, Helicopter Transmission System, Synthetic Base, 	DOD-PRF-85734, PERFORMANCE SPECIFICATION: LUBRICATING OIL, HELICOPTER TRANSMISSION SYSTEM, SYNTHETIC BASE., This specification covers the requirements for one grade of a synthetic base helicopter transmission system lubricating oil.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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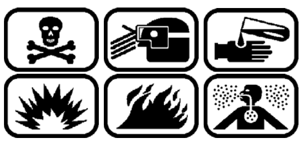
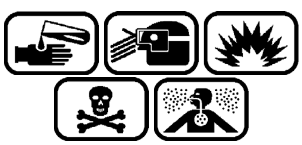
29	MIL-PRF-87257, Hydraulic Fluid, Fire Resistant, Synthetic Base, 	MIL-PRF-87257, PERFORMANCE SPECIFICATION: HYDRAULIC FLUID, FIRE RESISTANT; LOW TEMPERATURE, SYNTHETIC HYDROCARBON BASE, AIRCRAFT AND MISSILE. This specification describes the characteristics and provides the requirements for a synthetic hydrocarbon base hydraulic fluid for use in the -54 degrees C to +200 degrees C temperature range in aircraft and missile hydraulic systems. This hydraulic fluid is identified by NATO Code No. H-538. Hydraulic fluid, MIL-PRF-87257, is a skin, eye, and respiratory tract irritant. May contain small quantities of tricresyl-phosphate, a toxic substance. There is a slight fire/explosive hazard when fluid is exposed to heat and flames. Use in well ventilated area. Keep container tightly closed when not in use. Keep away from heat sparks, open flames, and oxidizing agents. Avoid contact with clothing, eyes and skin. Wash hands thoroughly with soap and water after use. Protection: Wear chemical goggles, butyl gloves, and face shield; half-mask respirator with organic vapor cartridge may be required in poorly ventilated areas. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water, remove contaminated clothing and shoes. If inhalation occurs, remove from area to fresh air.
30	Skydrol® Hydraulic Fluid 	Skydrol® Hydraulic fluid is an odorless, oily liquid, clear to purple in color. It is flammable, toxic and an irritant. Keep away from heat, sparks, open flames and static electricity. Use in well-ventilated area, especially when exposure to hot oil or oil mist is possible. Eye contact: Immediately flush with plenty of water; get medical attention if irritation persists. Skin contact: Immediately flush with plenty of water. Remove contaminated clothing. Wash skin gently with soap as soon as available. Get medical attention if irritation persists. Wash contaminated clothing before re-use. Ingestion: Immediate first aid is not likely required. Get medical attention if irritation persists. Wash hands with soap and water after use and before eating, drinking or smoking.

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HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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31	Philips 66 Reference Oil 50, Lubricating Oil, Base Oil (Petroleum), 	Reference Oil 50 is an eye and skin irritant. No harmful effects are expected from swallowing. Studies by other exposure route suggest a low degree of toxicity by inhalation. Effects of overexposure may include irritation of the digestive tract, nausea or diarrhea. Inhalation of oil mist or vapors at elevated temperatures may cause respiratory irritation. If eye irritation or redness develops, move the victim away from the exposure and into fresh air. Flush eyes with clean water. If symptoms persist seek medical attention. Wipe material from skin and remove contaminated shoes and clothing. Cleanse affected area(s) thoroughly by washing with mild soap and water and if necessary, a waterless skin cleanser. If irritation or redness develops persists, seek medical attention. If respiratory symptoms develop, move victim away from source of exposure and into fresh air. If symptoms persist, seek medical attention. If victim is not breathing, clear airway and immediately begin artificial respiration. If breathing difficulties develop, oxygen should be administered by qualified personnel. Seek immediate medical attention. Fire Protection: This material my burn, but will not ignite readily. If container is not properly cooled, it can rupture in the heat of a fire. Vapors are heavier tan air and can accumulate in low areas. Handling and Storage: The use of appropriate respiratory protection is advised when concentrations exceed any established exposure limits (refer to MSDS). Do not wear contaminated clothing or shoes. "Empty" containers retain residue and may be dangerous. Use and store this material in cool, dry, well-ventilated areas away from heat and all sources of ignition. Store only in approved containers. Personal Protection: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use. The use of gloves impervious to the specific material handled is advised to prevent skin contact and possible irritation. Approved eye protection to safeguard against potential eye contact, irritation or injury is recommended. Depending on conditions of use, a face shield may be necessary. The oil is stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. Extended exposure to high temperatures can cause decomposition. Avoid contact with strong oxidizing agents.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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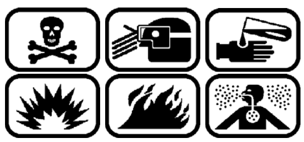
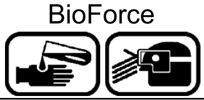
32	Alcohol, Isopropyl TT-I-735 	Isopropyl alcohol, TT-I-735, is toxic, flammable, and a skin and respiratory tract irritant. It may be fatal if swallowed. **DO NOT** use near open flame, sparks or heat. **DO NOT** use synthetic cloths for wiping with this solvent. **DO NOT** smoke, eat or drink when using solvent. Avoid breathing vapor. Use only in well ventilated areas. Metal containers containing solvent shall be grounded to prevent sparking and fires. Avoid prolonged breathing of vapor and skin contact, which can cause dermatitis, irritated nose and throat, and dizziness. Protection: Wear butyl gloves and chemical goggles; faceshield and protective clothing required when splashing is possible or expected; half-mask respirator with organic vapor cartridge required in poorly ventilated areas. If eye contact occurs, flush immediately with large amounts of water for 15 minutes and seek medical attention. If skin contact occurs, wash with soap and water, remove contaminated clothing and shoes. If ingested, give water to drink and seek medical attention. Do not induce vomiting. If inhalation occurs, remove from area to fresh air.
33	BioForce 	BioForce is an eye and skin irritant. Protection: Chemical splash proof goggles, and rubber or plastic gloves. Insure good personal hygiene prior to eating, drinking, or smoking.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
34	1-Bromonaphthalene 96% contains max. 2% 2-bromonapthalene, AF Coolant Contam. Test 	1-Bromonaphthalene is harmful if swallowed. May cause eye, skin and respiratory tract irritation. Target organs: Blood and eyes. Eyes: May cause eye irritation, Naphthalene is an eye irritant and the vapor causes eye irritation at 15 PPM. Eye contact with the solid material may result in conjunctivitis, superficial injury to the cornea, diminished visual acuity and other effects. It may cause cataracts. Skin: May cause skin irritation. May be harmful if absorbed through the skin. The toxicological properties of this material have not been fully investigated. Ingestion: Harmful if swallowed. May cause gastrointestinal irritation with nausea, vomiting and diarrhea. The toxicological properties of this substance have not been fully investigated. Inhalation: May cause respiratory tract irritation. The toxicological properties of this substance have not been fully investigated. May be harmful if inhaled. Chronic: Chronic inhalation, skin absorption or ingestion of naphthalene have caused severe hemolytic anemia. First Aid Measures. Eyes: Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid. Skin: Get medical aid. Flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Ingestion: Get medical aid. DO NOT induce vomiting. If conscious and alert, rinse mouth and drink 2-4 cupfuls of milk or water. Inhalation: Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid if cough or other symptoms appear.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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35	2(3H)-Benzothiazolethione, Sodium Salt (Liquid), AF Coolant Contam. Test 	2(3H)-Benzothiazolethione, sodium salt causes eye and skin burns and may cause allergic skin reactions. Do not get in eyes or on skin or clothing. Avoid breathing vapor or mist. Keep container closed. Use only with adequate ventilation. Wash thoroughly after handling. Routes of entry: Dermal contact. Eye contact. Inhalation. Ingestion. Eye contact: Check for and remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical attention immediately. Skin contact: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately. Inhalation: Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately. Ingestion: Wash out mouth with water. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately. Notes to physician: In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours. Medical conditions aggravated by overexposure: Pre-existing skin disorders may be aggravated by over-exposure to this product. Handling and Storage: Wash hands and face before eating, drinking and smoking. Do not get in eyes or on skin or clothing. Do not breathe vapor or mist. Do not ingest. If during normal use the material presents a respiratory hazard, use only with adequate ventilation or wear appropriate respirator. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Keep away from acids. Empty containers retain product residue and can be hazardous. Do not reuse container. Oxidizes if exposed to air for prolonged periods, resulting in the precipitation of solids. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area. Separate from acids. Personal Protection: Use a properly fitted, air-purifying or air-fed respirator. Chemical-resistant, impervious gloves complying with an approved standard should be worn. Safety eyewear should be used.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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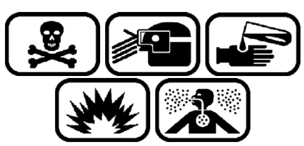
36	Acetic Acid, 96%, AF Coolant Contam. Test 	Acetic acid causes severe eye and skin burns. Causes severe digestive and respiratory tract burns. Flammable liquid and vapor. May be harmful if absorbed through the skin. Glacial acetic acid solidifies below 62°F (17°C). Corrosive to metal. Target Organs: Teeth, eyes, skin, mucous membranes. Potential Health Effects Eye: Causes severe eye irritation. Contact with liquid or vapor causes severe burns and possible irreversible eye damage. Skin: Causes skin burns. May be harmful if absorbed through the skin. Contact with the skin may cause blackening and hyperkeratosis of the skin of the hands. Ingestion: May cause severe and permanent damage to the digestive tract. Causes severe pain, nausea, vomiting, diarrhea, and shock. May cause polyuria, oliguria (excretion of a diminished amount of urine in relation to the fluid intake) and anuria (complete suppression of urination). Rapidly absorbed from the gastrointestinal tract. Inhalation: Effects may be delayed. Causes chemical burns to the respiratory tract. Exposure may lead to bronchitis, pharyngitis, and dental erosion. May be absorbed through the lungs. First Aid Measures Eyes: In case of contact, immediately flush eyes with plenty of water for a t least 15 minutes. Get medical aid immediately. Skin: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse. Ingestion: If swallowed, do NOT induce vomiting. Get medical aid immediately. If victim is fully conscious, give a cupful of water. Never give anything by mouth to an unconscious person. Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid. Notes to Physician: Persons with pre-existing skin disorders or impaired respiratory or pulmonary function may be at increased risk to the effects of this substance. Treat symptomatically and supportively.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
37	Benzotriazole-1,2,3, AF Coolant Contam. Test 	Benzotriazole-1,2,3 is hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Corrosive to eyes and skin. The amount of tissue damage depends on length of contact. Eye contact can result in corneal damage or blindness. Skin contact can produce inflammation and blistering. Inhalation of dust will produce irritation to gastro-intestinal or respiratory tract, characterized by burning, sneezing and coughing. Severe over-exposure can produce lung damage, choking, unconsciousness or death. Potential Chronic Health Effects: The substance may be toxic to the nervous system, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction, or dermatitis. Repeated inhalation of dust can produce varying degree of respiratory irritation or lung damage. First Aid: Eyes - Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately. Skin - immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately. Inhalation - remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. Ingestion - Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband. Personal Protection - Splash goggles. Synthetic apron. Vapor and dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Storage - Keep container tightly closed. Keep container in a cool, well-ventilated area. Keep container dry. Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk,

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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38	BIO-TEK 134 HI-SOLV Cleaning Compound, Solvent, Microscopic Analyses 	BIO-TEK -- 134 HI-SOLV - CLEANING COMPOUND is a clear colorless liquid that is virtually odorless. Avoid strong oxidizers. Prolonged exposure may lead to defatting of the skin. Product is a slight eye irritant. If ingested there is a possibility of nausea. There are no known acute and chronic health hazards. Respiratory Protection: Not normally needed. Ventilation: Local exhaust/mechanical (general): not applicable per manufacturer. Protective gloves: Not normally needed Eye Protection: Not needed. Other Protective Equipment: Not needed. Work Hygienic Practices: None specified by mfr.
39	Chevron FLO-COOL 180, AF Coolant Contam. Test 	Chevron FLO-COOL 180 is a lung, skin and eye irritant. Inhalation of mist may cause irritation. Minute amounts aspirated into lungs may cause pulmonary injury. Skin irritation is not normally expected. Prolonged or repeated skin contact may cause irritation. Signs of overexposure include mild irritation, vomiting and diarrhea. First Aid: Inhalation – remove to fresh air. Eye Contact – Flush with water for 15 minutes. Skin Contact – Wash with soap and water. Get medical attention if symptoms persist. Ingestion – Get medical help. Handling: Avoid prolonged and repeated skin contact and splashing in eyes. Use general ventilation if temperatures are excessively high. Use rubber gloves and goggles. Storage: Store materials in a cool, dry place. Moisture may react with strong oxidizing materials such as chlorates, nitrates and peroxides.

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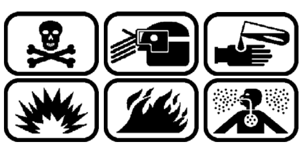
40	COOLANOL 25R, AF Coolant Contam. Test 	COOLANOL 25R is toxic, and a skin, eye, and respiratory tract irritant. Eye Contact - If splashed into the eyes, flush with clear water for 15 minutes or until irritation subsides. If irritation persists, call a physician. Skin Contact - In case of skin contact, remove any contaminated clothing and wash skin with soap and water. Launder or dry-clean clothing before reuse. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Inhalation - Vapor inhalation under ambient conditions is normally not a problem. If overcome by vapor from hot product, immediately remove from exposure and call a physician. If breathing is irregular or has stopped, start resuscitation; Ingestion - If ingested, DO NOT induce vomiting; call a physician immediately. Handling and Personal Protection Use product with caution around heat, sparks, pilot lights, static electricity, and open flame. Ventilation - Use local exhaust to capture vapor, mists or fumes, if necessary. Provide ventilation sufficient to prevent exceeding recommended exposure limit or buildup of explosive concentrations of vapor in air. No smoking or use of flame or other ignition sources. Use supplied-air respiratory protection in confined or enclosed spaces, if needed. Use chemical-resistant gloves, if needed, to avoid prolonged or repeated skin contact. Use splash goggles or face shield when eye contact may occur. Use chemical-resistant apron or other impervious clothing, if needed, to avoid contaminating regular clothing, which could result in prolonged or repeated skin contact. Avoid contact with strong oxidants such as liquid chlorine, concentrated oxygen, sodium hypochlorite, calcium hypochlorite, etc., as this presents a serious explosion hazard. Storage Keep containers closed when not in use. Do not store near heat, sparks, flame or strong oxidants. In order to prevent fire or explosion hazards, use appropriate equipment Personal Hygiene Minimize breathing vapor, mist or fumes. Avoid prolonged or repeated contact with skin. Remove contaminated clothing; launder or dry-clean before re-use. Remove contaminated shoes and thoroughly clean before re-use; discard if oil-soaked. Cleanse skin thoroughly after contact, before breaks and meals, and at end of work period. Product is readily removed from skin by waterless hand cleaners followed by washing thoroughly with soap and water.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
41	Diesel Fuel NO. 2, Fuel Detection Meter 	Diesel fuel no. 2 is a combustible liquid and vapor. Skin contact: Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention if irritation develops. Hands: Wear gloves that cannot be penetrated by chemicals or oil. The correct choice of protective gloves depends upon the chemicals being handled, the conditions of work and use, and the condition of the gloves (even the best chemically resistant glove will break down after repeated chemical exposures). Most gloves provide only a short time of protection before they must be discarded and replaced. Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Inhalation: use only with adequate ventilation. Do not breathe vapor or mist. If ventilation is inadequate, use a NIOSH-certified respirator with an organic vapor cartridge and P95 particulate filter. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. Eyes: Avoid contact with eyes use safety glasses with side shields. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention. Ingestion: Aspiration hazard if swallowed. Can enter lungs and cause damage. Do not induce vomiting. Never give anything by mouth to an unconscious person. Get medical attention immediately. Handling: Vapor may cause flash fire. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard. Explosive in the presence of the following materials or conditions: open flames, sparks and static discharge and heat. In case of fire, use water fog, foam, dry chemicals, or carbon dioxide. Storage Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use non-sparking tools. Take precautionary measures against electrostatic discharges. To avoid fire or explosion, dissipate static electricity during transfer by grounding and bonding containers and equipment before transferring material.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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42	ECOLINK Electron, Rotrode AES Method 	ELECTRON is a non-halogenated industrial chemical. It is a skin irritant avoid extended exposure to unprotected skin wear gloves, and Avoid getting it in eyes, or breathing large amounts of the vapor, (it will dry out nasal passages). Used on a rag or from a spray bottle, the product won't produce fumes in any great quantity, (don't spray ELECTRON under high pressure without adequate ventilation). Primary Routes of Exposure: Oral, Inhalation, & Skin Ingestion: Swallowing large amounts may be harmful by causing gastrointestinal irritation. Inhalation: Breathing large amounts may be harmful by causing nose, throat, and respiratory tract irritation. Eyes: Irritant. Liquid contact will irritate eyes and may cause stinging, tearing, and redness. Skin or Contact: May cause mild irritation of redness and burning. First Aid: Ingestion: Seek medical attention immediately. If individual is drowsy or unconscious, do not give anything by mouth; place individual on left side with head down. Contact medical facility or poison Control center for advice on whether to induce vomiting. Inhalation: Remove to fresh air. If breathing is difficult, give oxygen. Keep person warm and quiet. Seek medical attention. Eyes: Irrigate immediately with water for at least 15 minutes. Get medical attention if irritation persists. Skin: Wash with soap and water. Thoroughly clean contaminated clothes and shoes before re-use. If symptoms persist, seek medical attention. Personal Protection: Eye Protection Safety glasses and splash protection required. Protective Gloves: Nitrile gloves. Respiratory Protection: Not required under conditions of normal use. If vapor mist is present, use NIOSH certified organic vapor mask. Ventilation: Local exhaust/hood or fan may be used. Other Protective Clothing: None required under normal use. Work Practices: Store rags used with this material in an airtight, metal container to prevent spontaneous combustion. Treat this chemical with respect and follow all MSDS instructions.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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43	Ethylene Glycol, AF Coolant Contam. Test 	Ethylene glycol is a toxic material causing immediate and serious toxic effects if swallowed. Symptoms of poisoning may occur after several hours; therefore medical observation for at least 48 hours after the accident. Inhalation: Supply fresh air or oxygen; call for doctor. In case of unconsciousness place patient stably in side position for transportation. Supply fresh air. If required, provide artificial respiration. Keep patient warm. Seek immediate medical advice. Skin Contact: Immediately wash with water and soap and rinse thoroughly. Seek immediate medical advice. Eye Contact: Rinse opened eye for several minutes under running water. Then consult a doctor. Ingestion: Drink lots of water. Induce vomiting if patient is conscious. Call a doctor immediately. Seek immediate medical advice. For safe handling keep container tightly sealed. Store in cool, dry place in tightly closed containers. Ensure good ventilation at the workplace. Store away from oxidizing agents. Store away from water/moisture. This product is hygroscopic. Keep container tightly sealed, protect from humidity and water. In case suitable respirator when high concentrations are present. Use safety glasses, protective work clothing and gloves.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
44	Gasoline, All Grades 	Gasoline is an extremely flammable eye and mucous membrane irritant. It affects the central nervous system and is harmful or fatal If swallowed—aspiration hazard. Gasoline has a high fire hazard. Keep away from heat, sparks, open flame, and other ignition sources. Contact may cause eye, skin and mucous membrane irritation. Harmful if absorbed through the skin. Avoid prolonged breathing of vapors or mists. Inhalation may cause irritation, anesthetic effects (dizziness, nausea, headache, intoxication), and respiratory system effects. Contains benzene, which can cause blood disease, including anemia and leukemia. Gasoline is a moderate eye irritant, may cause skin irritation with repeated contact. Practically non-toxic if absorbed. In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention. On skin contact remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops. The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death. Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur. DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Remove person to fresh air. If person is not breathing, ensure an open airway and provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately. Gasoline contains benzene, a regulated human carcinogen. Benzene has the potential to cause anemia and other blood diseases, including leukemia, after repeated and prolonged exposure. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
45	Heptane, Laboratory Grade, FT-IR Method 	Heptane is an extremely flammable liquid and vapor. Vapor may cause flash fire. Aspiration hazard if swallowed - can enter lungs and cause damage. May cause pulmonary edema. Irritating to eyes and skin. Inhalation may cause central nervous system effects. The product is irritating to eyes, skin, lungs and gastro-intestinal tract. Inhalation may cause central nervous system effects. If ingested there is an aspiration hazard and may cause gastrointestinal irritation, nausea, vomiting and diarrhea. May cause adverse chronic liver and kidney effects. First Aid: Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention. Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Obtain medical attention. Inhalation Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Obtain medical attention. Ingestion Call a physician or Poison Control Center immediately. Do not induce vomiting. Notes to Physician Treat symptomatically. Handling and Storage Use only under a chemical fume hood. Wear personal protective equipment. Keep away from open flames, hot surfaces and sources of ignition. Use only non-sparking tools. Use explosion proof equipment. Take precautionary measures against static discharges. Do not get in eyes, on skin, or on clothing. Do not breathe vapors or spray mist. Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from heat and sources of ignition. Flammables area. Personal Protective Equipment Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. Wear appropriate protective gloves and clothing to prevent skin exposure. Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
46	Hexane, Laboratory Grade, FT-IR Method 	Hexane is an extremely flammable liquid and vapor. Vapor may cause flash fire. Aspiration hazard if swallowed - can enter lungs and cause damage. May cause pulmonary edema. Irritating to eyes and skin. Inhalation may cause central nervous system effects. The product is irritating to eyes, skin, lungs and gastro-intestinal tract. Inhalation may cause central nervous system effects. If ingested there is an aspiration hazard and may cause gastrointestinal irritation, nausea, vomiting and diarrhea. May cause adverse chronic liver and kidney effects. First Aid: Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention. Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Obtain medical attention. Inhalation Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Obtain medical attention. Ingestion Call a physician or Poison Control Center immediately. Do not induce vomiting. Notes to Physician Treat symptomatically. Handling and Storage Use only under a chemical fume hood. Wear personal protective equipment. Keep away from open flames, hot surfaces and sources of ignition. Use only non-sparking tools. Use explosion proof equipment. Take precautionary measures against static discharges. Do not get in eyes, on skin, or on clothing. Do not breathe vapors or spray mist. Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from heat and sources of ignition. Flammables area. Personal Protective Equipment Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. Wear appropriate protective gloves and clothing to prevent skin exposure. Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

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47	MIL-DTL-5624, Jet Fuel JP-5, Fuel Detection Meter 	Jet Fuel JP-5 is a combustible liquid and vapor. Skin contact: Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention if irritation develops. Hands: Wear gloves that cannot be penetrated by chemicals or oil. The correct choice of protective gloves depends upon the chemicals being handled, the conditions of work and use, and the condition of the gloves (even the best chemically resistant glove will break down after repeated chemical exposures). Most gloves provide only a short time of protection before they must be discarded and replaced. Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Inhalation: use only with adequate ventilation. Do not breathe vapor or mist. If ventilation is inadequate, use a NIOSH-certified respirator with an organic vapor cartridge and P95 particulate filter. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. Eyes: Avoid contact with eyes use safety glasses with side shields. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention. Ingestion: Aspiration hazard if swallowed. Can enter lungs and cause damage. Do not induce vomiting. Never give anything by mouth to an unconscious person. Get medical attention immediately. Handling: Vapor may cause flash fire. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard. Explosive in the presence of the following materials or conditions: open flames, sparks and static discharge and heat. In case of fire, use water fog, foam, dry chemicals, or carbon dioxide. Storage Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use non-sparking tools. Take precautionary measures against electrostatic discharges. To avoid fire or explosion, dissipate static electricity during transfer by grounding and bonding containers and equipment before transferring material.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
48	MIL-DTL-83133, Jet Fuel JP-8, Fuel Detection Meter 	Jet Fuel JP-8 is a combustible liquid and vapor. Skin contact: Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention if irritation develops. Hands: Wear gloves that cannot be penetrated by chemicals or oil. The correct choice of protective gloves depends upon the chemicals being handled, the conditions of work and use, and the condition of the gloves (even the best chemically resistant glove will break down after repeated chemical exposures). Most gloves provide only a short time of protection before they must be discarded and replaced. Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Inhalation: use only with adequate ventilation. Do not breathe vapor or mist. If ventilation is inadequate, use a NIOSH-certified respirator with an organic vapor cartridge and P95 particulate filter. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. Eyes: Avoid contact with eyes use safety glasses with side shields. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention. Ingestion: Aspiration hazard if swallowed. Can enter lungs and cause damage. Do not induce vomiting. Never give anything by mouth to an unconscious person. Get medical attention immediately. Handling: Vapor may cause flash fire. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard. Explosive in the presence of the following materials or conditions: open flames, sparks and static discharge and heat. In case of fire, use water fog, foam, dry chemicals, or carbon dioxide. Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use non-sparking tools. Take precautionary measures against electrostatic discharges. To avoid fire or explosion, dissipate static electricity during transfer by grounding and bonding containers and equipment before transferring material.

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49	Methanol 99.9%, Methyl Alcohol, AquaTest 8 Method 	Methanol (Methyl alcohol) is a flammable liquid and vapor. It will easily be ignited by heat, spark or flames. Overexposure causes weakness, headache, and nausea, and vomiting, abdominal pain, dizziness of vision, narcosis coma, and respiratory failure. Routes of exposure include ingestion, inhalation, skin contact and eye contact. Causes irritation to eyes, skin, and the respiratory tract. There is a danger of very serious irreversible toxic effects through inhalation. Maybe be harmful or fatal if ingested. First Aid: Eye contact - Irrigate with water for at least 15 minutes. Move to fresh air, remove contaminated clothing, wash body with soap and water. Ingestation – Induce vomiting, stomach wash if swallowed with 4% solution of sodium bicarbonate. When stored, keep containers closed tightly in cool well ventilated place. Avoid use near strong oxidizers and sources of ignition (heat, sparks and open flames). Burning may produce irritating funes. To protect eyes wear chemical goggles or a face shield. Avoid breathing vapors using a respirator with chemical cartridge. Protect skin/hands wearing rubber gloves, apron and boots.
50	Nitric Acid, 65% - 70%, Karl Fischer Method 	Nitric acid is a severe skin, eye, and respiratory tract irritant. Contact with liquid is corrosive. The acid liberates explosive hydrogen gas when reacting with chlorides or stainless steel. Do not add water to acid. Use only in a well ventilated area. Do not ingest or inhale. Wash hands and face thoroughly after use. Keep container closed when not in use. Keep away from metals. Store in a separate safety storage area for corrosive materials. Protection: Wear faceshield or chemical splash goggles and rubber gloves; halfmask respirator may be required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes, lifting upper/lower eyelids occasionally, and seek medical attention. If skin contact occurs, remove contaminated clothing and shoes, wash with soap and water for 15 minutes, seek medical attention. Discard contaminated clothes. If ingested, do not induce vomiting, give 2-4 cups of milk or water, and seek medical attention. If inhalation occurs, remove from area to fresh air. If breathing is difficult, give oxygen. If not breathing, give CPR. Seek medical attention immediately.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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51	Petroleum Ether, AF Coolant Contam. Test 	Petroleum ether is a dangerous flammable liquid and vapor. Breathing vapors may cause drowsiness and dizziness. Harmful if inhaled or swallowed. Cancer hazard. May cause eye, skin, and respiratory tract irritation. Aspiration hazard if swallowed. Can enter lungs and cause damage. May cause central nervous system depression. Target organs are kidneys, central nervous system and lungs. Chronic exposure to vapors may produce polyneuropathy. May cause kidney damage. Potential cancer hazard. Eyes: May cause eye irritation. On contact immediately flush with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid. Skin: Exposure may cause irritation characterized by redness, dryness, and inflammation. May aggravate existing skin disorders. On contact get medical aid. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Ingestion: Aspiration hazard. May cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure. If ingested do not induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid immediately. Inhalation: Inhalation of high concentrations may cause central nervous system effects characterized by nausea, headache, dizziness, unconsciousness and coma. High vapor concentrations may cause drowsiness. Aspiration may cause respiratory swelling and pneumonitis. May cause numbness in the extremities. For inhalation get medical aid immediately. Remove from exposure and move to fresh air immediately. If breathing is difficult, give oxygen. Do NOT use mouth-to-mouth resuscitation. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask. Handling: Use with adequate ventilation. Wear appropriate protective eyeglasses or chemical safety goggles. Wear appropriate protective gloves. Wear appropriate protective clothing to prevent skin exposure. Avoid ingestion and inhalation. Wash thoroughly after handling. Keep away from sources of ignition. Avoid build up of vapors to explosive concentration. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames. Keep away from heat, sparks and flame. Store in a tightly closed container in a cool, dry, well ventilated area away from incompatible substances.

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52	pH 4 Buffer Calibration Solution, AF Coolant Contam. Test 	pH 4 buffer solution is 99% water however it may irritate eyes, skin, and the respiratory tract. Upon contact with skin, immediately flush with excess water for 15 minutes while removing contaminated clothing. Get medical help if irritation persists. For eye contact, immediately flush with excess water for 15 minutes, lifting lower and upper eyelids occasionally. Get medical help if irritation persists. If ingested call Poison Control immediately. Rinse mouth with cold water. Give victim 1-2 cups of water or milk to drink. Induce vomiting immediately. For inhalation, remove to fresh air. If not breathing, give artificial respiration. This is a pink-orange odorless liquid. It is a noncombustible solution. When heated to decomposition, emits acrid fumes. For normal use ensure adequate ventilation and do not breathe dust or vapor. Avoid contact with skin, eyes, or clothing. Wash hands thoroughly after handling. Store in General Storage Area with other items with no specific storage hazards. Store in a cool, dry, well-ventilated, locked store room away from incompatible materials. For spills, wipe up with absorbent paper or cloth and dispose of in a container. Flush spill area with water.
53	pH 7.00 Buffer Calibration Solution, AF Coolant Contam. Test 	pH 7 buffer solution is 99% water however it may irritate eyes, skin, and the respiratory tract. Upon contact with skin, wash exposed area with soap and water. Get medical help if irritation persists. For eye contact, flush the eye thoroughly with running water. Get medical help if irritation persists. This is a pink-orange odorless liquid. It is quite stable with no defined fire hazard. For spills, wipe up with absorbent paper or cloth and dispose of in a container. Flush spill area with water.
54	Phosphoric Acid, 85+% solution in water, AF Coolant Contam. Test 	Phosphoric acid is a severe skin, eye, and respiratory tract irritant. Contact with liquid is corrosive. The acid liberates explosive hydrogen gas when reacting with chlorides or stainless steel. Do not add water to acid. Use only in a well ventilated area. Do not ingest or inhale. Wash hands and face thoroughly after use. Keep container closed when not in use. Keep away from metals. Store in a separate safety storage area for corrosive materials. Protection: Wear faceshield or chemical splash goggles and rubber gloves; halfmask respirator may be required in poorly ventilated areas, especially when misting occurs. If eye contact occurs, flush immediately with large amounts of water for 15 minutes, lifting upper/lower eyelids occasionally, and seek medical attention. If skin contact occurs, remove contaminated clothing and shoes, wash with soap and water for 15 minutes, seek medical attention. Discard contaminated clothes. If ingested, do not induce vomiting, give 2-4 cups of milk or water, and seek medical attention. If inhalation occurs, remove from area to fresh air. If breathing is difficult, give oxygen. If not breathing, give CPR. Seek medical attention immediately.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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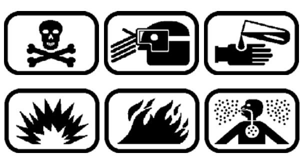
55	Aquatest 2% Water Standard 2712803, Karl Fischer Method 	The PhotoVolt Aquatest 2% Water Standard is a dangerous, highly flammable liquid and vapor containing 98% methyl alcohol. It is toxic if swallowed and/or if comes in contact with skin. It causes serious eye irritation and is toxic if inhaled and may cause respiratory irritation. It may possibly cause drowsiness or dizziness. It can damage fertility or the unborn child. Through prolonged or repeated exposure causes damage to organs, central nervous system and visual organs. Methyl alcohol is a flammable liquid and vapor. It will easily be ignited by heat, spark or flames. Overexposure causes weakness, headache, and nausea, and vomiting, abdominal pain, dizziness of vision, narcosis coma, and respiratory failure. Routes of exposure include ingestion, inhalation, skin contact and eye contact. Causes irritation to eyes, skin, and the respiratory tract. There is a danger of very serious irreversible toxic effects through inhalation. Maybe be harmful or fatal if ingested. First Aid: Eye and skin contact and inhalation - Irrigate with water for at least 15 minutes. Move to fresh air, remove contaminated clothing, and wash body with soap and water. Ingestion – Induce vomiting, stomach wash if swallowed with 4% solution of sodium bicarbonate. When stored, keep containers closed tightly in cool well ventilated place. Avoid use near strong oxidizers and sources of ignition (heat, sparks and open flames). Burning may produce irritating funes. To protect eyes wear chemical goggles or a face shield. Avoid breathing vapors using a respirator with chemical cartridge. Protect skin/hands wearing rubber gloves, apron and boots.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
56	Aquatest Generator Solution 2791003, Karl Fischer Method 	PhotoVolt Aquatest generator solution is a dangerous flammable liquid and vapor. Causes severe skin burns, serious eye damage and irritation of mucous membranes. May damage fertility or the unborn child. Causes damage to organs (central nervous system, kidney, liver, respiratory system, testes, hematopoietic system, respiratory system, thyroid gland) through prolonged or repeated exposure. First Aid: Skin contact - Take off immediately all contaminated clothing. Wash off with soap and plenty of water. Call a physician or poison control center immediately. Call a POISON CENTER or doctor/physician if you feel unwell. For minor skin contact, avoid spreading material on unaffected skin. If skin irritation or rash occurs: Get medical advice/attention. Eye contact - Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Call a physician or poison control center immediately. Get medical attention if irritation develops and persists. Inhalation - Remove person to fresh air and keep comfortable for breathing. Remove contact lenses, if present and easy to do. Seek medical advice/attention. Ingestion - Call a physician or poison control center immediately. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Hygiene and Personal protective equipment - When using, do not eat, drink or smoke. Do not get in eyes. Do not get this material in contact with skin. Do not get this material on clothing. Wash hands before breaks and immediately after handling the product. Contaminated work clothing should not be allowed out of the workplace. Chemical goggles are recommended. Wear protective gloves. Wear appropriate chemical resistant clothing. Conditions to avoid - Heat, flames and sparks. Avoid temperatures exceeding the flash point. Avoid aluminum, strong oxidizing agents, ammonia and oxidizing agents. Storage - Store in a well-ventilated place. Keep cool. Keep away from heat, sparks and open flame. Keep container tightly closed. Store in an area equipped with sprinklers. Disposal - This material and its container must be disposed of as hazardous waste. Dispose of contents/container in accordance with local/regional/national/international regulations. Collect and reclaim or dispose in sealed containers at licensed waste disposal site.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
57	Aquatest Vessel Solution, 891002 Pyridine-Free, Karl Fischer Method (AquaTest 8) 	Photovolt Aquatest Pyridine-Free Vessel Solution is a highly flammable liquid and vapor. Toxic if swallowed. Toxic in contact with skin. Causes severe skin burns and eye damage. May cause an allergic skin reaction. Causes serious eye damage. May cause drowsiness or dizziness. Suspected of causing genetic defects. Suspected of causing cancer. May damage fertility or the unborn child. Causes damage to organs (kidney, liver, respiratory system). Causes damage to organs (central nervous system, kidney, liver, respiratory system, thyroid gland, visual organs) through prolonged or repeated exposure. First Aid: Skin contact - Take off immediately all contaminated clothing. Wash off with soap and plenty of water. Call a physician or poison control center immediately. Call a POISON CENTER or doctor/physician if you feel unwell. For minor skin contact, avoid spreading material on unaffected skin. If skin irritation or rash occurs: Get medical advice/attention. Eye contact - Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Call a physician or poison control center immediately. Get medical attention if irritation develops and persists. Inhalation - Remove person to fresh air and keep comfortable for breathing. Remove contact lenses, if present and easy to do. Seek medical advice/attention. Ingestion - Call a physician or poison control center immediately. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Hygiene and Personal protective equipment - When using, do not eat, drink or smoke. Do not get in eyes. Do not get this material in contact with skin. Do not get this material on clothing. Wash hands before breaks and immediately after handling the product. Contaminated work clothing should not be allowed out of the workplace. Chemical goggles are recommended. Wear protective gloves. Wear appropriate chemical resistant clothing. Conditions to avoid - Heat, flames and sparks. Avoid temperatures exceeding the flash point. Avoid aluminum, strong oxidizing agents, ammonia and oxidizing agents. Storage - Store in a well-ventilated place. Keep cool. Keep away from heat, sparks and open flame. Keep container tightly closed. Store in an area equipped with sprinklers. Disposal - This material and its container must be disposed of as hazardous waste. Dispose of contents/container in accordance with local/regional/national/international regulations. Collect and reclaim or dispose in sealed containers at licensed waste disposal site.

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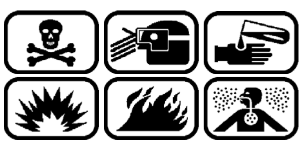
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
58	p-Naphtholbenzein, TAN Method 	p-Naphtholbenzein is a skin and eye irritant and is hazardous when inhaled or ingested. First Aid: Skin Contact - Wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing. Eye Contact - Check for and remove any contact lenses. Do not use an eye ointment. Seek medical attention. Inhalation - Allow the victim to rest in a well-ventilated area. Seek immediate medical attention. Ingestion - Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention. Use and Handling: Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk; evaporate the residue under a fume hood. Do not breathe dust. Wear suitable protective clothing In case of insufficient ventilation, wear suitable respiratory equipment If you feel unwell, seek medical attention and show the label when possible. Avoid contact with skin and eyes. May be combustible at high temperature. Storage: Keep container in a well-ventilated, cool and dry place. Keep container tightly closed. Combustible materials should be stored away from extreme heat and away from strong oxidizing agents. Personal Protection: Wear splash goggles, gloves and a lab coat. Be sure to use an approved/certified respirator or equivalent.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
59	Potassium Hydroxide 0.1N Solution in Methanol, TAN Method 	Potassium hydroxide solution in methanol is a dangerous flammable liquid and vapor containing 92% to 99% methyl alcohol. Causes burns by all exposure routes, is a poison and may be fatal or cause blindness if swallowed. The product may be absorbed through the skin. Prolonged exposure may cause harmful central nervous system effects or pulmonary edema. This product contains a chemical known in to cause birth defects or other reproductive harm. First Aid: Eye Contact - Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required. Skin Contact - Wash off immediately with plenty of water for at least 15 minutes. Get medical attention immediately if symptoms occur. Immediate medical attention is required. Inhalation - Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required. Ingestion - Do not induce vomiting. Call a physician or Poison Control Center immediately. Handling: Use only under a chemical fume hood. Wear personal protective equipment. Keep away from open flames, hot surfaces and sources of ignition. Take precautionary measures against static discharges. Use spark-proof tools and explosion-proof equipment. Use personal protective equipment. Ensure adequate ventilation. Remove all sources of ignition. Take precautionary measures against static discharges. Avoid contact with the skin and the eyes. . Storage: Keep container tightly closed in a dry and well-ventilated place. Keep away from open flames, hot surfaces and sources of ignition. Keep away from acids and metals. Personal Protective Equipment: Eye/face Protection - Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. Skin and body protection - Wear appropriate protective gloves and clothing to prevent skin exposure.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
60	S60S Viscometer Calibration Standard - Cambridge Viscometer 	The S60S Viscometer Calibration Standard is a petroleum hydrocarbon with additives. Inhalation of vapors and/or mists might irritate respiratory tract. Prolonged skin contact will cause defatting and possible irritation. Eye contact might cause irritation. At elevated temperatures flammable vapors and decomposition products will be released. If inhalation of mists, fumes or vapors occurs causing irritation or nausea, move to fresh air. If the symptoms persist obtain medical advice. Material if aspirated into lungs may cause chemical pneumonitis. Remove immediately adhering matter and wash off with soap and plenty of water. Clean mouth with water and drink plenty of water afterwards. Obtain medical advice if a large amount has been swallowed. Do not induce vomiting. Handle in accordance with good industrial hygiene and safety practices. If handled at elevated temperatures or with high-speed mechanical equipment, vapors or mists might be released and require a well-ventilated workplace. Store at ambient temperature or with lowest necessary heating, as handling requires. No special requirements under ordinary conditions of use and with adequate ventilation. Wear oil-resistant protective gloves if there is a risk of repeated skin contact. Wear safety goggles if splashes may occur. Wear protective clothing if there is a risk of skin contact and change them frequently.
61	Silicone (Liquid) - Brookfield Viscometer Method 	Use Silicone liquid calibration fluid with adequate ventilation and avoid eye contact. The product may cause temporary redness and discomfort with eye contact. Flush with water 15 minutes. No significant irritation is expected from a single short-term skin exposure or inhalation. There is a low ingestion hazard with normal use of the product, no first aid required. Personal Protective Equipment for Routine Handling: Eyes: Use proper protection - safety glasses as a minimum. Skin: Washing at mealtime and end of shift is adequate. Suitable Gloves: No special protection needed. Inhalation: No respiratory protection should be needed. Suitable Respirator: None should be needed. Materials to Avoid: Oxidizing material can cause a reaction. Use reasonable care and store away from oxidizing materials.

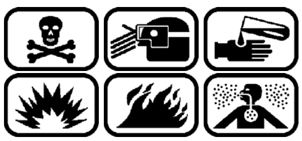
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
62	Sodium Hydroxide 1N (AquaTest 8 Method) 	Sodium hydroxide 1N solution Causes eye burns. May cause lacrimation (tearing), blurred vision, and photophobia. May cause chemical conjunctivitis and corneal damage. In case of contact, immediately flush eyes with plenty of water for a t least 15 minutes. Get medical aid immediately. Causes skin burns. In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse. May cause severe and permanent damage to the digestive tract. Causes gastrointestinal tract burns. May cause perforation of the digestive tract. If swallowed, do NOT induce vomiting. Get medical aid immediately. If victim is fully conscious, give a cupful of water. Never give anything by mouth to an unconscious person. Irritation may lead to chemical pneumonitis and pulmonary edema. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid. Wash hands thoroughly after handling. Remove contaminated clothing and wash before reuse. Use with adequate ventilation. Do not get in eyes, on skin, or on clothing. Keep container tightly closed. Discard contaminated shoes. Do not breathe spray or mist. Keep container closed when not in use. Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from strong acids. Keep away from metals. Keep away from flammable liquids. Keep away from organic halogens. Wear chemical splash goggles. Wear appropriate protective gloves to prevent skin exposure. Wear appropriate protective clothing to prevent skin exposure. A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant respirator use. Avoid extreme temperatures. Incompatible with Metals, acids, aluminum, nitro compounds, zinc, tin, halogenated organics (e.g. dibromoethane, hexachlorobenzene, methyl chloride, trichloroethylene), nitromethane, flammable liquids.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
63	Toluene (Methylbenzene) TAN Method 	Toluene is a dangerous flammable liquid and vapor. Causes eye, skin, and respiratory tract irritation. Vapors may cause drowsiness and dizziness. Aspiration hazard if swallowed - can enter lungs and cause damage. Danger of serious damage to health by prolonged exposure. Possible risk of harm to the unborn child. May cause adverse kidney and liver effects. Target organs: Eyes, Skin, Respiratory system, Liver, Kidney, Central nervous system (CNS), Blood, spleen Irritating to skin; can be harmful when absorbed through skin. Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required Irritating to eyes; rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required. Irritating to respiratory system; may be harmful if inhaled and may cause drowsiness and dizziness. Inhalation: Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required. If ingested do not induce vomiting. Call a physician or Poison Control Center immediately. Aspiration hazard if swallowed - can enter lungs and cause damage. May be harmful if swallowed. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea. Handling: Use only under a chemical fume hood. Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Avoid ingestion and inhalation. Keep away from open flames, hot surfaces and sources of ignition. Use only non-sparking tools. Use explosion-proof equipment. Take precautionary measures against static discharges. Storage: Keep containers tightly closed in a dry, cool and well-ventilated place. Flammables area. Keep away from heat and sources of ignition. Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location. Personal Protective Equipment Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles. Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
64	Viscometer Calibration Standard, Petroleum Base, Cannon 	Cannon General Purpose Petroleum Oil Viscosity Standard is slightly irritating to eyes and skin. Direct contact may cause temporary redness and discomfort. Wash contact skin areas with soap and water. Remove and clean oil soaked clothing daily and wash affected area. Flush eyes thoroughly with water. If irritation occurs, call a physician. Use proper protection – safety glasses as a minimum. No significant effects expected from a single short-term inhalation exposure. Not expected under recommended uses/conditions. However, if respiratory irritation, dizziness, nausea, or unconsciousness occurs due to excessive vapor or mist exposure, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or mouth-to-mouth resuscitation. There is a low ingestion hazard in normal use. If ingested, do not induce vomiting. Repeated and/or prolonged exposure may cause irritation to the skin, eyes or respiratory tract. There are no studies showing evidence of carcinogenic effects. When stored, keep containers closed when not in use. Do not store in open or unlabeled containers. Store away from strong oxidizing agents and combustible materials. Do not store near heat, sparks, flame or strong oxidants.
65	Viscometer Calibration Standard, Synthetic Base, Cannon 	Cannon General Purpose Synthetic Oil Viscosity Standard is slightly irritating to eyes and skin. Direct contact may cause temporary redness and discomfort. Wash contact skin areas with soap and water. Remove and clean oil soaked clothing daily and wash affected area. Flush eyes thoroughly with water. If irritation occurs, call a physician. Use proper protection – safety glasses as a minimum. No significant effects expected from a single short-term inhalation exposure. Not expected under recommended uses/conditions. However, if respiratory irritation, dizziness, nausea, or unconsciousness occurs due to excessive vapor or mist exposure, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or mouth-to-mouth resuscitation. There is a low ingestion hazard in normal use. If ingested, do not induce vomiting. Repeated and/or prolonged exposure may cause irritation to the skin, eyes or respiratory tract. There are no studies showing evidence of carcinogenic effects. When stored, keep containers closed when not in use. Do not store in open or unlabeled containers. Store away from strong oxidizing agents and combustible materials. Do not store near heat, sparks, flame or strong oxidants.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

Index	Material	Warning
66	MIL-DTL-85694, Spectrometric Oil Standards 	MIL-DTL-85694, SPECTROMETRIC OIL STANDARDS., This specification covers the requirements for blended spectrometric oil standards for use in calibrating or verifying the calibration of spectrometers used in spectrometric analysis of metallic elements found in oils and other fluids. Spectrometric oil standards, MIL-DTL-85694, are toxic, and a skin and respiratory tract irritant. Keep away from sources of ignition and heat. Store in cool, dry place in tightly closed original receptacle. Use in well-ventilated area. Eye Contact: Rinse opened eye for several minutes under running water. Skin Contact: Immediately was with water and soap and rinse thoroughly. Ingestion: Rinse mouth. Do not induce vomiting. Immediately call a doctor. Avoid contact with the eyes and skin. Wear appropriate protective eyeglasses or chemical safety goggles and appropriate protective gloves.

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INTRODUCTION TO VOLUME 2 INCLUDING MINIMUM REQUIREMENTS AND SPECTROMETER OPERATING PROCEDURES FOR JOAP LABORATORIES

Table of Contents

1. Introduction. The Purpose of Volume 2 is to standardize the Joint Oil Analysis Program (JOAP) laboratory requirements and operating procedures. The primary test performed by all JOAP laboratories is the spectrometric wear metal analysis of in-service oil samples. This work package contains basic information and instructions regarding equipment and consumable supplies that are recommended for operation of a JOAP laboratory performing spectrometric analysis. Additional requirements and operating instructions for oil analysis laboratories are contained in the applicable Service specific Work Package, i.e. Army – WP 002; Navy – WP 003; AF – WP 004.

2. Facilities. The Laboratory shall have sufficient bench space and proper ventilation to accommodate and operate the oil analysis spectrometer as well as manage the oil sample workload.

3. JOAP Training.

a. Training course available.

(1) Defense Joint Oil Analysis Program Training Course:

Title: Atomic Emission Spectrometer with Physical Properties Testing

Course No.: Navy CIN: A-491-0017B

(2) A model M spectrometer maintenance training course is available from Spectro Scientific owned by AMETEK.

NOTE

It is highly recommended that personnel scheduled for spectrometer maintenance training possess an electronics background.

b. Training requests. Submit training requests in accordance with established service procedures.

4. JOAP Laboratory Instruments. The following atomic emission rotrode instruments are approved for use in the JOAP and are eligible for JOAP certification when enrolled and operated by DOD laboratory personnel.

a. Spectro, Inc. Model M. The "M" is a bench top spectrometer designed for both laboratory and mobility use. It has many built-in safety features for power applications and routine operation. The spectrometer is configured for the fifteen JOAP elements.

b. Spectro, Inc. Model M/N. The "M/N" is essentially the same as the "M". The "M/N has Electro- Magnetic Interference (EMI) protection that meets the requirements of the US Navy. Additionally, the "M/N" has a convenient port for measuring the source frequency.

5. Instrument Requirements Specific to Rotrode AES.

a. Environmental controls. Temperature and humidity will be controlled at 75 ±10°F and relative humidity should be controlled between approximately 20% and 60%. It is important that the temperature and humidity are controlled within the ranges listed and is stable over the course of a working period, shift and/or day. In general this means that environmental conditions should not be allowed to change by more than 10°F (5.5°C) or 10% relative humidity during a 60-minute working period. If a computer is used or is an integral part of the instrument, problems may occur if excessive heat is encountered. For spectrometers in deployed locations, every effort must be made to meet these requirements, as a minimum the spectrometer shall be utilized indoors. In the event that a deployed location cannot meet the temperature and humidity requirements due to mission necessity then the lab shall contact the appropriate Program Manager for guidance and assistance. If temperature and humidity requirements listed are not utilized at deployed locations standardization and operation issues may likely be encountered. For efficient computer operation and to prevent frequent standardizations, environmental control is necessary.

b. Power requirements. Refer to the spectrometer manufacturer's information concerning the application of power to the instrument as the requirements vary from instrument to instrument and country to country. Ensure that all measures are taken to set up the instrument for the correct voltage and frequency (Hz) before applying power. If a multimeter is available, ensure the voltage is constant and within specifications.

c. Exhaust vent. Fumes from the spectrometer must be vented to the outdoors to protect the operator. If you are operating the spectrometer outdoors with mobility equipment, vent the exhaust away from the operator to a sufficient distance to avoid inhalation of fumes. For exhaust systems longer than 25 feet in length, a booster fan is needed to insure adequate ventilation.

6. Laboratory Supplies Required.

a. Spectrometric oil standards.

(1) Description. The D12 and D3 standards are soluble complex metallo-organic compounds that are blended in hydrocarbon base oil. The D12 standards contain approximately the same weight of each of 12 elements (aluminum, chromium, copper, iron, lead, magnesium, nickel, silicon, silver, sodium, tin, and titanium). The D3 standards contain approximately the same weight of each of 3 elements (boron, molybdenum, and zinc). The D19-0 standard is base oil with no elements added. All standards have a minimum flash point of 340 °F (171.1 °C) and a viscosity of approximately 245 centistokes at 100 °F (37.6 °C). The CS-24, D15X, and D30 standards are primarily used by the Navy when standardizing the new 30 element spectrometers.

(2) Ordering Standards. The D19-0, D12, and D3 standards are available in 8 ounce bottles through normal supply sources as stock numbered items. The D19-0, D3 and D12 standards are manufactured by VHG Labs, Inc., 276 Abby Road, Manchester NH 03103 under MIL-DTL-85694 and are distributed to all users through FedMall, https://www.fedmall.mil/index.html.

(a) Standards available.

Table 1. Available Standards

Designation	Elements	Available Concentrations	Shelf Life[1]
D19	None	0	30 months
D3	B, Mo, Zn	100	12 months
D12	Fe, Al, Cr, Cu, Pb, Na, Mg, Ni, Si, Ag, Sn, Ti	5, 10, 30, 50, 100 ,300	30 months
CS-24 [2]	Fe, Ag, Al, Cr, Cu, Mg, Na, Ni, Pb, Si, Sn, Ti, B, Mo, Zn, Ba, Cd, Mn, V, Ca, K, Li, P, As	100	12 months
D15X [2]	Ba, Cd, Mn, V, Ca, K, Li, P, As, Bi, Ce, Co, In, W, Zr	100	12 months
D30 [2]	None	0	12 months

NOTES:

1 Spectrometric Oil Standards reaching the manufacturer's expiration date shall be locally disposed of according to applicable service regulations. When determined operationally necessary, service program managers for the affected weapon system (i.e., AFOAP, NOAP, or AOAP) may permit the use of Spectrometric Oil Standards which have exceeded their manufacturer expiration date.

2 The CS-24, D15X, and D30 standards are primarily for use by Navy laboratories

NOTE

Up to 2 bottles of expired oil standards, normally referred to as "slop oil", may be retained for use for warm-up burns. Higher concentrations of expired standards such as 50, 100 or 300 PPM are best for this purpose. These slop oil bottles must be clearly marked on the label as slop oil - “for warm-up burns only" to ensure that they are not used for standardization of the spectrometer.

Table 2. Elements and Their Symbols

Aluminum	Al		Nickel	Ni		Arsenic*	As
Barium	Ba		Silicon	Si		Bismuth*	Bi
Boron	B		Silver	Ag		Calcium*	Ca
Cadmium	Cd		Sodium	Na		Cerium*	Ce
Chromium	Cr		Tin	Sn		Cobalt*	Co
Copper	Cu		Titanium	Ti		Indium*	In
Iron	Fe		Vanadium	V		Potassium*	K
Lead	Pb		Zinc	Zn		Lithium*	Li
Magnesium	Mg					Phosphorus*	P
Manganese	Mn					Tungsten*	W
Molybdenum	Mo					Zirconium*	Zr

*Navy Instruments Only

(b) Applicable stock number for the D19-0, D3, D12, D15X, CS24, and D30 standards are as follows:

Table 3. Stock Numbers for Spectrometer Standards

PPM Concentration	National Stock Number
0	1RM 9150-00-179-5137-SX
5	1RM 9150-01-307-3343-SX
10	1RM 9150-00-179-5145-SX
30	1RM 9150-00-179-5144-SX
50	1RM 9150-00-179-5143-SX
100 (D3)	1RM 9150-01-283-0249-SX
100 (D12)	1RM 9150-00-179-5142-SX
300	1RM 9150-00-179-5141-SX
100 (D15X)	1680-01-674-3233
100 (CS24)	1680-01-674-3164
0 (D30)	1680-01-675-4175

NOTE

Only spectrometer standards obtained using the National Stock Numbers listed in Table 3 are to be used.

(3) Stocking standards. Due to shelf life control requirements of spectrometer oil standards, local supply departments are prohibited from maintaining standards in stock. Standards ordered through local supply activities will be forwarded from the Navy Inventory Control Point stocking point. Therefore, it is recommended that laboratories frequently inventory standards on hand, maintain no more than 6 months usage level on hand, and order replacement stock 30 to 45 days in advance of anticipated requirements.

b. Electrodes. Both disc and rod electrodes listed below are operating activity expense items and must be ordered through normal supply channels from The Fed Mall, https://www.fedmall.mil/index.html. A suggested 6-month supply is listed in table 4. Only electrodes available through the DoD supply system under the NSN's listed below are approved for use.

Table 4. Spectrometer Electrodes and Stock Numbers

Electrode	P/N	Unit of Issue	NSN
Rod (6 inches long)	M8971-2-2	Box (50 ea)	5977-00-464-8433
Disc (0.200 inch thick)	M8971-1-2	Box (500 ea)	5977-00-464-8496

NOTE

Shipboard and mobile laboratories should order sufficient electrodes to last a full deployment. Six-inch rod electrodes normally provide for 25 to 30 analyses; disc electrodes are for one time use only. Individual packages of electrodes should not be opened until needed and different manufacturer's electrodes should not be intermixed (see paragraph 11 b (1)).

c. Oil sample vessels.

(1) Bottle caps NSN 6640-01-686-2530, with nomenclature of Cap, Screw, Bottle & Jar, P/N 258734, size 24mm, white urea, linerless plastic will be used for performing sample analysis when a JOAP approved cap is not provided with the oil analysis bottle. (These bottle caps were formerly available under NSN 6640-01-042-6583.) They may be obtained either through normal supply channels or by open purchase. A suggested six-month supply is listed in table 5.

NOTE

AF Only: Bottle caps (black) can be used to perform sample analysis. Part number: P-10524 or equivalent. Nomenclature: Sample Holder High Temperature. Quantity: 1000 package. Manufacturer: Ametek Spectro

Scientific. Website: https://www.spectrosci.com/. Phone: 978-486-0123. Labs may purchase from other suppliers as long as part numbers are equivalent.

Table 5. Quantities of Electrodes and Bottle Caps for Six (6) Months

Expected Number of Samples per Month	Electrodes		Bottle Caps
	Disc	Rod	
Up to 1000	16 boxes	6 boxes	8,000
1000 to 3000	40 boxes	16 boxes	20,000
3000 to 5000	64 boxes	26 boxes	32,000

(2) Reusable sample vessels (aluminum boats) are available through normal supply channels under NSN 6650-00-086-1571.

NOTE

AF Only: Locally manufactured reusable aluminum caps are authorized. Please see engineering layout (AF Form 1652). This is the only local manufactured aluminum cap that is approved for use. No deviations or other prototypes are allowed.

d. Miscellaneous supplies.

Table 6. Miscellaneous Laboratory Supplies

Item	Unit of Issue	National Stock No.
Cleaning Compound	QT	6850-00-227-1887
Paper Tissues	40 Sq In.	7920-00-721-8884
TECH Wipes	Large Box	7920-00-965-1709
Stop Watch TBI	EA	6645-00-250-4680
Ultrasonic Cleaner (BF)	EA	4940-00-164-8997
Electrode Sharpener	EA	6650-00-498-8182

(1) Electron (parts washing solvent) has been approved for use in the JOAP program and is available in FedMall as a replacement for trichloroethane. See Table 7 for units of issue and NSN's.

7. Forms Required.

a. Oil Analysis Request (DD Form 2026) may be required by the laboratory to replace damaged or oil soaked copies for analysis results entry and return to customer activities (as required by service policy).

b. Oil Analysis Recommendation and Feedback Form, DA Form 3254-R (Army laboratories).

8. Publications Required. The following publications are required for daily operational reference guides for oil analysis laboratories as indicated.

a. Joint Oil Analysis Program Manual, NAVAIR 17-15-50, TM 38-301, T.O. 33-1-37. All laboratories should have Volumes 1, 2 and 3. Laboratories providing support for non-aeronautical equipment must have Volume 4.

b. Spectro, Inc. Model M/N Operation and User Maintenance Manual applicable to the specific model/series of spectrometer being used for analysis. These include U. S. Air Force T.O. 33B4-2-29-11, 33B4-2-29-1, 33B4-2-29-21, 33B4-2-29-22, 33B4-2-29-41 (depends on Spectrometer series) and U.S. Navy NA 17-15BF-95

c. Message Address Directory: Army DA Pamphlet 25-1-1 (Army laboratories only).

9. Sample Processing.

a. Test and evaluation priority shall be as follows:

(1) Special aeronautical.

(2) Routine aeronautical.

(3) Special non-aeronautical.

(4) Routine non-aeronautical.

b. Each laboratory shall analyze samples, evaluate results, and transmit recommendations to the customer as soon as possible during normal working hours on a non-reimbursable basis. Aeronautical samples shall be processed within 24 clock hours of receipt and non-aeronautical samples within 72 clock hours of receipt, weekends and holidays excluded. Equipment specific variations to these time requirements are noted in the specific equipment tables in volumes 3 and 4.

c. If delays are expected in processing priority samples, the laboratory shall notify the customer as soon as possible.

d. The laboratory shall normally request a special sample for verification of analysis prior to a recommendation for maintenance action.

10. Disposal of Oil Sample Bottles and Caps. All oil sample bottles (glass and plastic), bottle caps, plastic tubing and unused oil shall be segregated for disposal and disposed of in accordance with local base requirements.

11. Spectrometer Preparation and Operation. Spectrometers shall be operated in accordance with the applicable manual (See paragraph 8.a (3)) including any superseding Technical Order(s) or Program Manager Instructions. This paragraph provides basic policies and minimum procedures related to the operating procedures of specific instruction. All spectrometers require preliminary preparation prior to operational use (spectrometers that are being used that flying day). Daily standardization checks in accordance with procedures identified in the manuals for each spectrometer shall be performed once each day prior to operation (As a minimum Air Force labs will perform a daily standardization at the beginning of each shift.)

If the daily standardization check is out of acceptable ranges, a complete standardization shall be performed in accordance with the applicable spectrometer manual. A complete standardization should be performed at least once each week to ensure that the instrument is operating correctly and available to test samples (not applicable to AF LABS). Those spectrometers that do not have any automatic frequency adjustment (Spectro M and M/N) shall be checked at least once every 2000 burns. Laboratories will periodically check standardization throughout the operational period using the zero (0) and 5 ppm standards. At a minimum these checks will be made midway through the operational period (shift). Army and Navy laboratories will conduct a standardization check when switching from the analysis of aeronautical to non-aeronautical samples or vice versa. The following instructions also apply:

a. All laboratories. Personnel shall not smoke, eat, or drink in close proximity (<3 feet) to oil analysis equipment, sample preparation areas, or ADP (Automatic Data Processing) equipment. Cell phone use is not allowed while operating laboratory analytical or ADP equipment. Laboratories shall operate observing recommended environmental requirements (such as temperature and humidity) including adequate overhead illumination and ventilation so as to safely and accurately process samples.

b. Atomic Emission Laboratories.

(1) Electrodes. An analysis obtained on a sample using one manufacturer's electrodes will frequently vary from results obtained on the same sample when using electrodes from another manufacturer. Therefore, when a change is made from one manufacturer's to another manufacturer's disc electrodes, or a change in lot or batch number of the same manufacturer occurs, a disc offset and daily standardization check must be performed using the new disc electrodes before continuing operations. Also, ensure that the operator performs a disc-offset procedure if this procedure is required for the spectrometer in use (typically Spectro, Inc. Model M and M/N). Refer to the spectrometer manual.

(a) Rod electrodes will be sharpened only on one end after each burn. The burnt end of a rod electrode should be wiped using a laboratory tech wipe prior to sharpening or storing. The sharpening process must remove all contamination from the previous burn. Contamination is readily visible as stains/discolorations on the flat face and the sides of the electrode and must be completely removed in order to avoid contamination of subsequent analysis burns. The sharpened end should have a smooth, polished appearance and the slight point on the sharpened end must be geometrically centered. Rod electrodes must not be handled by the sharpened end in order to avoid contamination. Place tape around the end of the rod electrode which will be handled by the operator to avoid contamination. Electrodes will be kept in a contamination free covered container while not in use.

(b) Disc electrodes are one time use only and must be discarded after each sample analysis. Electrodes will not be picked up or touched with the hands but will always be handled with a tissue to avoid the possibility of contamination. Discs will not be poured out in an open container, but will be left in the original container until ready for use. Dropped or spilled electrodes should be discarded due to the possibility of being chipped, broken or contaminated.

(2) Sample vessels. White caps (NSN 6640-01-686-2530) [and Black caps (P-10524 or equivalent), AF Only] will be used as sample vessels for all sample analyses except when analyzing low flash point fluids (approved sample bottle cap may be used as a vessel for analysis. See WP003, T.O. 33-1-37-1). Low flash point fluids shall be analyzed using the aluminum boat with cover (NSN 6650-01-011-3472). If an insufficient amount of fluid is available for analysis to fill a cap, an aluminum boat may be used for the analysis. Aluminum boats and covers must be thoroughly cleaned before use. All caps and aluminum boats must be covered or in a contamination free container when not actively

being used. Electron solvent is the primary fluid recommended for cleaning the aluminum boats and covers. Any solvent that dissolves the oil may be used, but the solvent must have no metallic content to contaminate the boats and covers and present no serious health risk to the user or the environment. The solvent must also not affect the sample stand components when used for cleaning the sample stand. No cleaner may be used that has a flash point below 140 degrees F or one which is considered an ozone depleting substance. Consult with your local environmental personnel to ensure that any fluid that is used is completely safe and that correct usage and disposal procedures are in effect. See Table 7 for information on obtaining Electron Solvent.

Table 7. Electron Cleaning Solvent Stock Numbers

Unit of Issue	NSN
55 gallons drum	6850-01-375-5555
6 gallons	6850-01-375-5553
1 gallon	6850-01-375-5554
Aerosol spray (12 cans per box)	6850-01-371-8048
Pump spray (12 bottles per box)	6850-01-371-8049

(3) Sample excitation stand cleaning. The excitation stand area must be kept clean in order to obtain accurate and repeatable analyses. Dirt and oil, in addition to distorting sample results, may also cause high-voltage arcing, which may result in damage to the instrument. All personnel must adhere to the cleaning procedures and schedules given in the applicable instrument owner's manual. Refer to 8.a (3) of this work package for the applicable manual numbers.

12. Data Recording, Processing, and Warehousing. Each Service has unique software and data handling processes and procedures. Refer to Volume 2 WP 002 (Army), WP 003 (Navy), and WP 004 (Air Force) as applicable for the appropriate requirements, information and procedures.

a. The US Army data is processed and warehoused by the U.S. Army Program Management office at Redstone Arsenal, Huntsville, AL. The U.S. Navy data is processed and warehoused by the U.S. Navy Program Management office at NAS Patuxent River MD. The US Air Force data is processed and warehoused by the US Air Force Program Management Office at Tinker AFB, Oklahoma City, OK.

(1) Laboratories shall submit data to their respective service database as directed by the Service Program Manager or as contained in Volume 1, Work Package 004 00.

(2) Each Service Program Manager is responsible for routine data transfer to the other services.

NOTE

JOAP laboratory personnel are responsible for ensuring that all processed oil analysis results are entered into the applicable service database. This includes assigned, temporarily assigned, transient, and deployed assets. The analysis information shall be supplied to the owning organization or home base location for database entry or update of records as applicable. Retain a copy of the analysis data until receipt is confirmed to ensure that no analysis data is lost.

Army only: The AOAP Program Manager will provide technical assistance and initiate corrective software program changes to the Oil Analysis Standard

Interservice System (OASIS) laboratory operating system. If OASIS software support is required, contact the AOAP Manager as follows:

Army Oil Analysis Program
ATTN: AMAS-SPR-A
Building 3661 Ajax Road
Redstone Arsenal, AL 35898
AOAP Field Operations Hot Line:
DSN: 645-0236 / (256) 955-0236 or
Email: usarmy.redstone.asc.list.aoap-field-ops@mail.mil

(3) Data Reports. Routine reports are produced from laboratories and from the service database. Examples of some of the reports available are included in Volume 2 Work Packages 002 (Army), 003 (Navy) and 004 (Air Force).

b. The DD Form 2026 is used as a source document for basic information to access the computer file data and for entry of variable sample data into the computer files. Entry of sample analysis data on the DD Form 2026 by the laboratory is not required unless required by individual service policy for return of the DD Form 2026 to the customer.

c. Non-automated laboratories (All AF labs). The following information is for use by those non-automated laboratories required to transmit manually accumulated data into the JOAP database and may be directed for use by other service program managers for their automated laboratories experiencing ADP equipment failure.

(1) The DD Form 2026 is used by Air Force non-automated laboratories for submission of data for entry into the JOAP data base (see WP 004 03 for specific Air Force data submission instructions), and may be directed for use by other service program managers in appropriate circumstances.

NOTE

If the DD Form 2026 reports that oil was added since the last sample data was submitted, use wear-metal columns Ba, Cd, and Mn to record the unit of measurement in Ounces (O), Pints (P), Quarts (Q), or Gallons (G), the numerical quantity of oil added, and the oil consumption rate in unit quantity per hour. (For example, Q1-0.5; i.e., 1 quart of oil added and a consumption rate of 0.5 quarts per hour.) To determine the oil consumption rate, compute the operating hours between oil additions by subtracting previously reported oil addition time since oil change (TSOC) or time since overhaul (TSO) from latest oil addition TSOC or TSO. Divide the reported quantity of oil added by the operating hours calculated above for the oil consumption rate per operative hour. The oil consumption rate trend provides additional information to aid the laboratory evaluator and maintenance personnel in evaluating equipment condition. The individual taking the sample must ensure that all oil added since the last sample (regardless of the number of hours between samples) is documented on the DD Form 2026, including oil added after the current sample is taken so that the rate of oil usage can be correctly determined. For example, over the course of 100 hours between samples, oil has been added 8 times and added after the current sample for a total amount of 1 quart.

13. Analytical Data Evaluation. Techniques for evaluating analytical results, evaluation criteria, and the methodology for establishing criteria are contained in Volumes 3 and 4.

14. Response to Customers.

a. Response requirements. Each laboratory is required to provide analysis results, recommendations, and additional information, when applicable, to customers as shown below. Shorter laboratory response time requirements than those specified in paragraph 9 may be assigned by parent program management offices since response time requirements vary according to type equipment, operational and mission differences and individual service requirements. Equipment specific variations to these time requirements are noted in the specific equipment tables in Volumes 3 and 4.

(1) Army and Navy. Upon receipt, laboratory personnel shall stamp the DD Form 2026 with a sample number and the date received.

(2) The Army requires the processed DD Form 2026/DA Form 5991-E, Oil Analysis Request, to be returned to the submitting Army unit personnel.

(a) Laboratory personnel shall circle in red all incomplete or obviously incorrect entries on DD Form 2026 submitted with samples and a copy of the incorrect or incomplete DD Form 2026 shall be returned to the customer's QA for corrective action. Laboratories shall return the processed DD Form 2026 stamped with either PROCESSED (date) NORMAL RESULTS" or "PROCESSED (date) ABNORMAL RESULTS" to all customers. The laboratory shall annotate the DD Form 2026 with the laboratory recommendation and if the recommendation is other than normal with enough information to identify what was abnormal. For example "High iron" or "low viscosity." At a minimum. DD Form 2026 will be returned within a week.

(b) Each laboratory is required to provide information to customers that will enable the customer to ensure that all samples taken were received and analyzed by the laboratory. For samples with normal results, return of the processed DD Form 2026 will serve as notification of completion of sample analysis. For samples with abnormal results, the laboratory shall advise the owning unit of the laboratory recommendation either in person, by telephone or electronic correspondence within 24 clock hours of sample receipt for aeronautical samples and within 72 clock hours of sample receipt for nonaeronautical samples, weekends and holidays excluded.

(c) Laboratories shall provide units with Oil Analysis Standard Interservice System reports as required.

At a minimum, Army laboratories shall provide the Components enrolled in AOAP and the Resample and Type Recommendation Reports monthly to all using units.

(d) Army only. Requests for samples and oil changes shall be made on DD Form 2026. Recommendations for maintenance actions shall be made on DA Form 3254-R, Oil Analysis Recommendation and Feedback. Once initial contact is made in person or by telephone, the laboratory shall follow up with a DA Form 3254-R for all on-post units and for off-post nonaeronautical Reserve and National Guard units. For aeronautical Reserve and National

Guard units and for off-post active Army units (aeronautical and non-aeronautical) the laboratory shall follow up initial contact with a priority message confirming initial contact and a DA Form 3254-R by mail. The DA Form 3254-R shall be forwarded within 24 clock hours following the initial contact. A DA Form 3254-R and instructions for laboratory preparation of the form are in WP 002 03.

(3) Air Force laboratories and Navy non-aviation samples do not require the processed DD Form 2026 to be returned. They should ensure that the customer is notified of the receipt and processing of all samples. Navy laboratories shall also be responsible for providing adequate analysis information to the customer, as directed by responsible authority, to enable the customer to comply with the requirement imposed by COMNAVAIRFORINST 4790.2B to maintain records of oil analysis results to highlight equipment trends.

(4) Interservice response requirements. Laboratories performing interservice fluid analysis service shall comply with the requirements of the customer's parent service regarding sample response unless alternate response procedural agreements between services are reached.

(5) Samples requiring amplified response. All laboratories must provide sample analysis results, including laboratory recommendation information when applicable, to the customer activity for all types of samples listed below:

(a) All special samples.

(b) All samples for which the analysis indicates possible discrepancy.

(c) All samples suspected to be invalid.

(d) All samples for which response is specifically requested by the operating activity in special circumstances.

b. Content and terminology. Each response shall contain the following information:

(1) Equipment model and serial number and end item model and serial number. This information is provided by the customer on the Oil Analysis Request (DD Form 2026).

(2) Sample analysis. The sample analysis shall be reported as normal, marginal, high, or abnormal for individual metal content. In cases where there are no limits specified in Volumes 3 or 4 just provide the data.

(3) Date sample Taken. As provided on DD Form 2026.

(4) Recommendations. Each response shall contain the complete recommendation description corresponding to the applicable recommendation code.

NOTE

Laboratory recommendations are indeed only recommendations. It is the customer's responsibility to take appropriate corrective action. If a disagreement between the laboratory and customer arises concerning corrective action, the discrepancy should be entered in the equipment forms by laboratory personnel and corrective action taken, if any, entered by the customer.

c. Method of response. Each laboratory response shall be prepared and delivered as follows:

(1) Results involving operational/flight safety. Whenever analysis of any sample results in a laboratory determination that operational/flight safety is affected, the laboratory shall immediately provide detailed information to the customer by telephone, when possible, followed by priority message (or memorandum for on base responses if desired) for confirmation of results and recommendations.

(2) Results not involving operational/flight safety. Whenever analysis of a sample results in a recommendation requiring the customer to take action, but does not involve operational/flight safety, reports shall be made verbally followed by a memorandum report for on base/post customers (except in cases where information copies of official notification correspondence are required by higher commands) and by message, email or letter, as appropriate for off base/post customers. All sample results shall be reported to the customer within 3 working days.

(3) Message format. A recommended format for a priority message for use in reporting analysis results Involving operational/flight safety follows:

FROM: LABORATORY

TO: CUSTOMER

INFO: SERVICE OIL ANALYSIS PROGRAM MANAGEMENT OFFICE

COGNIZANT FIELD ACTIVITY (USN) /ITEM MANAGER (USAF)

(Engine/component removal recommendations only)

TYCOM (USN) /MAJOR COMMAND (USA, USAF)

(Engine/component removal recommendations only)

OTHER INFO ADDRESSEES (as directed by individual service requirements)

UNCLAS

SUBJ: JOAP OIL SAMPLE ANALYSIS REPORT

REF: (A) NA 17 15 50/TM 38 301/T.O. 33 1 37

1 IAW REF (A) FOLLOWING REPORT SUBMITTED

a. SAMPLE NUMBER (if assigned) AND TYPE (routine/ Special).

b. DATE SAMPLE TAKEN.

c. END ITEM IDENTIFICATION (serial / ID number).

d. EQUIPMENT MODEL AND SERIAL NUMBER.

e. SAMPLE ANALYSIS RESULTS (normal, marginal, high, abnormal for specific elements)

f. RECOMMENDATIONS (use plain language corresponding to specific recommendation codes) RECOMMEND DO NOT FLY, DO NOT CHANGE OIL, SUBMIT CHECK SAMPLE ASAP, ETC.

(4) Laboratory responses to contractor customers requiring oil analysis support in support of a contract with a component of DOD shall contain the same information as responses made to military operating activity customers.

15. Transfer of Oil Analysis Records. Any time that an oil analysis customer relocates, either deployed or permanently, and oil analysis services are required at the new location, the transfer of workload and provision of services shall be handled through the normal chain of command in order to ensure orderly transfer of support. Unusual problems encountered should be referred to the appropriate service oil analysis program management office for resolution.

a. Transient equipment records. Transient customers are responsible for obtaining complete oil analysis records for their equipment from the losing laboratory and for delivery of the records to the gaining laboratory at the new operating site. If sufficient time is not available to comply with these procedures prior to departure, the customer shall notify the losing laboratory concerning the relocation and the losing laboratory shall email, mail or fax all required oil analysis records to the gaining laboratory.

b. Permanent relocation/temporary deployment. Whenever the oil analysis workload is transferred from one laboratory to another due to customer transfer, the following instructions apply:

(1) Transferring activity (Customer). The customer activity is responsible for notifying the home base (supporting) oil analysis laboratory concerning transfer/deployment schedules in advance of departure. Advance notice is required in order to provide the laboratory sufficient time for orderly processing of records for transfer to the new supporting laboratory to avoid disruption in equipment oil analysis monitoring schedules.

(2) Transferring/losing laboratory. The losing laboratory will forward equipment oil analysis records directly to the gaining laboratory unless directed otherwise by competent authority. The losing laboratory shall ensure that each equipment record transferred is complete, accurate and legible.

(a) When both the losing and gaining laboratories are equipped with appropriate automated systems the record transfer may be accomplished using ADP products in accordance with instructions provided by the appropriate service program management office.

(b) When only one or neither laboratory is equipped with an automated data system, a copy of records must be made for transfer. Either a hardcopy computer record printout or copies of DD Form 2026 may be used, depending upon the losing laboratory capabilities.

(c) The following actions will be taken by transferring/losing laboratories:

1. Customer temporary deployment.

a. Retain original oil analysis records.

b. Forward copies of records to gaining laboratories.

c. Update or replace original records upon return of customer/equipment and notify deployment site laboratory of records receipt.

NOTE

In cases where equipment will be deployed for lengthy periods exceeding normal laboratory equipment data retention periods, losing laboratories may elect to transfer the original records and retain copies only for the normal retention period.

2. Customer permanent transfer.

a. Retain copies of oil analysis records.

b. Forward original records.

c. Destroy copies retained either upon notification of receipt of records by the gaining laboratory or at the expiration of the normal record retention period depending Service requirements.

(3) Gaining laboratory. The historical records for gained equipment will provide a baseline for evaluations and recommendations when providing service to the new customer. Problems encountered in data transfer should be immediately referred to the appropriate program management office. The gaining laboratory will take the following actions upon receipt of newly gained equipment oil analysis records:

(a) Notify losing laboratory when oil analysis records have been received and screened for completeness, accuracy, and legibility.

(b) Initiate new records if required.

(c) If deployed customer, forward original of records accumulated during deployment to the customer's home base supporting laboratory upon completion of deployment. Format of records for transfer will be determined by ADP capabilities of both laboratories involved. Retain data/copies of records until notified of records receipt by customer's home base supporting laboratory.

(d) Lost oil analysis records. In the event copies of oil analysis records are lost during transfer, either the customer or the gaining laboratory, as appropriate, should request new copies of the oil analysis records from the losing laboratory.

NOTE

The above procedures also apply to an operating activity that is reassigned to another service's laboratory.

16. Disposal of Oil Analysis Records. The original copy of an oil analysis record (DD Form 2026) may be destroyed by the originating laboratory 3 calendar months after receipt.

17. Contingency Operations. Whenever a JOAP laboratory becomes inoperative, the following procedures apply.

a. If operational capability cannot be restored within a reasonable time consistent with operational safety, as determined by the appropriate program manager or the on-site commander for deployed units, the laboratory shall contact their program management office and the back-up laboratory listed in the JOAP Directory (or as directed by the applicable program manager) and provide the following information:

(1) Estimate of duration of laboratory downtime.

(2) Number of samples backlogged.

(3) Average number of samples received daily.

(4) Method of transporting samples to back-up laboratory.

b. Temporary additional staffing, TAD/TDY of personnel from an inoperative laboratory for the reassignment of workloads may be necessary. The two laboratories shall negotiate staffing requirements and coordinate with local management as required. (At those bases/posts having no government or contract laboratories, U.S. government personnel shall negotiate workload transfers and personnel support for the laboratories.) Staffing problems not settled between affected laboratories shall be referred to the appropriate OAP management office for resolution (AF labs refer to your local management and/or MAJCOM Functional for resolution).

c. If the laboratory supports customers of more than one service, the disposition of backlogged samples shall be coordinated between the appropriate service program management offices.

18. Requests for Spectrometer Maintenance.

a. Army laboratories. After exhausting local capabilities for repair, Army laboratories shall contact the AOAP Program Office.

b. Navy laboratories. After exhausting local capabilities for repair, Navy laboratories shall contact the Navy Oil Analysis Program Office for assistance.

c. Air Force laboratories. After exhausting local maintenance capabilities, Air Force laboratories shall contact the spectrometer manufacturer for additional troubleshooting assistance. Contact Spectro via phone, 1-888-486-0123, or email at service@spectroinc.com. If the problem still cannot be resolved, Air Force laboratories shall contact the AF OAP PMO for assistance.

NOTE

An unauthorized modification to USAF oil analysis equipment (software/hardware) is a violation of government contracts and will void warranty/maintenance contract. Costs associated with repair of unauthorized modification will be levied on the owning unit.

19. Spectrometer Protection during Shutdown Periods. During in-port shutdown periods in excess of two weeks and during shutdown periods when spectrometer protection is required, such as shop renovation or shipyard repair, laboratory managers shall ensure that laboratory personnel protect the spectrometer from

contamination (dust, paint chips, moisture, etc.). A plastic covering or preservation paper, taped to form a complete barrier is recommended for this purpose. NOAP Labs should contact the NOAP Office and request their spectrometer(s) be placed in “Stored” status.

20. Laboratory Authorization. Based upon laboratory facilities, personnel qualifications, and adherence to applicable JOAP guidance, laboratories are categorized as either authorized or unauthorized by the applicable individual Service Oil Analysis Program Manager. Authorized Laboratories in conjunction with Certified Spectrometers may provide oil analysis support to customers

21. JOAP Lab Correlation Program. The JOAP Correlation Program verifies systematic DoD Spectrometer Correlation. Based upon Monthly Correlation scores, individual spectrometers are categorized as Certified (i.e., PASS) or Uncertified (i.e., FAIL). Decertification refers to any scenario besides failing monthly correlations where the Spectrometer is considered non-operational (e.g. SN not enrolled; Correlation Non-submittal). Participation in this spectrometer correlation program is mandatory for all atomic emission rotrode spectrometer oil analysis laboratories, organic or under contract to a U.S. military service for analyzing used oils from U.S. government equipment. The following paragraphs provide detailed step-by-step procedures for execution of the Correlation Program:

CAUTION

Uncertified or Decertified spectrometers are prohibited from providing oil analysis services to any customers unless the appropriate Service Program Management Office grants a waiver. This waiver must be in writing and shall normally limit the laboratory to intraservice support. A waiver granting authority for interservice support shall be supported by written concurrence of the program manager of the other supported service(s).

NOTES

The Correlation Program is primarily a Spectrometer evaluation tool. Therefore, Spectrometers failing (i.e., Uncertified) is necessary to identify ailing units and aid in DoD Program efficacy.

If operator OAP improficiency is suspected, the lab supervisor or designated personnel shall provide the essential knowledge and training to remedy the proficiency gap.

The JOAP has decided to reduce the number of individual oil samples included with the Quarterly Correlation Package from four to two separate samples. This reduction in the number of samples is anticipated to begin with the First Quarter of 2022

a. The Quarterly Correlation Package is received by the Sample Delivery Due Date shown in Table 8. If a laboratory receives damaged correlation samples or does not receive samples by the 15th of the month, the laboratory shall notify OAPCORR@US.AF.MIL of the problem immediately.

Table 8 – Due Dates for Correlation Sample Delivery (USPS/FedEx)

Quarter	Months Covered	Sample Delivery Due Date
1	Jan/Feb/Mar	15 January
2	Apr/May/June	15 April
3	July/Aug/Sept	15 July
4	Oct/Nov/Dec	15 October

NOTES

When mission/manning allows, labs shall analyze and submit correlations within 5-duty days of the start date annotated on the sample bottles but no later than the 21st of the Correlation month.

Submittal of correlations within 5-duty days is essential to support laboratories in extenuating circumstances that require immediate Certification results.

A minimum of 80% of DoD submittals is necessary for the AF OAP Office to perform Monthly Correlation scoring.

Submittals after the 21st will be deemed late submittals and may not be used to help calculate the JOAP Correlation Trim Mean, minimizing the Program's efficiency to isolate ailing Spectrometers.

In addition, late submittals will delay the delivery of certification results to the laboratory in violation. Therefore, advise oapcorr@us.af.mil when correlation submittals are at risk of being submitted late. Late submittal shall not be standard lab practice.

Do NOT analyze correlations before the start date annotated on the sample bottle (e.g., 1-JAN-2020).

Do NOT alter or misrepresent the results of one spectrometer based on another. Doing so may cause submittal failure or warrant automatic decertification.

JOAP laboratories shall ensure that results from the previous month are received prior to submitting current month results. Results are to be sent by email to OAPCORR@US.AF.MIL. When sending data by e-mail, be sure to attach the data using the standard form supplied and indicate the Spectrometer Serial Number, Month of Submittal and Base Name on the email SUBJECT line (e.g., 0827-AUG-Beale).

Spectrometer operators / laboratory managers must comply with any special instructions from OAPCorr@us.af.mil received with the correlation samples.

b. The spectrometer operator performs any special procedures recommended or required by the specific spectrometer operator’s manual prior to analyzing correlation samples, such as optical alignment or a check of the source frequency using a test meter or an oscilloscope. Operators with Spectrometers that may not display Source Frequency Test instructions in the applicable Operator's Manual (e.g., Serial Numbers Starting with 6001, Modifications 6 & 7) should utilize alternate Spectrometer's Operations and User Maintenance Manual to perform the Source Frequency Test. If further guidance or information is necessary, contact Spectro via phone, 1-888-486-0123 or e-mail at service@spectroinc.com."

c. The spectrometer operator performs a complete standardization of the spectrometer.

NOTES

All remaining correlation oil will be retained for 1 month in the event a re-submittal is required. The operator is permitted to pour the remaining oil from the analyzed sample back into the original container. Daily Standardization Check (digital or hardcopy) will be retained for 1 month. Correlation results (digital or hardcopy) will be maintained for 3 months. Retention of these records can be extended based on each Service Program Manager's needs.

The month of the correlation is annotated on the sample bottle label (e.g., 1-JAN-2020). Ensure the monthly correlation sample analyzed on the spectrometer coincides with the required month due for submittal.

NOTE

AF Labs Only: Before analyzing Correlations, perform a Daily Standardization Check consisting of 0 through 30ppm standards. Service Program Managers may waive 30ppm standard on a case-by-case basis. Daily Standardizations Checks can be retained in the OAP software as a digital record and/or within the spectrometer's windows based OS. This information is vital for troubleshooting instruments that score low in the program. The Program Managers may also request printouts as a quality assurance check at any time.

d. The spectrometer operator analyzes each sample a minimum of three (3) times and averages the results. If there is not enough oil to complete this step, email oapcorr@us.af.mil for assistance.

NOTE

When averaging results ensure any inconsistent burns are removed prior to calculating the average. Sample line #1 will display results higher than sample line #2. If results are reversed this could be evidence that the samples were analyzed out of order and do not represent their correct value. Please ensure samples are analyzed and submitted in the proper order sequence.

e. The spectrometer operator retains remaining oil for 1 month, in the event a resubmittal is required. The operator is permitted to pour the remaining oil from the analyzed sample back into the original container.

f. The spectrometer operator or laboratory manager reports results as described in the following paragraphs:

NOTES

Sample results should be reported to the tenth decimal point (e.g., 14.4) whenever possible to increase correlation result accuracy. "0's" (zeros) are not permitted when submitting correlation results. If a "0" (zero) reading is obtained immediately contact your service program manager for further guidance.

The Laboratory shall review the All Received Statement no later than the 21st of each month to confirm OAPCorr's receipt of Spectrometer(s) Correlation Submittal. AF labs will confirm submittal receipt by reviewing statement on the AF OAP Share Point. Navy and Army Program Managers will receive statement from OAPCORR. If your spectrometer is not listed, the submittal may have contained an error; contact oapcorr@us.af.mil.

Common Errors of Submittals:

a. Submittals stuck in Sender's Outbox
b. PDF format
c. Zeros "0 " recorded
d. From, Lab Code, Date, Date Received, or Date Analyzed missing or inaccurate"

(1) AF Laboratories utilizing CPIN 81E-OAP software REV# follow software two sample correlation submittal instructions below:

1. Operator enters analysis results for Corr. sample one (1) on line one (1) of software.

2. Operator enters analysis results for Corr. Sample two (2) on line two (2) of software.

3. Verify sample one (1) results by retyping analysis results in line three (3) of software.

4. Verify sample two (2) results by retyping analysis results in line four (4) of software.

(2) Army and Navy Labs that receive a Quarterly Correlation Package that contains only two samples must use the new Two-Sample Correlation Submittal MS Word report template. A completed example of the new template is shown as Figure 1. The lab operators must complete the new template via the following four step procedure:

1. Operator enters analysis results for Corr. sample one (1) on line one (1).

2. Operator enters analysis results for Corr. Sample two (2) on line two (2).

3. Operator verifies sample one (1) entry by retyping results in lower number one (1) block.

4. Operator verifies sample two (2) entry by retyping results in lower number two (2) block.

g. The AF OAPCORR publishes Correlation Program Reports as follows.

(1) General. The AF OAPCORR publishes Correlation Program reports between the 28th and 31st of each month. Report dates that fall on a non-duty day will be posted the following duty day.

Laboratories shall develop a method of verifying Monthly Correlation Certification status and ensure all potential operators are advised.

Navy and Amry service program managers will receive program reports from OAPCorr. Air Force and Space Force OAP Labs will view Correlation program reports on the AF OAP SharePoint.

Individual scoresheets are provided on a case-by-case basis when necessary for service technicians to remedy failing spectrometers.

Laboratories are responsible for verifying the status of their Spectrometers. Spectrometers that revert to Uncertified status due to unsatisfactory program scores are permitted 24-hours of continuous use from the time of AF OAP Corr notification with supplemental successful Daily Standardization check. If the supplemental Daily standardization check fails, contact the appropriate service program manager for further instruction.

It is unnecessary to retest all oil samples analyzed before Uncertified notification when the initial Daily Standardization check performed at the start of the duty shift was successful.

NOTE

Lab/Operator receipt of Correlation results or waiver is identified as posting on the AF OAP SharePoint, e-mail to individual lab personnel or org box, and/or Services PM notification, whichever comes first.

All lab personnel are responsible for verifying the status (i.e., Certified, Uncertified, Decertified, Waivered) of OAP equipment in operational use.

(2) Late results.

(a) Non-submission (NS). If the missing report indicates N/S for the current month and results were submitted, check sent folder and/or outbox then contact OAPCORR@us.af.mil as soon as possible. If results were not submitted, please submit them as soon as possible indicating on the email SUBJECT line LATE, Spectrometer Serial Number, Month of Submittal and Base Name (e.g., LATE-0827-AUG-BEALE). Non-submission of Correlations will automatically move Spectrometer into a Decertified status.

(b) Reported maintenance (RM). Laboratories unable to analyze their correlation samples due to an inoperative spectrometer should report this fact to OAPCORR@US.AF.MIL and respective OAP Manager prior to the data submission cutoff date; these laboratories will be placed in an RM status for that month. RM status laboratories must ensure repairs are expedited and that results are submitted as soon as the spectrometer is operational.

(3) Sub-Correlation, Extensions, and Waivers. In extraordinary circumstances, OAPCORR may provide laboratories specific Correlation instructions. Sub-Correlation, Extensions, and Waivers are provided on a case-by-case basis. For AF laboratories Shop Chiefs and NCOICs will address oapcorr@us.af.mil directly. Navy and Army service program managers will address OAPCORR on behalf of their laboratories.

(a). Sub-Correlation. When advised, analysis of an alternate correlation month is temporarily permitted.

(b). Extension. When advised alternate time frame for analysis or submittal is temporarily permitted.

(c). Waiver. When advised, standards and procedures preventing analysis are temporarily permitted.

NOTES

Spectrometers in RM status may not receive scheduled correlation samples.

Once the spectrometer is operational, laboratories shall e-mail OAPCORR officially requesting RM status be removed.

Indicate on the email SUBJECT line REMOVE RM, Spectrometer Serial Number and Base Name (e.g., REMOVE RM-0827-BEALE).

h. Delayed Correlation Results or Waiver. In the event a lab does not receive correlation results or waiver by the end of the certification month the lab may operate specific spectrometers under their responsibility for the first duty week of the new month (e.g., 1st – 7th) when meeting all the guidance provided in paragraphs (1) through (5) below:

(1) The spectrometer's previous month Correlation, Sub-Correlation, or Certification Kit received a passing score.

(2) A successful Optical Profile is performed on the spectrometer. (This is not applicable to the new 30 element Navy spectrometer.)

(3) A Complete Standardization is successfully performed on the spectrometer.

(4) At least once per shift a successful Daily Standardization Check is performed on the spectrometer. The Daily Standardization Check shall consist of three standards in the expected range of actual samples as per the applicable Spectro Manual.

(5) The lab makes daily attempts to retrieve correlation results or waiver from AF OAP Office at oapcorr@us.af.mil. All emails shall include a cc copy to af.oil.analysis@us.af.mil.

NOTE

Receipt of Correlation results or waiver is identified as posting on the AF OAP SharePoint, e-mail to individual lab personnel or org box, and/or Services PM notification, whichever comes first. All lab personnel are responsible for verifying the status (i.e., Certified, Uncertified, Decertified, Waivered) of OAP equipment in operational use.

TWO SAMPLE-CORRELATION SUBMITTAL FORM_2022.v0

CORRELATION RESULTS FOR (Mmm-yy): Aug-21 Monthly Correlation

Base/Location: TINKER AFB
JOAP Code: M27
Serial Number: 4321
Model: Spectroil M/N

Note: If JOAP Code unknown enter XXXX

Note: No dashes (-) or slashes (/) in Serial No. Example: 0690, 5378 or 12021

Note: Verify correlation line one and two inputs by retyping results in lower blocks one and two

	Fe	Ag	Al	Cr	Cu	Mg	Na	Ni	Pb	Si	Sn	Ti	B	Mo	Zn
#1	6.3	5.2	4.2	4.0	6.3	6.3	6.3	4.2	6.3	5.2	9.5	7.4	12.8	10.6	17.0
#2	5.4	4.5	3.6	3.4	5.4	5.4	5.4	3.6	5.4	4.5	8.1	6.3	10.9	9.0	14.5
#1	6.3	5.2	4.2	4.0	6.3	6.3	6.3	4.2	6.3	5.2	9.5	7.4	12.8	10.6	17.0
#2	5.4	4.5	3.6	3.4	5.4	5.4	5.4	3.6	5.4	4.5	8.1	6.3	10.9	9.0	14.5

Date Received (m/dd/yyyy) 1/1/2022
Date Analyzed (m/dd/yyyy) 1/6/2022

ELECTRODES
Disc Lot: 082786
Rod Lot: 022790

STANDARDS	BATCH/LOT	MFG DATE	EXP DATE
D19-0:	Q131022790	10/1/2022	4/11/2024
D12-100:	Q211010910	11/2/2022	5/12/2024
D3-100:	Q308082413	12/3/2022	6/13/2024

D30-0 (Navy 30-Element):
D15X-100 (Navy 30-Element):
CS24-100 (Navy 30-Element):

SAVE FILE:** **Spectro. SN--Month of Correlation--Location Name (Ex. 4321--August--Tinker AFB)

Commercial Phone: 405-739-7773
Office Phone (DSN): 339-7773
Operator: MSGT SETH W. LUCAS
Operator e-mail: seth.lucas@us.af.mil
Supervisor: MSGT MARCEL J. WILTZ
Supervisor e-mail: marcel.wiltz@us.af.mil
Commander Name/Rank: Lt Col LOGAN L. NUTTER

Form Details: Location: https://cs2.eis.af.mil/sites/13234/OAP/Shared%20Corr%20Docs/Forms/AllItems.aspx Redesigned By: MSgt Marcel J. Wiltz

FIGURE 1. Monthly Correlation Results for Two Samples in MS Word Template 2020

TABLE 9. JOAP Fluids

The following fluids are the primary types used in the engines, transmissions and components enrolled in the Joint Oil Analysis Program. Volume 4 WP 101 00 contains a list of the fluids used in Navy ship engines and components.

STOCK NUMBER	PRODUCT	SPECIFICATION	NATO	TYPE*
9150-01-152-7060	LUB OIL	**ASTO750**		S
9150-00-985-7232	HYDRAULIC FLUID	MIL-PRF-17672	H-573	
9150-01-113-2045	HYDRAULIC FLUID	MIL-H-19457	H-580	
9150-01-080-5961	HYDRAULIC FLUID	MIL-H-22072	H-579	S
9150-00-111-6255	HYDRAULIC FLUID YELLOW	MIL-PRF-46170	H-544	S
9150-00-223-4134	HYDRAULIC FLUID PETRO	MIL-PRF-5606	H-515	S
9150-01-290-2943	HYDRAULIC FLUID	MIL-PRF-6083	C-635	S
9150-00-149-7431	HYDRAULIC FLUID	MIL-PRF-83282		
9150-00-942-9343	LUB OIL STEAM	MIL-PRF-17331	0-250	M
9150-01-177-3988	LUB OIL ENG 10 GRADE	MIL-PRF-2104	0-237	M
9150-01-178-4726	LUB OIL ENG 30 GRADE	MIL-PRF-2104	0-238	M
9150-00-189-6730	LUB OIL ENG 40 GRADE	MIL-PRF-2104		M
9150-00-188-9864	LUB OIL ENG 50 GRADE	MIL-PRF-2104		M
9150-01-178-4725	LUB OIL ENG 15W/40	MIL-PRF-2104	0-1236	M
9150-00-111-3199	LUB OIL PRESERV.	MIL-PRF-21260	C-640	
9150-00-111-0209	LUB OIL PRESER. 30	MIL-PRF-21260	C-642	
9150-01-293-7696	LUB OIL PRESER. 15-40	MIL-PRF-21260		
9150-00-111-0211	LUB OIL PRESER. 50	MIL-PRF-21260	C-644	M
9150-00-168-6889	LUB OIL A/C	SAE J1899	0-128	S
9150-01-476-1074	LUB OIL A/C TURBINE 5cSt STD	MIL-PRF-23699	0-156	S
9150-00-985-7099	LUB OIL A/C TURBINE 5cSt C/I	MIL-PRF-23699	O-152	S
9150-01-439-0756	LUB OIL A/C TURBINE 5cSt HTSI	MIL-PRF-23699	O-154	S
9150-00-402-2372	LUB OIL ENG	MIL-PRF-46167	0-183	M
9150-00-782-2627	LUB OIL A/C TURBINE Grade 3	MIL-PRF-7808	0-148	S
9150-01-414-5926	LUB OIL A/C TURBINE Grade 4t	MIL-PRF-7808	O-163	S
9150-01-209-2684	LUB OIL HELO	DOD-PRF-85734	O-164	S
9150-00-181-8229	LUB OIL SHIP	MIL-PRF-9000	0278	M
9150-00-664-4449	OIL REFRIGERANT COMPRESSOR	VV-L-825	0283	
NOTE: M – Mineral, S - Synthetic				

ARMY OIL ANALYSIS PROGRAM LABORATORIES OPERATING REQUIREMENTS AND PROCEDURES

1. Purpose. The purpose of this work package is to establish the specific configuration requirements and operating procedures for Army Oil Analysis Program Laboratories.

2. Applicability. The provisions of this work package apply to all Army Oil Analysis Program Laboratories.

3. Work Package Structure. This Work Package is divided into three sections (subordinate work packages):

   WP 002 01 – General Laboratory operating procedures and operator training requirements.

   WP 002 02 – Laboratory Equipment / Configuration Requirements

   WP 002 03 – Oil Analysis Data Recording, Processing, and Warehousing

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ARMY OIL ANALYSIS PROGRAM - GENERAL LABORATORY OPERATING PROCEDURES AND OPERATOR TRAINING AND CERTIFICATION REQUIREMENTS

1. Purpose. This work package contains information and instructions regarding operating requirements and procedures specific to Army Oil Analysis Laboratories.

2. Applicability. AOAP Laboratories are comprised of government owned / government operated (GOGO), government owned / contractor operated (GOCO) and Depot. The following training and certification requirements pertain to GOGO and GOCO laboratories only.

3. Facilities. Laboratory square footage space requirements have been omitted for fixed land based laboratories since operational requirements, work loading, service directive specifications, and facility availability vary so widely between service activities. Activities experiencing problems with space requirements should refer inquiries to the appropriate service oil analysis program manager.

   a. Mobile laboratory. A mobile laboratory should have at least 200 square feet of floor space, be completely self contained (equipment, supplies and work space) and capable of deployment. The spectrometer should be shock mounted and the facility should be capable of air transport without any disassembly. All environmental control features should be built-in, with only external grounding and power plug-in required for immediate operational capability.

4. Staffing Requirements. An ICML LLA-II Certified Analyst must be present during all hours of laboratory operations. All Army laboratories must employ a minimum of two full-time ICML LLA-II Certified Analysts. The role of an analyst in Army Oil Analysis Program (AOAP) laboratories is to make diagnostic and prognostic recommendations based on analytical instrument test data. All other laboratory personnel, designated as a technician, shall be ICML LLA I certified. Program Manager AOAP will assign OASIS roles for all laboratory personnel serving in Army laboratories according to the following procedure:

Certification Requirements

a. AOAP Analyst Requirements:

(1) Applicant must successfully pass a written test from the International Council for Machinery Lubrication (ICML) LLA II.

(2) Be recommended to the PM AOAP by the AOAP Lab Chief or government office responsible for the laboratory.

(3) Capable of performing designated OASIS role assignment.

b. AOAP Technician Requirements:

(1) Applicant must successfully pass a written test from the International Council for Machinery Lubrication (ICML) LLA I.

(2) Be recommended to the PM AOAP by the AOAP Lab Chief or government office responsible for the laboratory.

(3) Capable of performing designated OASIS role assignment.

c. Required documentation for LLA II OASIS Evaluator Role assignment.

(1) A completed applicant Training Plan for Aeronautical/Non-aeronautical OASIS evaluator role Assignment (ASC AOAP PMO-01 R).

(2) The required training period mentioned below in paragraph "f" may be waived for Analyst applicants possessing LLA II certifications at the time of hire. Waivers will be granted on a case-by-case basis.

d. Requirements for certification in Ferrography:

(1) In addition to the requirements outlined in Section 4 above, the following are applicable to Army laboratory personnel who are to be certified to analyze grease samples through the use of Ferrography.

(2) Must be an ICML LLA-II Certified Analyst and;

(a) Should have completed the ferrographic instrument manufacturer's 1 week Introduction to Ferrography Course and a minimum of 3 months on-the-job training preparing and evaluating Ferrograms under the supervision of a certified ferrograph evaluator.

(b) Requests for attendance at either of the Ferrography courses will be coordinated through the Program Manager. Expenses associated with attendance and completion of these training courses will be at the expense of the applicant or the applicant's company. Written tests are not required for Ferrography certification; however, the applicant will be required to successfully pass a performance test.

e. Additional Training and Experience required for all AOAP Laboratory Personnel:

(1) AR 750-1, Army Material Maintenance Policies, published in the Maintenance Management UPDATE (Chapter 7, Army Oil Analysis Program).

(2) AR 700-132 Joint Oil Analysis Program (JOAP).

(3) TM 38-301, Joint Oil Analysis Program Manual, Volumes 1-4.

(4) TB 43-0211, AOAP Guide for Leaders and Users.

(5) DA Pam 750-8, the Army Maintenance Management System (TAMMS).

(6) DA Pam 738-751, the Army Maintenance Management System - Aviation.

f. To gain the role of evaluator within OASIS, the LLA-II certified Analyst must work a minimum of 3 (three) months with a LLA II certified Analyst in possession of an evaluator role in OASIS. All training shall be documented in the Training Plan for Aeronautical / Non-aeronautical testing and evaluation certification (ASC AOAP PMO-01 R) which will be provided to each lab by the AOAP PMO. The lab chief must submit the completed training plan to the AOAP PMO for review before consideration for OASIS Role assignment will be given.

OASIS Role Revocation:

a. Role revocation shall automatically occur if any of the following conditions exists:

(1) An analyst or technician is not employed full-time in an AOAP laboratory for 6 consecutive months.

(2) An analyst or technician willingly disregards AOAP policies or procedures.

(3) An analyst or technician is removed from a laboratory or military installation for cause, by any authorized government official.

(4) An analyst or technician willingly falsifies analytical or sample record data.

5. JOAP Training.

a. Training courses available.

(1) Defense Joint Oil Analysis Program Training Courses available:

Title	**Course No.**
Physical Properties Testing	J3AZP2A752-003
Ferrography Testing	J3AZP2A752-004

NOTE

Air Force Non-Destructive Inspection (NDI) course, JCABP2A732-048C (or equivalent), includes evaluator training and operation/maintenance of the Model M and M/N spectrometers.

(2) A model M spectrometer maintenance training course is available from Spectro Scientific, Inc.

NOTE

It is highly recommended that personnel scheduled for spectrometer maintenance training possesses an electronics background.

b. Training requests. Submit training requests in accordance with established service procedures.

6. Publications Required. The following publications are required for daily operational reference guides for oil analysis laboratories as indicated.

a. All oil analysis laboratories.

(1) Message Address Directory: Army DA Pamphlet 25-1-1, Navy USN PLAD 1, as appropriate.

(2) Joint Oil Analysis Program Manual, NAVAIR 17-15-50, TM 38-301, T.O. 33-1-37. All laboratories should have Volumes I, II and III. Laboratories providing support for nonaeronautical equipment should have Volume IV.

(3) ADP System Users Guide (as applicable).

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ARMY OIL ANALYSIS PROGRAM
LABORATORY EQUIPMENT AND CONFIGURATION REQUIREMENTS

1. Purpose. This work package contains information and instructions regarding operating requirements and procedures specific to Army Oil Analysis Laboratories.

2. Applicability. The provisions of this work package apply to all Army Oil Analysis Program Laboratories.

3. Facilities. Laboratory square footage space requirements have been omitted for fixed land based laboratories since operational requirements, work loading, service directive specifications, and facility availability vary so widely between service activities. Activities experiencing problems with space requirements should refer inquiries to the appropriate service oil analysis program manager.

   a. Laboratory Space Requirements. Recommended space requirements shown in figure 1 are to be used as guidelines only, since operational requirements and facility availability vary widely among service activities. The area required for a spectrometric testing facility is not included in figure 1. Activities experiencing problems with space requirements should contact the appropriate oil analysis program manager.

   b. Mobile laboratory. A mobile laboratory should have at least 200 square feet of floor space, be completely self contained (equipment, supplies and work space) and capable of deployment. The spectrometer should be shock mounted and the facility should be capable of air transport without any disassembly. All environmental control features should be built-in, with only external grounding and power plug-in required for immediate operational capability.

   c. Laboratory Environmental Requirements. Each laboratory shall be environmentally controlled for operational efficiency. Proper ventilation and exhaust capabilities (for crackle, water (KF), and flash point) shall be provided to conform to safety requirements. Physical property test equipment is designed to operate over a wide range of environmental conditions. Refer to equipment operation, maintenance manuals and local base policies for specific equipment requirements. A portable fire extinguisher shall be readily accessible in all testing areas.

4. Staffing Requirements. A ICML LLA-II Certified Analyst must be present in GOGO and GOCO laboratories during all hours of operation.. The role of an analyst in Army Oil Analysis Program (AOAP) laboratories is to make diagnostic and prognostic recommendations based on analytical instrument test data.

5. Laboratory Testing Requirements. Figure 2 outlines the Army sample analysis requirements to be followed for engines, transmissions, and hydraulic system samples.

   a. Engines. The laboratory shall conduct at least the following screening tests on engine samples.

      (1) Spectrometric analysis - Spectrometric results shall be reviewed to determine whether a critical condition requiring maintenance action or a non-critical condition, such as oil contamination, exists. In either case, a resample shall be requested for verification. A critical condition may be discovered by high wear-metal concentrations or abnormal trend indications. A non-critical condition could be detected by high silicon concentrations indicating contamination of the oil by dust/dirt. Spectrometric values may also be reviewed for additive levels for elements such as zinc, boron, copper, and magnesium.

(2) Viscosity.

(3) Water test or Karl Fischer (KF) depending on lubricant type.

(4) Fourier Transform Infrared (FT-IR) Oil Analysis Spectrometer.

b. Transmissions. The laboratory shall conduct the following screening tests on transmission samples:

(1) Spectrometric analysis.

(2) Viscosity.

(3) Water test, FT-IR or Karl Fischer, depending on lubricant type.

(4) Fourier Transform Infrared (FT-IR) Oil Analysis Spectrometer

c. Hydraulic Fluids. The following tests are provided as a means of screening hydraulic fluid samples taken from equipment and may be used as directed by the appropriate service program manager.

(1) Spectrometric analysis.

(2) Viscosity.

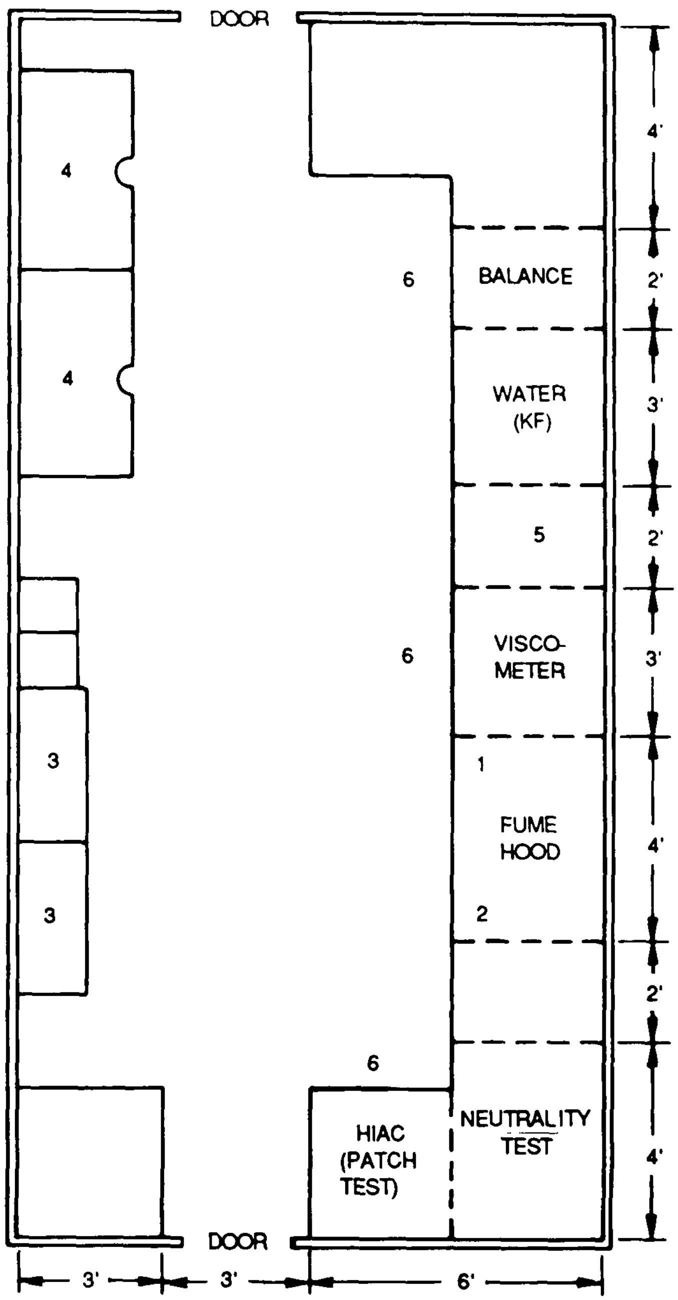
(3) Water by Karl Fischer Titration. If water contamination exceeds the guidelines, the laboratory shall recommend flushing the system and replacing the fluid.

(4) Automatic Electronic Particle Counting. If the particle count exceeds published guidelines, the laboratory shall recommend flushing the system and replacing the fluid.

(5) Fourier Transform Infrared (FT-IR) spectrometric analysis. If water contamination, oil additive depletion levels, or lubrication degradation exceed the specified guideline, the laboratory will recommend flushing the system and replacing the fluid to include servicing/replacing the oil filter.

(6) Patch test contamination analysis. If the test results exceed the class level allowed for the type equipment, the laboratory shall recommend cleaning the system and replacing the fluid.

d. Grease. The laboratory shall perform ferrographic analysis of samples as directed by the AOAP Program Manager.



LEGEND

1 CRACKLE TEST
2 FLASH POINT
3 2 EA 36" X 18", STORAGE CABINETS FOR PARTS, SUPPLIES, ETC.
4 DESK AND CHAIR
5 BLOTTER/TOTAL SOLIDS
6 CHAIRS OR STOOLS

NOTE 1: THE BALANCE, KF EQUIPMENT VISCOMETER, PATCH TEST (PARTICLE COUNT) EQUIPMENT, ETC., ARE POSITIONED ON BENCH-TOPS OF LABORATORY FURNITURE. SUPPLIES, EQUIPMENT, ETC., MAY BE STORED BENEATH WHEN NOT IN USE. ALSO, ABOVE THIS EQUIPMENT ARE WALL CABINETS FOR STORAGE OF SUPPLIES, ETC.

NOTE 2: SPACE FOR A SPECTROMETRIC TESTING FACILITY IS NOT INCLUDED ON THIS LAYOUT.

Figure 1. Typical Physical Test Laboratory Layout

NONAERONAUTICAL EQUIPMENT LUBRICANT SAMPLE
ANALYSIS REQUIREMENT GUIDE*

I. ENGINES

A. Spectrometric
1. Pass - Go to I.B.
2. Fail - See wear-metal guidelines for specific equipment.
a.Critical - Resample to verify.
(1) Wear Metals - abnormal or high range.
(2) Oil contamination by dirt or dust - Si increase.
b.Noncritical - Resample to verify, then change oil.
(1) Oil contamination by dirt or dust - Si increase.
(2) Additive depletion - Zn, Mg, or Cu decrease.
(3) Coolant Problem - B or Na increase by 20 PPM or more.

B. Viscosity
1. Pass - Go to I.C or I.D depending on oil type.
2. Fail - See viscosity guidelines.
a. Low - Fuel dilution or wrong oil. Verify by flash point test and change oil. If repeat problem, make maintenance recommendation for fuel dilution.
b. High - Soot, sludge, water or wrong oil. Verify by blotter and water tests and change oil.

C. Karl Fischer Test for Water
1. Pass
2. Fail – Refer to Volume II WP 009 00 for the Aquatest 2010 test method.

D. Fourier Transform Infrared (FT-IR) Spectrometric Analysis Results
1. Pass
2. Fail - See FT-IR method number guidelines and analysis readings. Refer to Volume II WP 014 00.
a.Free water - Change oil and service filters.
b. Contaminated oil - Soot, Oxidation, Glycol, and Fuel Readings exceed established guidelines, recommend oil changes or inspect and initiate repairs of faulty systems.

Figure 2. Nonaeronautical Equipment Lubricant Sample Analysis Requirement Guide (Sheet 1 of 2)

II. TRANSMISSIONS

A. Spectrometric
1. Pass - Go to II.B.
2. Fail - See wear-metal guidelines for specific equipment.
a.Critical - Resample to verify.
(1) Wear Metals - abnormal to high range.
(2) Oil contamination by dirt or dust - Si Increase.
b. Noncritical - Resample to verify, then change oil.
(1) Oil contamination by dirt or dust - SI Increase.
(2) Additive depletion - Zn, Mg, or Cu decrease.
(3) Water or moisture condensation - Na increase.

B. Viscosity
1. Pass - Go to II.C or II.D depending on oil type.
2. Fail - See viscosity guidelines.
a. Low - Wrong oil, change oil.
b. High - Sludge, water or wrong oil. Verify by water test and change oil.

C. Water test - Karl Fischer
1. Pass
2. Fail – Refer to Volume II WP 009 00 for the Aquatest 2010 test method.

D. Fourier Transform Infrared (FT-IR) Spectrometric Analysis Results
1. Pass
2. Fail - See FT-IR method number guidelines and component analysis warnings. Refer to Volume II WP 014 for the FT-IR test method
a. Submitting unit to correct the faulty system initiate Critical - Recommend corrective maintenance actions.
b. Non-critical - Change oil and service filter.
(1) Oil contamination by dirt or dust.
(2) Additive depletion.
(3) Water or moisture condensation - Sodium (Na) increase.

III. HYDRAULIC SYSTEMS

The following tests are approved methods of testing hydraulic fluid condition and may be directed by services as required. These tests may be performed singly or in combination as required. (Army laboratories shall use spectrometric, viscosity and water testing as a minimum.)

A. Spectrometric
B. Viscosity
C. Water testing, Karl Fischer Method
D. Electronic Particulate Count
E. Colorimetric Patch Testing
F. Fourier Transform Infrared (FT-IR) Spectrometric analysis (Volume II WP 014 00) for additive depletion and lubrication degradation contaminants in the components servicing the oil system.
1. Pass
2. Fail - See prescribed guidelines for specific components.
a. Water: Change oil and service or replace component filters.

*Sequence of test provided as a guide, not as mandatory requirements.

Figure 2. Nonaeronautical Equipment Lubricant Sample Analysis Requirement Guide (Sheet 2 of 2)

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15 March 2021

ARMY OIL ANALYSIS PROGRAM
DATA RECORDING, PROCESSING, AND WAREHOUSING

Table of Contents

1. INTRODUCTION. The Oil Analysis Standard Interservice System (OASIS) is the primary software program used by Army Oil Analysis Program Laboratories to collect, process and warehouse oil analysis data. The AOAP Program Manager will provide technical assistance and initiate corrective software program changes to OASIS as necessary. If OASIS software support is required, contact the AOAP Manager as follows:

   ARMY OIL ANALYSIS PROGRAM OFFICE
   ASC REDSTONE DETACHMENT
   ATTN AMAS-SPR-A BUILDING 3661
   REDSTONE ARSENAL AL 35898-7466
   AOAP Hot Line DSN: 645-0236 / (256) 955-0236
   DDN address: usarmy.redstone.asc.list.aoap-field-ops@mail.mil

2. OASIS DATABASE STRUCTURE SUMMARY

   a. Structure for Database: TAPEFILE.DBF

Fld	Fld Name	Type	Width	Dec Start	End	
1	TRANSCODE	C	1	1	1	Code for Transaction being recorded I - Initial Record for this Sample C - Change Record for Sample D - Sample Deleted Record F - Feedback Record U - Undelete Sample Record

Fld	Fld Name	Type	Width	Dec Start	End	
2	DT_STAMP	C	14	2	15	Date and time record created Format = YYYYMMDDHHMMSS
3	TYPEQUIP	C	1	16	16	Type of Equipment (Air, Grd, Qa, etc)
4	TEC	C	4	17	20	Component TEC
5	ACCES	C	1	21	21	Currently Unused
6	COMPSN	C	15	22	36	Component Serial Number
7	DT_SAMPLE	C	8	37	44	Date Sample Taken
8	SAMPNO	C	5	45	49	Sample Number9
9	COMPMOD	C	12	50	61	Component Model Number
10	EISN	C	12	62	73	End Item Serial Number at Time Component Sampled
11	EIMOD	C	11	74	84	End Item Model Number
12	UIC	C	6	85	90	UIC at time Component Sampled
13	MAJCOM	C	3	91	93	Major Command of UIC in Field 12
14	LABCODE	C	3	94	96	Testing Labs Lab Code
15	TRANSIT	C	2	97	98	Days from Sample Date to Received
16	REASSAMP	N	1	99	99	Reason for this sample
17	HRSCOMP	N	6	100	105	Hours since last complete overhaul
18	HRSOIL	N	4	106	109	Hours since last oil change
19	OIL	C	3	110	112	Amount of Oil Added
20	MEAS	C	1	113	113	Measurement unit of Oil Added
21	LABREC	C	1	114	114	Lab Rec for this sample
22	COMPREC	C	1	115	115	Calculated Computer Rec for Sample
23	SPEC_REDG	C	60	116	175	Spectrometer readings and Flags in Character format (15 elements)
24	MILEIND	C	1	176	176	Mileage Reading (M, K, or H)
25	MILEAGE	N	6	177	182	Mileage or Hours usage
26	REMARKS	C	30	183	212	1st 30 characters or remarks field Fields 27 thru 38 will be blank of 0's in cases where component does not require physical tests
27	CRACKLE	C	3	213	215	Crackle test results code
28	VISC	C	3	216	218	Viscosity test results code
29	FUELDIL	C	3	219	221	Fuel dilution percent
30	INSOL	C	3	222	224	Solubility test results code
31	PHYSREC1	C	2	225	226	Lab Physical Rec. Code 1
32	PHYSREC2	C	2	227	228	Lab Physical Rec. Code 2
33	PHYSREC3	C	2	229	230	Lab Physical Rec. Code 3
34	TEMP	C	3	231	233	Oil temp. for physical test
35	CONTAM	C	1	234	234	Contamination results code
36	COOL	C	1	235	235	Coolant test results code

Fld	Fld Name	Type	Width	Dec Start	End	
37	ALKIN	C	1	236	236	Alkalinity test results code
38	DISPERS	C	1	237	237	Dispersancy test results code Fields 39 thru 45 will be blank or 0's for all records which are not feedback records
39	DT_FB	C	8	238	245	Date feedback received
40	ACTION	C	1	246	246	Feedback action code
41	HOWFND	C	1	247	247	Feedback How found code
42	DISITEM	C	2	248	249	Feedback Discrepancy code
43	HOWMAL	C	1	250	250	Feedback How Malfunctioned code
44	ACTION2	C	1	251	251	2nd feedback Action code
45	FBRMKS	C	29	252	280	Remarks from feedback
46	DT_ANAL	C	8	281	288	Date Sample Analyzed
47	HOWTAKEN	C	1	289	289	How sample was taken
48	TYPEOIL	C	1	290	290	Type Oil used
49	SAMPTEMP	C	1	291	291	Temperature from physical test
50	DT_RECEIV	C	8	292	299	Date Sample received in lab
51	EVALSPEC	C	3	300	302	Initials of Spectro Evaluator
52	EVALPHYS	C	3	303	305	Initial of Physical Evaluator
53	CHGCOUNT	C	1	306	306	Number this change is if fld 1 = C
54	DT_XFER	D	8	307	314	Date record sent to Log SA
55	CHG_ID	C	1	315	315	Identifies change as Physical or Spectrometer Change
**	Total **		316			

3. US ARMY OIL ANALYSIS REPORTS

a. (Monthly) Resample and Type Recommendation Report.

(1). This report is a summary of the latest samples with a laboratory recommendation other than normal. A recommendation is considered abnormal if it is other than an "A" for spectrometric advices or other than "AA" for physical advices. In case of ground equipment with an advice code of "Z" (previous recommendation still applies), the number of Z advices is also counted and reported.

(2). The report shows the component serial number, end-item model, end-item serial number, component model, date sample analyzed, either the physical or spectrometric lab advice depending on the level of significance of the advice code, and a narrative interpretation of the advice code.

(3). The report items are grouped by UIC. The report may address only specific UIC's, Sort Codes, or all UIC's. See Figure 1 for an example of this report.

b. (Monthly) Activity Report.

(1). The Monthly Activity Report is grouped by UIC, and up to four copies may be requested. The report shows the component model, component serial number, end-item serial number, sample number, date sample analyzed, days in transit, hours since overhaul, hours since oil change, reason for sample and either the physical or spectrometric lab advice depending on the level of significance of the advice code.

(2). This information is shown for all samples for each piece of equipment. The report also includes totals for number of samples analyzed for the month, the average days in transit, and the number of samples processed with 'UNKNOWN" HSOH (hours since overhaul) and HSOC (hours since oil change). See Figure 2 for an example of this report.

c. (Monthly) End Item Configuration Report. The End Item Configuration Report shows the end-item model, end-item serial number, UIC, component model, component serial number, and dates of the last five samples taken. This report is sorted by end-item serial number, component model, and component serial number. See Figure 3 for an example of this report.

d. (Monthly) Summary by Equipment Type Report. The Summary by Equipment Type Report is a summary of laboratory recommendations given for samples processed for the previous month. See Figure 4 for an example of this report.

e. (Monthly) Components Enrolled Report.

(1). The Components Enrolled Report lists the history records that contain a sample processed in the lab during the reporting period. The report includes all components enrolled through the last day of the previous month.

(2). The top of the report shows the sort code, UIC, unit name and address, report date, and name of the laboratory.

(3). For ground equipment, the body of the reports shows bumper number, end-item model, end-item serial number, component model, component serial number, hours since overhaul, hours since oil change, sampling interval hours/days, date sample taken, reason sampled, and remarks. If the equipment is TDY, the word TDY will appear in the remarks column.

(4). The report is sorted by sort code, UIC, end-item serial number, TEC, and the component serial number and bumper number for ground equipment. See Figures 5 and 6 for an example of this report.

f. Laboratory Workload Summary Report.

(1). The Laboratory Workload Summary report is sorted by sort code, UIC, end-item serial number, component TEC, and component serial number. The report shows a breakdown of lab recommendations, reasons for sample, and feedback required for samples within a UIC. The report is a summary of samples analyzed during the previous month.

(2). The "unit summary" part of the report shows the number of end-items enrolled, the number of components enrolled, and the number of feedback required within a UIC. In addition for ground equipment, the report shows the percentage of components that have no usage reported and the percentage of components that are delinquent. Delinquency occurs when an enrolled component is not sampled during the established sampling interval.

(3). The "type sample" part of the reports shows a breakdown of the reason for sample codes given to the samples. Any samples with the reason "R" are classified as routine; any with an "L" are classified as lab requests, and all others are classified as "other".

(4). The "lab recommendation" part of the report shows either the physical or spectrometric lab advice depending on the level of significance in the advice code file for the samples. The advices are grouped as normal, resample, purify oil, and inspect. See Figures 7 and 8 for an example of this report.

g. (On Request) Laboratory Response Time Report.

(1). This report is automatically produced when the laboratory workload summary is selected. The Laboratory Response Time Report reflects the number of days between receiving and processing a sample. The report is a summary of the number of samples processed within 0-10 days, over 10 days, unknown days, total samples processed, and the average response time in days.

(2). The grand totals produced by the report are saved in a disk file for transmission of FSA (PROV). See Figure 9 for an example of the report.

h. (Monthly) Usage and Sample Status Report.

(1). The end-item usage and component status report is produced on a monthly basis by UIC for ground equipment only.

(2). The report shows the bumper number, component model, end-item model, end-item serial number, end-item meter reading, component serial number, sample number, date sample taken, date sample next due, days delinquent, feedback required, sample number, date, and remarks. Totals are provided end-items enrolled, components enrolled, end-items with no usage, recommendations with no feedback, components delinquent, and percentage of end-items with no usage. See Figure 10 for an example of this report.

NON-AERONAUTICAL

SORT CODE: 065

RESAMPLE AND TYPE RECOMMENDATION REPORT
BY FT. CAMPBELL

UIC NO. :WABOTO

REPORT DATE: 19 APRIL 1994
BY DATE SAMPLE RECEIVED

UNIT NAME: 1ST BN 5TH SPECIAL FORCES
ATTN: AOAP POC
FT CAMPBELL, KY 42223-5000

END-ITEM MODEL	END-ITEM SERIAL NO.	COMPONENT MODEL	COMPONENT SERIAL No.	DATE ANALYZED	RECOMMEND LAB CODE	NARRATIVE	CODE	PREVIOUS REQUESTS
M35A2	022515329	LDT-465-1C	3802058	11/06-92	B OIL	RESAMPLE ASAP DO NOT CHANGE		

Figure 1 - (Monthly) Resample and Type Recommendation Report

SORT CODE: 212

065

NON-AERONAUTICAL
OIL ANALYSIS MONTHLY ACTIVITY REPORT

FOR SAMPLE AND ANALYZED DURING
JANUARY, 1992

REPORT DATE: 11 APRIL 1994
COMMAND : FORSCOM

UIC NO. :WOXY26

UNIT NAME: MAINTENANCE DIV,
FT MCCOY, ATTN: AFZR-DLM-CV
FT MCCOY, SPARTA WI, 54656

COMPONENT MODEL	COMPONENT SERIAL #	END ITEM SERIAL #	SAMPLE NUMBER	DATE ANAL	DAYS TRANS	HRS OVH	HRS SINCE OIL CHANGE	REASON FOR SAMPLE
NHC-250	750697	10377	2501	01/30/92	8	2270	1814	ROUTINE
5R82	1078	61G1060	1532	01/21/92	4	UNKNOWN	UNKNOWN	ROUTINE
DD6V92	N2956535	6JD032163	2499	01/30/92	3	UNKNOWN	UNKNOWN	ROUTINE
CAT D333	2S13372	75E1091	168	01/06/92	3	UNKNOWN	510	ROUTINE
3R2211	2368	75E1738	2511	01/30/92	3	UNKNOWN	53	ROUTINE
5R6192	IHC00725	7GB00662	2436	01/29/92	6	UNKNOWN	2705	ROUTINE
5R6192	IHC00726	7GB00664	2437	01/29/92	6	UNKNOWN	1720	ROUTINE
DD6V92	06VF163109	8JD032164	2532	01/31/92	2	UNKNOWN	UNKNOWN	ROUTINE
HT750DRD	2510124937	8JD032164	2531	01/31/92	2	UNKNOWN	UNKNOWN	ROUTINE
DD6V92	N2956544	8JD032164	2534	01/31/92	2	UNKNOWN	UNKNOWN	ROUTINE
CASE 504BD	10367709	9160408	2500	01/30/92	3	UNKNOWN	863	ROUTINE
CASE 504BD	10367789	9160413	185	01/06/92	3	UNKNOWN	19	LAB REQUEST
CASE 504BD	10367511	9160420	186	01/06/92	3	UNKNOWN	965	LAB REQUEST
CASE 504BD	10367511	9160420	2199	01/28/92	4	UNKNOWN	UNKNOWN	LAB REQUEST
TT2421-1	5110142354	9160420	2438	01/29/92	6	UNKNOWN	UNKNOWN	ROUTINE
360311	130805	A177B26354K	2510	01/30/92	3	UNKNOWN	UNKNOWN	ROUTINE
ISUZU C240	709267	A177B26354K	2497	01/30/92	3	UNKNOWN	UNKNOWN	ROUTINE
NHC-250	10265252	C12610198	2498	01/30/92	3	UNKNOWN	UNKNOWN	ROUTINE
NHC-250	752034	C12610356	2435	01/29/92	6	UNKNOWN	UNKNOWN	ROUTINE
NHC-250	10287488	C14010023	2533	01/31/92	2	UNKNOWN	13	ROUTINE
HT750DRD	2510124974	JD032163	2512	01/30/92	3	UNKNOWN	UNKNOWN	ROUTINE
IHC S-700	1662	U002932	154	01/06/92	3	UNKNOWN	UNKNOWN	ROUTINE
IHC DT-466B	194904	U002932	169	01/06/92	3	UNKNOWN	133	ROUTINE

LAB ADVICE

NORMAL
RESAMPLE ASAP
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
CHANGE OIL &
RESAMPLE AFTER
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL
NORMAL

SUMMARY FOR UIC: WOXY26

TOTAL SAMPLES ANALYZED	AVERAGE DAYS IN TRANSIT	TOTAL UNKNOWN OVERHAUL	TOTAL UNKNOWN OIL CHANGE
23	3.7	22	13

SUMMARY FOR LAB: Ft. Campbell

TOTAL SAMPLES ANALYZED	AVERAGE DAYS IN TRANSIT	TOTAL UNKNOWN OVERHAUL	TOTAL UNKNOWN OIL CHANGE
23	3.7	22	13

Figure 2 - (Monthly) Activity Report

CONFIGURATION REPORT BY: END-ITEM   Page 1
Ft. Campbell   11 APRIL 1994
NON-AERONAUTICAL

END-ITEM	END-ITEM	CUSTOMER	COMPONENT	COMPONENT	DATES LAST FIVE (5) SAMPLES TAKEN
	MODEL	S/N	UIC	MODEL	S/N
130G	7GB00662	WOXY26	5R6192	IHC00725	04/23/91 07/23/91 10/23/91 01/23/92 04/22/92
130G	7GB00662	WOXY26	CAT 3304 DIT	07211276	10/01/91 12/24/91 03/25/92 06/25/92 07/23/92
130G	7GB00663	WOXY26	5R6192	IHC00740	05/21/91 08/20/91 11/20/91 02/21/92 04/22/92
130G	7GB00663	WOXY26	CAT 3304 DIT	07211284	12/24/91 03/25/92 04/21/92 05/06/92 06/02/92
130G	7GB00664	WOXY26	5R6192	IHC00726	04/23/91 07/23/91 10/22/91 01/23/92 04/22/92
130G	7GB00664	WOXY26	CAT3304 DIT	07211292	08/27/91 10/01/91 12/24/91 03/25/92 06/25/92
22BM	129937	WOXY26	JN6I	618434	05/21/91 08/20/91 11/19/91 02/19/92 05/20/92
2500L	6JD032163	WOXY26	DD6V92	06VF163043	05/07/91 07/31/91 08/27/91 11/26/91 02/28/92
2500L	6JD032163	WOXY26	DD6V92	N2956535	05/07/91 07/31/91 10/29/91 01/27/92 04/24/92
2500L	8JD032164	WOXY26	DD6V92	06VF163109	05/07/91 07/31/91 10/30/91 01/28/92 04/30/92
21500L	8JD032164	WOXY26	DD6V92	N2956544	07/31/91 10/30/91 11/26/91 01/28/92 04/30/92
2500L	8JD032164	WOXY26	HT750DRD	2510124937	05/07/91 07/31/91 10/30/91 01/28/92 04/30/92
2500L	JD032163	WOXY26	HT750DRD	2510124974	07/31/91 10/29/91 01/27/92 04/24/92 07/23/92
ARTFT6	4D80256	WOXY26	DD-453N	D1192	11/09/92
ARTFT6	D1192	WOXY26	ALS 3331-1	63853	11/09/92 11/24/92
ARTFT6	D1192	WOXY26	HYD SYS	D1192	11/09/92
ARTFT6	E1425	WOXY26	DD-453N	4D0093571	08/20/91 11/19/91 02/19/92 03/04/92 05/19/92
ARTFT6	F1494	WOXY26	ALS 3331-1	6777976	06/03/89 11/08/89 05/16/90 05/20/90 07/11/90
ARTFT6	F1494	WOXY26	DD-453N	4D106329	11/09/92
ARTFT6	F1494	WOXY26	HYD SYS	F1494	11/09/92
CAT D7E	75E1091	WOXY26	3R2211	1366	09/17/91 10/01/91 11/19/91 02/24/92 05/26/92
CAT D7E	75E1091	WOXY26	CAT D333	2S13372	10/04/91 01/03/92 04/03/92 06/25/92 07/28/92
CAT D7E	75E1091	WOXY26	HYD SYS	75E1091	11/25/92
CAT D7E	75E1738	WOXY26	3R2211	2368	01/27/92 04/24/92 07/23/92 08/12/92 08/31/92
CAT D7E	75E1738	WOXY26	CAT D333	75E1738	12/03/91 03/04/92 03/24/92 04/17/92 07/23/92
CAT D7F	61G1060	WOXY26	5R82	1078	07/17/91 10/16/91 01/17/92 02/11/92 05/12/92
CAT D7F	61G1060	WOXY26	CAT 3306	61G1060	05/07/91 08/05/91 11/14/91 02/11/92 05/12/92

Figure 3 - (Monthly) End Item Configuration Report

NON-AERONAUTICAL
AOAP SUMMARY BY EQUIPMENT TYPE FOR SAMPLES RECEIVED
BY FT. CAMPBELL
1 OCT 1992 - 31 OCT 1992

SORT CODE: 212

UIC NO: WABOTO
UNIT NAME: MAINTENANCE DIV,
COMMANDER
FT MCCOY, ATTN: AFZR-DLM-CV
FT MCCOY, SPARTA, WI 54656

END ITEM MODEL	COMP MODEL	NORMAL	RESAMPLE	CHANGE OIL	INSPECT EXAMINE	TOTAL SAMPLES	PERCENT NORMAL
130G	5R6192	3	0	0	0	3	100.00
130G	CAT 3304 DIT	1	1	0	0	2	50.00
2500L	DD6V92	1	0	0	0	1	100.00
2500L	HT750DRD	1	0	0	0	1	100.00
CAT D7F	CAT 3306	1	0	0	0	1	100.00
D60	NHC-250	1	0	0	0	1	100.00
H40XL-MIL	360311	2	0	0	0	2	100.00
H40XL-MIL	ISUZU C240	1	1	0	0	2	50.00
M10A	IHC DT-466B	1	0	0	0	1	100.00
M10A	IHC S-700	1	0	0	0	1	100.00
M810	NHC-250	2	0	0	0	2	100.00
MW24C	TT2421-1	1	1	0	0	2	50.00
UIC TOTAL >>>>>>		16	3	0	0	19	84.21

Figure 4 - (Monthly) Summary Equipment Type Report

NON-AERONAUTICAL
COMPONENTS ENROLLED IN AOAP
FOR FT. CAMPBELL
REPORT DATE: 19 APRIL 1994
BY DATE SAMPLE TAKEN

SORT CODE: 065
UIC NO.: WABOTO ACTIVE
UNIT: 1ST BN 5TH SPECIAL FORCES
COMMANDER

REPORT PERIOD ENDING
31 Mar 94

ATTN: AOAP POC
FT CAMPBELL, KY 42223-5000

BUMPER NUMBER	END-ITEM MODEL	END-ITEM SERIAL NO.	COMPONENT MODEL	COMPONENT SERIAL NO.	COMP HSOH	COMP HSOC	SMP INT HRS/DAY	DATE SAMPLED	REMARKS REASON SAMPLED
1D50	M35A2	012523540	LTD-465-1D	3988131	806	806	100/ 90	6Oct92	Routine
1D48	M35A2	012528596	LTD-465-1D	3993317	123	123	100/ 90	6Oct92	Routine
1D23	M35A2	012530980	LTD-465-1D	18009	406	406	100/ 90	6Oct92	Routine
1B3	M35A2	012532392	LTD-465-1D	3887827	27	27	100/ 90	6Oct92	Routine
1C3	M35A2	012533151	LD-465-1C	3924499	1669	1669	100/ 90	6Oct92	Routine
1A3	M35A2	022512765	LDT-465-1C	3900220	0	0	100/ 90	8Aug92	Routine
1B2	M35A2	022515329	LDT-465-1C	3802058	1190	1190	100/ 90	5Nov92	Lab Request
1D44	M35A2	022520253	LDT-465-1C	3807737	2202	220	100/ 90	22Sep92	Routine
1A2	M35A2	022522251	LDT-465-1C	3900592	1360	1360	100/ 90	5Nov92	Lab Request
1D27	M35A2	052525362	LDT-465-1C	3936051	1868	1868	100/ 90	5Nov92	Lab Request
1C2	M35A2	052525533	LD-465-1C	3889076	1765	1765	100/ 90	5Nov92	Lab Request
1D22	M35A2	053914027	LD-465-1C	3870176			100/ 90	3Nov92	Routine
1D25	M35A2C	054010373	LD-465-1	3831769	2461	2461	100/ 90	3Nov92	Routine
1D52	M35A2C	054010675	LDT-465-1C	3901222	1111	1111	100/ 90	22Sep92	Routine
1D24	M35A2	054012745	LDT-465-1C	3900520	11	11	100/ 90	7Oct92	Routine
1D49	M35A2C	054013570	LDT-465-1C	3900417			100/ 90	6Oct92	Routine
1D45	M35A2	054065909	LDT-465-1C	4886547	1209	1209	100/ 90	22Sep92	Routine
1D70	M10A	1004	HYD SYS	1004	427	302	0/365	7Oct92	Routine
1D70	M10A	1004	IHC S-700	1124678	302	302	50/ 90	3Nov92	Routine
1D70	M10A	1004	IHC DT-466B	79941	302	302	50/ 90	22Sep92	Routine
1D69	M936A2	1032AA026	HYD SYS	1032AA026	326	326	0/365	4May92	Routine
1D69	M936A2	1032AA026	MT 654	2420116480	34	29	100/ 90	22Sep92	Routine
1D69	M936A2	1032AA026	6CTA-8.3	44310302	342	342	100/ 90	22Sep92	Routine
1D51	M35A2	13446	LDT-465-1C	3904243	10059	1005	100/ 90	22Sep92	Routine
1D68	M923A2	2303323	MT 654	2420131371	177	177	100/ 90	6Oct92	Routine
1D68	M923A2	2303323	6CTA-8.3	44495233	177	177	100/ 90	6Oct92	Routine
1D26	M35A2C	30887	LDT-465-1D	821274T	210	209	100/ 90	22Sep92	Routine
1D46	M923	C52303394	NHC-250	11148480	546	546	100/ 90	6Oct92	Routine
1D46	M923	C52303394	MT 654	2420022752	488	488	100/ 90	6Oct92	Routine
1D47	M923	C52305301	NHC-250	111848480	385	385	100/ 90	15Oct92	Routine
1D47	M923	C52305301	MT 654	2420030705	373	373	100/ 90	22Sep92	Routine
1D48G	MEP-005A	RZ53532	D298ERX37	3468285	1894	1894	50/ 90	6Oct92	Routine
1D50G	MEP-005A	RZ53750	D298ERX37	3452512	1055	1055	50/ 90	22Sep92	Routine
1D51G	MEP-005A	RZ53754	D298ERX37	3452855	395	395	50/ 90	22Sep92	Routine

Figure 5 - (Monthly) Components Enrolled Report

NON-AERONAUTICAL
COMPONENTS ENROLLED IN AOAP

TOTAL END ITEMS ENROLLED = 28
TOTAL COMPONENTS ENROLLED = 35

NON-AERONAUTICAL
COMPONENTS ENROLLED IN AOAP AT FT. CAMPBELL
REPORT PERIOD ENDING
19 Apr 94

GRAND TOTAL OF END ITEMS ENROLLED = 28
GRAND TOTAL OF COMPONENTS ENROLLED = 35

Figure 6 - (Monthly) Components Enrolled Report (Continued)

NONAREONAUTICAL LABORATORY WORKLOAD SUMMARY
REPORT DATE: 18 April 1994
AT FT. CAMPBELL
1 OCT 1992 - 31 OCT 1992
---------FOR SAMPLES RECEIVED---------

SORT CODE UIC UNIT NAME	------UNIT SUMMARY------ END ITEMS	EI % UNK	USG COMP.	% DEL.	FEEDBKS REQ'D	TOTAL	------TYPE SAMPLE------ ROUTINE	LAB REQ.	OTHER	--LAB RECOMMENDATION-- NORM.	RESAMP	OIL	CHG INSP
212 WABOTO MAINTENANCE DIV.	19	15.79	19	0.00	0	19	19	0	0	16	3	0	0
TOTALS FOR UIC'S SELECTEC FOR SORT CODE 212	19	15.79	19	0.00	0	19	19	0	0	16	3	0	0

Figure 7 - Laboratory Workload Summary Report.

NON-AERONAUTICAL LABORATORY WORKLOAD SUMMARY REPORT DATE: 18 April 1994
AT FT. CAMPBELL
1

꞉T 1992 - 31 OCT 1992 --------FOR SAMPLES RECEIVED---------

SORT CODE UIC	UNIT NAME	------UNIT SUMMARY------- END ITEMS	EI % UNK	USG COMP.	% DEL	FEEDBKS REQ'D	-----TYPE SAMPLE---- TOTAL	ROUTINE	LAB REQ.	OTHER	--LAB RECOMMENDATIONS-- NORM	RESAMP.	CHG OIL	INSP
GRAND TOTALS FOR ALL SORT CODES		19	15.79	19	0.00	0	19	19	0	0	16	3	0	0

Figure 8 - Laboratory Workload Summary Report (Continued).

NON-AERONAUTICAL
LABORATORY RESPONSE TIME FOR SAMPLES RECEIVED
By Ft. Campbell
1 Oct 1992 - 31 Oct 1992

REPORT DATE: 18 April 1994

SORT CODE	UIC	UNIT	NAME	TOTAL SAMPLES	AVG TIME IN DAYS	0 DAYS	1 DAYS	2 DAYS	3 DAYS	4 DAYS	5 DAYS	6 DAYS	7 DAYS	8 DAYS	9 DAYS	10 DAYS	OVER 10 DAYS	UNKN DAYS
TOTAL ALL LAB DAYS >>>>>>>				19	0.16	16	3	0	0	0	0	0	0	0	0	0	0	0

Figure 9 - (On Request) Laboratory Response Time Report

NON-AERONAUTICAL
USAGE & SAMPLE STATUS REPORT
FOR FT. CAMPBELL
REPORT DATE: 18 APRIL 1994
BY DATE SAMPLE TAKEN

SORT CODE: 065
UIC NO.: WABOTO ACTIVE
UNIT: 1ST BN 5TH SPECIAL FORCES
COMMANDER

REPORT PERIOD ENDING
31 Mar 94

ATTN: AOAP POC
FT CAMPBELL, KY 42223-5000

BUMPER NUMBER	END ITEM MODEL	END-ITEM SERIAL NO.	E/I METER READING	COMPONENT	MODEL	COMPONENT SERIAL NO.	SAMP NUM	SAMPLE TAKEN - NEXT DUE	DATE DAYS DELINQ	DATE FEEDBACK SAMP	REQUIRED NO.	REMARKS DATE
1D50	M35A2	012523540	81021 M	LDT-465-1D		3988131	934	06OCT92-04JAN93				
1D48	M35A2	012528596	6172 M	LDT-4651D		3993317	929	06OCT92-04JAN93				
1D23	M35A2	012530980	4286 M	LDT-465-1D		18009	933	06OCT92-04JAN93				
1B3	M35A2	012532392	5901 M	LDT-465-1D		3887827	935	06OCT92-04JAN93				
1C3	M35A2	012533151	12754 M	LD-465-1C	-ENG	3924499	932	06OCT92-04JAN93				
1A3	M35A2	022512765	27165 M	LDT-465-1C		3900220	174	08AUG92-06NOV92				
1B2	M35A2	022515329	24608 M	LDT-465-1C		3802058	648	05NOV92-03FEB93				
1D44	M35A2	022520253	1 M	LDT-465-1C		3807737	2644	22SEP92-21DEC92				
1A2	M35A2	022522251	55630 M	LDT-465-1C		3900592	649	05NOV92-03FEB93				
1D27	M35A2	052525362	11459 M	LDT-465-1C		3936051	647	05NOV92-03FEB93				
1C2	M35A2	052525533	313356 M	LD-465-1C	-ENG	3889076	646	05NOV92-03FEB93				
1D22	M35A2	053914027	12085 M	LD-465-1C	-ENG	3870176	434	03NOV92-01FEB93				
1D25	M35A2C	054010373	62486 M	LD-465-1	-ENG	3731769	431	03NOV92-01FEB93				
1D52	M35A2C	054010675	23731 M	LDT-465-1C		3901222	2643	22SEP92-21DEC92				
1D24	M35A2	054012745	229 M	LDT-465-1C		3900520	1299	07OCT92-07OCT93				
1D49	M35A2C	054013570	389579 M	LDT-465-1C		3900417	936	03NOV92-01FEB93				
1D45	M35A2	054065909	50010 M	LDT-465-1C		4886547	2640	22SEP92-21DEC92				
1D70	M10A	1004	31 M	HYD SYS	-HYD	1004	1213	07OCT92-07OCT93				
1D70	M10A	1004	325 M	IHC S-700	-XMSN	1124678	430	03NOV92-01FEB93				
1D70	M10A	1004	310 M	UGC DT-466B	-ENG	79941	2818	22SEP92-21DEC92				
1D69	M936A2	1032AA026	10770 M	HYD SYS	-HYD	1032AA026	385	04MAY92-04MAY93				
1D69	M936A2	1032AA026	10973 M	MT 654	-XMSN	2420116480	2637	22SEP92-21DEC92				
1D69	M936A2	1032AA026	10973 M	6CTA-8.3	-ENG	44310302	2642	22SEP92-21DEC92				
1D51	M35A2	13446	42112 M	LDT-465-1C		3904243	2639	22SEP92-21DEC92				
1D68	M923A2	2303323	7475 M	MT 654	-XMSN	2420131371	939	06OCT92-04JAN93				
1D68	M923A2	2303323	7475 M	6CTA-8.3	-ENG	44495233	937	06OCT92-04JAN93				
1D26	M35A2C	30887	6704 M	LDT-465-1D		821274T	2641	22SEP92-21DEC92				
1D46	M923	C52303394	14778 M	NHC-250	-ENG	11148480	931	06OCT92-04JAN93				
1D46	M923	C52303394	14778 M	MT 654	-XMSN	2420022752	938	06OCT92-04JAN93				
1D47	M923	C52305301	104797 M	NHC-250	-ENG	11184543	2308	15OCT92-13JAN93				
1D47	M923	C52305301	104797 M	MT-654	-XMSN	2420030705	2636	22SEP92-21DEC92				

TOTAL END ITEMS ENROLLED = 24
TOTAL COMPONENTS ENROLLED = 31
TOTAL END ITEMS WITH NO USAGE REPORTED = 0

TOTAL RECOMMENDATIONS WITH FEEDBACK = 0
TOTAL COMPONENTS DELIENQUENT = 0
PERCENTAGE OF END ITEMS WITH NO USAGE REPORTED = 0.00

Figure 10 - (Monthly) Usage and Sample Status Report

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NAVY OIL ANALYSIS PROGRAM LABORATORIES OPERATING REQUIREMENTS AND PROCEDURES

1. Purpose. The purpose of this work package is to establish the specific configuration requirements and operating procedures for Navy Oil Analysis Program Laboratories.

2. Applicability. The provisions of this work package apply to all Navy Oil Analysis Program Laboratories.

3. Work Package Structure. This Work Package is divided into five sections (subordinate work packages):

   WP 03 01 – General Laboratory Operating Requirements and Procedures.

   WP 03 02 – Laboratory Equipment and Configuration Requirements

   WP 03 03 – Lubricant Analysis and Research Application (LARA) System Requirements and Resources

   WP 03 04 – Data Upload Guide and Requirements

   WP 03 05 – Testing Equipment Maintenance and Inspections

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Change 1 – 15 June 2022

NAVY OIL ANALYSIS PROGRAM - GENERAL LABORATORY OPERATING PROCEDURES

Table of Contents

1. Laboratory Operator and Instructor Training and Certification.

a. All NOAP Laboratory Operators must take Defense Joint Oil Analysis Program (Physical Properties Testing) Course Identification Number (CIN) A-491-0017B, and obtain certification to Navy Enlisted Classification AD-6403. For information on the course, review course information, quota control, seat availability and POC in the Catalog of Navy Training Courses (CANTRAC) at http://www.netc.navy.mil/Development.aspx. (Requires CAC log in). The telephone number for student registration is 850-452-8469 (DSN 459-8469. The entire course curriculum must be taken and is not available in other formats. On the job (OJT) refresher training under the guidance of a NOAP Laboratory operator is highly recommended for laboratory operators who are re-engaging in NOAP Laboratory testing operations after a hiatus of a year or more. Contact the NOAP Program Manager by sending an email to NOAP@navy.mil for more information about OJT.

NOTE

Legacy Operators who have received training under previous CINs and are currently active in lab operations, are exempt from the requirement to take this specific course provided they have received credible training for all new instrumentation and processes from the NOAP Tech reps.

b. Marine Certification Requirements And Laboratory Operator Responsibilities. Marine personnel pay-grade E3-E7 certification IAW this appendix:

1. Marine laboratory Operators must be pay-grade E3 or above and must complete Joint Oil Analysis Program (JOAP) Course Identification Number (CIN) A-491-0017B. This is a non-MOS awarding course.

2. Marine laboratory Operators must be a certified Navy Oil Analysis Program (NOAP) E4 or above to evaluate, certify and report analytical test data to the customer (not the Q/A NOAP Program Manager due to conflict of interest).

NOTE

Certified Marine pay-grade E3 personnel are not authorized to perform any laboratory duties unless under the direct supervision of a certified E4 NOAP Laboratory operator, and can only be utilized as an operator of all associated NOAP equipment to perform multi-fluid analysis.

c. All NOAP Laboratory Course Instructors shall be trained by taking Defense Joint Oil Analysis Program (Physical Properties Testing) Course Identification Number (CIN) A-491-0017B, meet all laboratory operator training and certification requirements, and have 3 years minimum experience working as a certified laboratory operator.

2. Laboratory Operator JTDI Registration. Laboratory Operators must register for an account on the Joint Technical Data Integration (JTDI – jtdi.mil) Navy Oil Analysis Program site for access to upload NOAP data. Contact the NOAP Office at NOAP@navy.mil for assistance with registration or status of approval. Once active, this account must remain active while the laboratory operator has laboratory duties.

Laboratory Operators who have already registered for JTDI access shall report changes in duty station including reassignment to a different NOAP Laboratory, email address or phone number(s) by contacting the NOAP Office at one of the following:

Via email: NOAP@navy.mil

Via phone: (301) 997-8260

Via mail: Navy Oil Analysis Program Manager
22229 Elmer Rd, Bldg 2360
Patuxent River, MD 20670

Laboratory Operators shall refer to Volume 2 WP 003 05 for additional information about the registration process, upload requirements, and the NOAP JTDI site.

3. NOAP Lab Email Account. Each lab must establish a unique email account with their email service provider, some examples are NOAPlab@cvn65.navy.mil; NOAPLabPaxRiver@navy.mil. The NOAP Program Manager will issue instructions and information to these accounts. All lab operators are required to verify receipt of messages in this account inbox by sending a reply to NOAP@navy.mil. Shore based laboratories operated by civilian or contract personnel may substitute a laboratory operator's email address for this requirement since they do not change frequently. The NOAP laboratory must notify the NOAP Program Manager of a new email address for communications when laboratory personnel change in civilian or contract laboratories.

4. Sample Processing and Turnaround Requirements. Laboratory operators are required to test all samples received for which they have the appropriate test equipment required and staffing level (See WP 003 02) regardless of the sample's source. If a NOAP laboratory does not have the appropriate test equipment and/or staffing level to test samples received then they are to contact the NOAP Office at NOAP@navy.mil for guidance and assistance.

Laboratory operators are required to report results from received and analyzed samples back to the submitting activity via email, Naval Message or regular mail as follows:

a. Routine Aeronautical Samples: Test the samples within 24 clock hours of receipt of sample(s) and provide the LARA History Listing report to the activity which submitted the sample within one week (See paragraph 6 on reporting requirements below). Laboratories may exclude weekends and holidays from the required analysis timeframe.

b. Routine Non-aeronautical Samples: Test within 72 clock hours of receipt of sample(s) and provide LARA History Listing report to the activity which submitted the sample within one week (See paragraph 6 on reporting requirements below). Laboratories may exclude weekends and holidays from the required analysis timeframe.

c. Special Samples: Test within 24 hours of receipt of sample(s) and provide the submitting activity with a copy of the report immediately.

NOTE:

Laboratories must report abnormal results that necessitate advising the submitting activity to take action (for example changing oil, re-sampling, grounding aircraft, etc) immediately via email or Naval Message.

5. Evaluation of Sample Results. The Laboratory Operator will evaluate each sample's test results in accordance with the applicable work package in Volume 3 or Volume 4 of this manual.

If Volume 3 does not contain an applicable work package for the specific component for aviation equipment samples, Laboratory Operators must issue an "X" code (analysis results supplied to customer, no recommendation required) and return the results to the customer without a recommendation. Contact NOAP@navy.mil for additional guidance on testing and evaluating aviation equipment samples

For shipboard equipment samples, Laboratory operators should first check Volume 4 WP 101 00 for limits on the physical / chemical properties for the specific lubricant. Contact NSWCPD_Lubricants@navy.mil for additional guidance on testing and evaluating shipboard equipment samples.

6. Reports. The Lubricant Analysis and Research Application (LARA) system generates the oil analysis reports to be sent to the customer. See Work Package WP 003 03 for a list of specific resources to learn more about the LARA system and its use. The following oil analysis reports shall be generated as described:

a. Sample Log. The sample log report is to list the samples analyzed by the lab for the current month or other date range specified within LARA by selecting a beginning date and an ending date. Generate this report as necessary.

b. Monthly Activity . Email the monthly activity report to each operating activity that has submitted samples to the NOAP laboratory in the last month or other date range specified by the customer. The monthly activity report will show the laboratory activity for the given time period. Provide this report monthly or as requested.

c. Components Enrolled. The components enrolled report lists the equipment enrolled in JOAP for which samples have been submitted to the laboratory, organized by UIC. Provide this report to each customer, as requested, for the time-period specified by the customer.

d. History Listing. The history listing report must be provided to the customer for each sample that is analyzed in the laboratory. Provide a duplicate upon request.

NOTES

The NOAP data and reports shall be stored on government computers and networks (e.g. Navy Marine Corps Internet (NMCI), Consolidated Afloat Networks and Enterprise Services (CANES), ETC.) and transmitted behind those networks or by other secure means (JTDI, DoD SAFE, etc.). The following distribution statement should be attached to NOAP data reports:

> Distribution Statement D. Distribution authorized to the U.S. Department of Defense and U.S. DoD contractors only (Critical Technology/Operational Security) (September 2020). Other requests for this document shall be referred to the Navy Oil Analysis Program (NOAP) office, 22229 Elmer Rd, Bldg. 2360, Patuxent River, MD 20670-1547.

If any issues occur while generating these reports in LARA, contact the NOAP Office at NOAP@navy.mil for guidance.

Sending reports to the NOAP team is not required, provided that each laboratory uploads the full database backup and JTDI export files to the JTDI NOAP website weekly. See Volume 2 WP 003 04 for more information about JTDI upload requirements

7. Participation in the JOAP Spectrometer Correlation Program. All NOAP Labs are required to participate in the JOAP Spectrometer Certification and Correlation Programs run by the Air Force Oil Analysis Program. See Vol 1 WP 004 00 for details. When submitting the monthly correlation test results to OAPCORR@US.AF.MIL NOAP Labs are required to cc NOAP@navy.mil.

8. Laboratory Logs. NOAP laboratories shall maintain the following series of logs.

   a. Lab Equipment Maintenance Action Log . NOAP laboratories shall maintain a log with the most recent service date logged for each laboratory testing instrument used for analysis. (See WP 003 05 Figure 1).

   b. Data Upload Log. Navy laboratories shall maintain a log of data uploads to the NOAP JTDI site. (See WP 003 05 Figure 2).

   c. Laboratory Operators Log. A laboratory operator log will include each operator's email address, full name, rank/grade, start date at the current lab, training level, and date of completion for the training course (See WP 003 05 Figure 3).

9. Data submission to the NOAP JTDI website.

   Once a week, each NOAP laboratory shall upload a full database backup and 17 export files to the JTDI NOAP website.

   Instructions for generating the full database backup and the export files are located in the instructions and training videos section on JTDI. Contact NOAP@navy.mil for more information.

NOTE

In accordance with JOAP policy, laboratory operators are required to test all samples received for which they have the appropriate test equipment required and staffing level (See WP 003 02) regardless of the sample's source.

If a NOAP lab has not received any samples during the prior week then the lab may report "No Data" to the NOAP Office at NOAP@navy.mil. The database backup and the JTDI export files provide critical data to the NOAP team and applicable engineering teams and are essential to flight safety. NOAP data has saved lives of Department of Defense personnel and avoided additional hardship, costs and workload for the DOD. NOAP laboratories provide a valuable service to the DOD by accurately accessing equipment health and reducing the risk of equipment failures. There are three main users of NOAP data. The squadrons use reports and recommendations to ensure flight safety at the flight line. Engineers use centralized data to track the state of engines and weapons systems across many platforms. The NOAP team uses centralized data to track laboratory status and ensure necessary program improvements are made according to fleet need. The NOAP Program Manager has the authority to suspend and/or revoke a NOAP laboratory's certification to operate if data is not uploaded every week. A NOAP laboratory shall immediately contact the NOAP Program Manager at NOAP@navy.mil in the event the laboratory cannot upload data to meet the requirement.

10. Laboratory Supplies. Laboratory Operators are responsible for tracking the status of their laboratory consumables and ensuring that an adequate supply is maintained. Funding for the purchase of supplies is the responsibility of the laboratory's operating command.

11. Testing Equipment Maintenance and Inspections.

    Laboratory Operators are required to ensure that all daily and periodic maintenance actions and inspections outlined in JOAP Manual Volume 2 WP 003 05 are performed prior to analysis equipment use.

12. NOAP Team Responsibilities.

    The support of the Navy Oil Analysis Program (NOAP) is provided by the following. This list is not a comprehensive list of duties.

    a. NOAP Office Team. Provides support for establishing plans for Navy laboratory equipment, facilities and training. Team consists of the following:

        (1) Program Manager/Team Lead is primary point of contact responsible for providing technical guidance to the staff-level personnel, such as PMA, FST, TYCOM and other customers in the Navy oil analysis area, and to field-level oil analysis laboratory and equipment maintenance personnel. They also provide support for the establishment/disestablishment of Navy laboratory equipment, facilities, and training.

        (2) Technical Representatives are responsible for providing maintenance support, troubleshooting issues with equipment, and providing refresher and maintenance training for all NOAP lab operators. The intent of this training is to increase self-sufficiency of the operators, to educate the operators on proper maintenance techniques, and to enable fewer on-site technical assist visits.

        (3) IT Software Support is responsible for the development and deployment of the Lubricant Analysis and Research Application (LARA) software system.

(4) Specialized Technical Experts are responsible for writing and revising the specifications, test methods, and manuals needed for NOAP. These experts also interface with field-service teams and program offices to support the improvement of platform operational availability through Oil Analysis.

b. NOAP Laboratory Operators and their respective Commands. The NOAP laboratory personnel and their respective commands are responsible for the operation, data reporting, repair, maintenance, and inventory of NOAP laboratory equipment.

(1) The NOAP laboratory's respective command is responsible for purchasing any parts needed to repair the equipment, and operating supplies for all of their NOAP laboratory equipment.

(2) NOAP Laboratory operators are responsible for formally requesting help from the NOAP Office by email whenever problems or questions arise with laboratory equipment, computers or procedures that cannot be resolved locally. When such a problem is encounter NOAP Laboratory operators must send an email to their NOAP Technica Representative with a copy (cc) to NOAP@navy.mil in order to initiate a Technical Support Visit or to obtain phone or email support.

c. Program offices and Commands; most commonly CNSF, PMA-260, and CNAF. The NOAP Office Team assists with the establishment, acquisition, relocation, and distribution of equipment for all NOAP laboratories with CNSF, CNAF, PMA-260, and other associated program offices or commands.

13. NOAP Office Plain Language Address (PLA).

The NOAP Office Plain Language Address (PLA) is NAVOAPROGMGR PATUXENT RIVER MD. The NOAP Office PLA is to be used for NOAP-related Naval Messages.

NAVY OIL ANALYSIS PROGRAM - LABORATORY EQUIPMENT AND CONFIGURATION REQUIREMENTS

Table of Contents

1. NOAP Laboratory Categories. There are three categories of NOAP Laboratories, delineated by their expected capabilities to perform specific tests as well as the anticipated quantity of tests. Each laboratory is assigned a Lab ID Code as listed in Figure 1. The Lab ID Code contains the three letter lab code which has been the traditional method of identifying laboratories in the Lubricants Analysis and Research Application (LARA) and earlier versions of laboratory software.

   a. Shore Laboratories. These are shore based labs that test high volumes of both aviation and shipboard equipment samples. Lab ID Code begins with a “1”.

   b. Ship Laboratories. These ship based laboratories are required to test both aviation and shipboard equipment samples. Lab ID Code begins with a “2”.

   c. Aviation Only Laboratories. These shore based labs are only required to test aviation samples. Lab ID Code begins with a “3”.

2. Required Testing Capabilities. Based on the assigned category outlined above, each NOAP laboratory must have the capability to test the properties listed in Figure 1.

   a. Shore and Ship Laboratories (both aviation and non-aviation)

      (1) Wear Metals: Ametek (Spectro Scientic) SpectrOil M/N-W
      (2) Viscosity: ASTM D445-compliant viscometer; the following models are currently in use: Anton Parr SVM 3000 series viscometer, Cambridge Viscolab 3000, Cannon miniAV-X, Cannon CAV 4.2
      (3) Total Acid Number: Digitrate Pro 50mL or Hanna Instruments HI902C
      (4) Scale (Balance): Mettler Toledo ML802E or equivalent (accuracy must be at least ± 0.01 grams). A hanging pan balance may work better than a digital scale for underway shipboard operations.
      (5) Fuel Dilution: Spectro FDM Q600, Spectro Scientific (Ametek) FDM 6000
      (6) Water: Photovolt Aquatest 2010
      (7) Particle Counter: Beckman Coulter HIAC PODS
      (8) Lubricant Crackle Test: Hot Plate and Thermometer
      (9) Flash Point Test: Ametek (Petrolab/Grabner) NAVIFLASH (Only required by Shore Laboratories that test ship as well as aviation equipment samples)

   b. Aviation Only Laboratories.

      (1) Wear Metals: Ametek (Spectro Scientic) SpectrOil M/N-W
      (2) Water: Photovolt Aquatest 2010, Pall Water Sensor

NOTE

Only the appropriate instruments for each test will be used to analyze samples submitted to NOAP laboratories. For assistance determining the appropriate instrument, contact the NOAP Office at NOAP@navy.mil.

HACH HIAC PODS shall be used only for particle counting measurements.

3. Special Testing Capabilities. Designated NOAP Laboratories may be required to perform special tests in support of specific aircraft of systems. When special test capabilities are required the NOAP Program Manager will provide directions and guidance.

4. Facilities.

   a. Shore laboratories. The laboratory shall have sufficient bench space and proper ventilation to accommodate and operate all NOAP laboratory test equipment as well as manage the oil sample workload anticipated for the specific laboratory.

   b. Shipboard laboratories. The optimum shipboard laboratory should have 200 square feet of working area to allow for semi-permanent spectrometer shock mounting with adequate bulkhead clearance to allow access to equipment for required maintenance and servicing and to provide adequate space for administrative/records filing and storage of supplies and spare parts. The area must be free of explosive/corrosive fumes, provided with positive ventilation and exhaust, and should be environmentally controlled with respect to both temperature and humidity.

5. Staffing Requirements. The number of personnel required for a laboratory will vary depending on the assigned workload, the utilization of civilian or military personnel, and the type and location of the laboratory. Staffing must be sufficient to meet the sample turnaround and data reporting requirements specified in WP 003 01.

6. Training Requirements. All personnel assigned to a NOAP Laboratory shall be take the NOAP course, A-491-0017B, taught by the Center for Naval Aviation Technical Training in Pensacola Florida and be certified prior to performing oil analysis testing and laboratory data management. The course includes training and certification for: wear metal analysis using a Rotrode Atomic Emission Spectrometerand various physical and chemical properties of the oils.

JOAP Lab Requirements Table

	Aviation Tests		Ship Equipment Tests					
Lab ID	Wear Metals	Water by Karl Fischer Test	Particle Counting	Viscosity	Total Acid Number	Fuel Dilution	Water by Crackle Test	Flash Point Test
1-Atsugi Japan - ANN	R	R	R	R	R	R	R	R
1-Bahrain- ANC	R	R	R	R	R	R	R	R
1-Kings Bay GA - AN0	R	R	R	R	R	R	R	R
1-Mayport FL - ANP	R	R	R	R	R	R	R	R
1-Norfolk VA - ANK	R	R	R	R	R	R	R	R
1-Pearl Harbor HI - ANR	R	R	R	R	R	R	R	R
1-San Diego - ANS	R	R	R	R	R	R	R	R
1-Sigonella Italy AIMD - AND	R	R	R	R	R	R	R	R
2-CVN-68 - Nimitz - AXN	R	R	R	R	R	R	R	
2-CVN-69 - Dwight Eisenhower - AXC	R	R	R	R	R	R	R	
2-CVN-70 - Carl Vinson - AXV	R	R	R	R	R	R	R	
2-CVN-71 - Theodore Roosevelt - AX9	R	R	R	R	R	R	R	
2-CVN-72 - Abraham Lincoln - AXX	R	R	R	R	R	R	R	
2-CVN-73 - George Washington - AX1	R	R	R	R	R	R	R	
2-CVN-74 - John Stennis - AXD	R	R	R	R	R	R	R	
2-CVN-75 - Harry Truman - AXZ	R	R	R	R	R	R	R	
2-CVN-76 - Ronald Regan - AXK	R	R	R	R	R	R	R	
2-CVN-77 - George Bush AXT	R	R	R	R	R	R	R	
2-CVN-78 - USS Ford	R	R	R	R	R	R	R	
2-CVN-79 - John Kennedy AX2	R	R	R	R	R	R	R	
2-LHA-6 - America - AX6	R	R	R	R	R	R	R	
2-LHA-7 - Tripoli - AX7	R	R	R	R	R	R	R	
2-LHA-8 - Bougainville - AX8	R	R	R	R	R	R	R	
2-LHD-1 - Wasp - AXW	R	R	R	R	R	R	R	
2-LHD-2 - Essex - AX5	R	R	R	R	R	R	R	
2-LHD-3 - Kearsarge - AXY	R	R	R	R	R	R	R	
2-LHD-4 - Boxer - AXJ	R	R	R	R	R	R	R	
2-LHD-5 - Bataan - AXO	R	R	R	R	R	R	R	
2-LHD-7 - Iwo Jima - AXG	R	R	R	R	R	R	R	
2-LHD-8 - Makin Island - AXB	R	R	R	R	R	R	R	
3-Cherry Point NC FRC East -AN4	R	R	A	A	A	A	A	A
3-Corpus Christi TX - ANQ	R	R	A					
3-Fallon NV FRC West Det - ANV	R	R						
3-Fallon NV NSAWC - ANE	R	R						
3-Jacksonville FL - AN9	R	R	A	A			A	A
3-Key West FL - ANJ	R	R						
3-Lemoore CA FRC West - ANA	R	R						
3-MALS 11 - Miramar CA - AN2	R	R						
3-MALS 12 - Iwakuni Japan - AN8	R	R						
3-MALS 13 - Yuma AZ - ANY & AY3	R	R						
3-MALS 14 - VMAQ-3 - AN2	R	R						
3-MALS 16 - Miramar CA - ALD	R	R						
3-MALS 29 - New Rivers NC - AND	R	R						
3-MALS 31 - Beaufort SC - ALB	R	R						
3-MALS 35 - Okinawa, Japan - AL3	R	R						
3-MALS 39 - Camp Pendleton CA - AN5	R	R						
3-Patuxent River MD AIMD - ANM	R	R						
3-Pensacola - ANH	R	R	A	A				
3-Quantico VA HMX-1 S6262 - ANX	R	R						
4-JOAP School	R	R	R	R	R	R	R	R

Legend

R	Required and Available
A	Available, but not Required
R	Required, Capability Needed

Figure 1. Testing Capabilities Currently Available (or Required) by Each NOAP Laboratory

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NAVY OIL ANALYSIS PROGRAM - LUBRICANTS ANALYSIS AND RESEARCH APPLICATION (LARA) SYSTEM REQUIREMENTS AND RESOURCES

Table of Contents

NOTE

This is a major revision of this work package. Due to the extensive changes they are not indicated with lines in the right margins.

1. Introduction. The Lubricant Analysis and Research Application (LARA) System is used to enter sample results, generate reports, manage customers and equipment, and create backups of oil analysis data for the NOAP Office. LARA is approved for use on authorized DOD workstations as a database template within Microsoft Access, which is part of Microsoft Office. Most, if not all, DOD workstations will have Microsoft Office installed.

   Stand-alone workstations that were provided by the NOAP Office to NOAP Laboratories are on a sundown schedule and will require special permission by the NOAP Office to operate. Prior versions of LARA shall be converted and upgraded according to the NOAP Office LARA conversion schedule.

   NOAP Laboratory operators can upload data directly to the NOAP JTDI website from the authorized and network-connected DOD workstation, such as NMCI and CANES. Contact the NOAP Office if this requirement cannot be met by your workstation or network. For assistance with LARA or Joint Technical Data Integration (JTDI), please visit the NOAP JTDI website for instructions and training videos or contact NOAP@navy.mil.

2. Data Entry, Reporting, and Upload Requirements

   a. Data Entry. Every sample that is submitted to a NOAP laboratory for analysis must be entered into the LARA system. Identifying information for the sample as well as results, findings, and recommendations are added to the sample record.

   b. Reporting. Reports, outlined in WP 003 01, must be sent to the submitting customer within the requirement window for the sample as outlined in WP 003 01.

   c. Upload Requirements. NOAP laboratories are required to upload a full database backup and 17 JTDI Export files to JTDI each week. More information on uploads and JTDI is outlined in WP 003 04.

3. IT Requirements. All NOAP Labs are required to have authorized DOD computers with Microsoft Office installed in order to use LARA. Authorized computer workstations include NMCI and CANES, and any other computer systems maintained and cyber secured by the command according to DOD policy.

NOTE

NOAP laboratories are required to upload data and backups to JTDI (see WP 003 04 for more information), which requires access to the internet. If the network is down and uploading is not possible, the laboratory must notify the NOAP Office by phone or email (if available) as follows:

NOAP Program Manager Phone: (301) 757-9249; email: NOAP@navy.mil

4. Support Staffing Resources.

   a. NOAP Office Support. For issues regarding the LARA System, please contact the NOAP Office at NOAP.navy.mil

   b. Command IT Support. All NOAP laboratories are required to obtain a workstation on an approved DoD network such as NMCI or CANES. These workstations are not the property of NOAP and will not be supported by the NOAP Office. Each command's IT group is responsible for the support of networked IT assets.

5. Instructions for Access LARA and Other Resources

   a. LARA Instructions. Please contact the NOAP Office for LARA instructions. The instructions include the steps to:

      (1) Create a sample record

      (2) Add tests, test results, findings, and recommendations

      (3) Generate reports

      (4) Manage customers and equipment

      (5) Create backups of NOAP data

   b. LARA Instructional Video. The NOAP Office created a video that can be used as training or as a refresher for using LARA. The video can be downloaded from the Instructions and Training Videos page on the NOAP JTDI website. Please contact the NOAP Office at NOAP@navy.mil for more information.

   c. Registration and Upload Instructions. Please contact NOAP@navy.mil for instructions on how to register for an account on JTDI. Upload instructions can be found on the JTDI website. Contact the NOAP Office for additional information about registration and upload.

      (1) JTDI Registration Instructions. All NOAP laboratory operators are required to register for an account to access the NOAP JTDI website for weekly data uploads

      (2) JTDI Upload Instructions. All NOAP laboratories are required to upload data to the NOAP JTDI website each week. A full database backup and 17 JTDI Export files must be uploaded each time.

15 March 2021

NAVY OIL ANALYSIS PROGRAM - DATA UPLOAD GUIDE AND REQUIREMENTS

Table of Contents

NOTE

This is a complete revision of this work package. Due to the extensive changes they are not indicated with lines in the right margins.

1. Introduction. NOAP laboratories are required to send reports for each sample to the submitting activity. In addition to sending the results to the customer, NOAP laboratories are required to upload NOAP data for further analysis by the NOAP team and platform engineering teams. NOAP data analysis is a crucial part of improving the Program's ability to identify potential issues prior to catastrophic machinery failures casualties. Database systems, such as CMAS and SDR, are being utilized by NAVSEA and NAVAIR NOAP teams, respectively, to further analyze oil analysis data and to make the data more accessible.

   Data must be uploaded weekly to the Joint Technical Data Interface (JTDI) NOAP website. To access this site, each laboratory operator must register for an account, which will then be approved by the NOAP team. All laboratory operators must have an account and any other personnel in the chain of command of the NOAP laboratory may also register for an account.

   In the event of a laboratory losing data or having issues with their workstation, the NOAP team can use the most recent database back up to set up the laboratory again. The more recent the backup, the fewer samples the laboratory will have to back fill manually.

2. User Registration. Each laboratory operator must request an account on the NOAP JTDI website. A member of the NOAP team will approve the request. Once approved, the laboratory operator will be able to upload and download data from the NOAP JTDI website. The account will be suspended if the user does not log in once every 30 days. After 45 days, the account will be deleted.

   For laboratory operators who are deployed, please log in as often as possible to keep the account active, in the case the laboratory or unit becomes disconnected unexpectedly. If a laboratory operator's account is suspended, please follow the instructions in the automated email from the JTDI website to confirm your registration information and request to reactivate the account. If a laboratory operator's account is deleted, the operator will need to re-register and wait for NOAP team approval. Please contact the NOAP Office at NOAP@navy.mil for assistance.

3. NOAP JTDI Website. Data movement is the primary use of the NOAP JTDI website. However, additional resources are available for laboratory operators such as:

   a. Manuals, including JOAP Manuals Volumes I-IV, NSTM Chapter 262, and test equipment maintenance manuals.

   b. Instructions and directives issued by the NOAP Office.

   c. Training materials, such as test equipment and LARA instructions and videos.

   d. NOAP Office software tools, such as LARA updates.

   e. NOAP contact information.

   f. Historical data from other laboratory locations for download and search for transient aircraft or other Navy platforms

4. Data Uploads. Each laboratory is required to upload a full database backup (Access Database .accdb) and 17 JTDI export files (Text Files .txt). Laboratories may also upload zip files containing all 18 files (.zip). Please include the lab code and date in the zip file name. For instructions on how to upload laboratory data to JTDI, please see the instructions on the JTDI website or contact the NOAP Office at NOAP@navy.mil.

5. Data Downloads. Each laboratory can access data from other laboratories to review previous samples. Specifically, this may be used for samples from transient equipment. For instructions on downloading laboratory backups from JTDI, please contact the NOAP Office at NOAP@navy.mil.

NAVY OIL ANALYSIS PROGRAM - TEST EQUIPMENT MAINTENANCE AND INSPECTIONS

Table of Contents

NOTE

This is a complete revision of this work package. Due to the extensive changes they are not indicated with lines in the right margins.

Table 1 – Spectrometer Daily Maintenance

Component	Required Maintenance	Frequency	Maintenance Level
Plate, Mounting, Sample Stand Component	Clean to remove oil and carbon buildup especially between disc electrode shaft and rod electrode holder.	Every 5 burns	Operator
Window, Quartz, Protective (entrance slit)	Clean to remove oil and carbon splashes with an ammonia based window cleaner.	Every 5 burns	Operator
Sensors, Sample Stand	Using a Q-tip, clean to remove oil and carbon splashes with an isopropyl alcohol or ammonia based window cleaner.	Daily	Operator
Sample Stand Area	Clean complete sample chamber to remove oil splashes and carbon buildup.	Twice Daily	Operator
Door, Sample Stand	Clean complete door to remove oil splashes and carbon buildup.	Twice Daily	Operator
Electrode Sharpener	Rotate cutting blade to new edge. (Can be performed until all three edges have been used.)	As Required	Operator
Panel, Readout and Control	Inspect for oil splashes and carbon residue. If present, remove with mild cleaning detergent.	Daily	Operator
Frame and Exterior Panels	Inspect for oil splashes and dust buildup. If present, remove with mild detergent. CAUTION: DO NOT USE ALCOHOL OR CHLORINATED SOLVENTS TO CLEAN PLASTIC OR PAINTED SURFACES.	Daily	Operator
Printer	Inspect for worn ribbon, loose cable connectors, and dirt and dust build- up. Replace worn ribbon, tighten loose connections and clean accordingly. Refer to printer operation and maintenance manual. It is recommended to keep the printer covered when not in use.	Daily	Operator

Table 2 – Spectrometer External Housing Maintenance Inspections

Component	Required Maintenance	Frequency	Maintenance Level
Filter on Heat Exchanger	Inspect for dust and dirt buildup. Clean in detergent and water bath by swishing vigorously.	Weekly or as required depending on operating environment.	Operator
Filter, Sample Stand Exhaust	Inspect for dust and dirt buildup. Clean or replace if holes in the filter are blocked.	Weekly	Operator
Frame and Exterior Panels	Inspect for oil, dust, dents, scratches and rust. Clean with mild detergent and if necessary, sand and repaint.	Monthly	Operator
Hardware	Inspect for loose or missing hard- ware. Tighten loose hardware and replace rusted hardware.	Monthly	Operator
External Cables	Inspect for loose connections. Inspect for damage.	Monthly	Operator
Shaft, Disc Electrode	Clean residue (varnish) from splined end with an ink eraser.	Monthly	Operator

Table 3 – Spectrometer Excitation Source Maintenance Inspections

Component	Required Maintenance	Frequency	Maintenance Level
Analytical Gap	Inspect the rod electrode holder and gap setting device for smooth sliding and release. If tight or binding, contact the NOAP Tech Rep.	Six months or every 2000 burns.	Operator
Analytical Gap	Polish tips to remove corrosion	Six months or every 2000 burns	Operator
Analytical Gap	Check electrode shape. If electrode points are flat, remove electrodes and replace them. Reset the auxiliary gap distance to 0.135 inches. Verify by checking excitation source frequency with Source Frequency Test Meter	Six months or every 2000 burns	Operator

Table 4 - Physical Properties Testing Equipment Maintenance and Inspections

Instrument	Required Maintenance	Frequency	Maintenance Level
Photovolt Aquatest 2010	Replace dessicant	when 50% of beads are no longer blue	Operator
	Rotate and reseal glass joints	When glass joints do not move smoothly	Operator
	Rinse titration cell with methanol or ethanol	If instrument is expected to be out of service for more than 3 weeks (do not allow reagents to fully evaporate)	Operator
	Rinse the titration cell with methanol or ethanol and replace reagents	Periodically to remove waste materials when titration cell appears contaminated or	Operator
	Clean frit in generator cartridge with methanol or other solvents	When instrument performance is impaired and/or overvoltage error message is displayed	Operator
HIAC PODS	Calibration	Annual	Original Equipment Manufacturer (OEM)
	Cell cleaning	After backflushing the filter or when large particles clog the cell	Operator, only with assistance from NATEC representative, FST, or OEM
Cannon miniAV-X	Instrument calibration	Annual	OEM
	Calibration verification using a certified standard	Daily, prior to running samples	Operator
	Refill solvents and empty waste container	As necessary	Operator
Cambridge Viscolab 3000	Instrument calibration	Annual	OEM
	Calibration verification using a certified standard	Daily, prior to running samples	Operator
Anton Paar SVM 3000	Instrument calibration	Annual	NAVY METCAL (if available) or OEM
	Continuing calibration verification (CCV) using a certified standard	Prior to running samples and at end of each sample batch	Operator
	Clean the instrument	If CCV is out of tolerance after four measurements	Operator
Hanna HI902C	Instrument calibration	Annual	OEM
	Calibration verification	Daily, prior to running samples	Operator

Table 4 - Physical Properties Testing Equipment Maintenance and Inspections (Continued)

Instrument	Required Maintenance	Frequency	Maintenance Level
FDM Q600 or FDM 6001	Calibration using a standard mixture	Daily prior to running samples or if ambient temperature drifts by more than +/- 2 C	Operator

NOAP LAB EQUIPMENT MAINTENANCE LOG				
SERVICE DATE	**EQUIPMENT S/N**	**SERVICE TECH**	**LAB TECH ON DUTY**	**NOTES**
e.g. 01/17/2010	*e.g. 0213/99*	*e.g. Russell Smith*	*e.g. AD1 John Doe*	

Figure 1. NOAP Lab Equipment Maintenance Log

NOAP LABORATORY DATA UPLOAD LOG			
DATE	**FILES UPLOADED**	**LABORATORY OPERATOR**	**UPLOAD FOLDER**
e.g. 08/08/2020	*e.g. ANM_BACKUP.ACCBD*	*e.g. AD1 John Doe*	*e.g. ANM-Patuxent_River*

Figure 2. NOAP Lab Data Transfer Log

NOAP LAB OPERATOR LOG			
START DATE	**LARA USER NAME / FULL STAFF NAME**	**TRAINING LEVEL/ DATE OF TRAINING**	**NOTES**
e.g. 01/17/2010	*e.g. jdoe / AD1 John Doe*	*e.g. Navy CIN A-491-0017A 01/01/08*	

Figure 3. NOAP Lab Operator Log

AIR FORCE OIL ANALYSIS PROGRAM LABORATORIES OPERATING REQUIREMENTS AND PROCEDURES

1. Purpose. The purpose of this work package is to establish the specific configuration requirements and operating procedures for Air Force Oil Analysis Program Laboratories.

2. Applicability. The provisions of this work package apply to all Air Force Oil Analysis Program Laboratories.

3. Work Package Structure. This Work Package is divided into four sections (subordinate work packages):

   WP 004 01 – General Laboratory operating procedures and operator training requirements.

   WP 004 02 – Laboratory Equipment / Configuration Requirements

   WP 004 03 – Oil Analysis Data Recording, Processing, and Warehousing

   WP 004 04 – Magnetic Chip Detector Sample Processing Procedures

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AIR FORCE OIL ANALYSIS PROGRAM - GENERAL LABORATORY OPERATING PROCEDURES

1. All laboratories must:

   a. Use the most current CPIN 81E-OAP/EXTERNAL/US-F001-00A. Current CPIN 81E-OAP software REV# can be found on the main page of the SharePoint site:

   https://cs2.eis.af.mil/sites/13234/oap/sitepages/home.aspx

   The OAP office does not issue software. Contact your local TODO for software distribution. Installation of this software must be on an external computer with AF Standard Desktop Configuration and connected to the LAN. A RS-232 connection cable may be used to automatically transfer spectrometer data to external computer. The RS-232 cable schematics are located in the spectrometer technical order or can be ordered from Spectro Scientific.

   NOTE

   CPIN 81E-OAP/INTERNAL/US-F001-00A is no longer authorized for installation on Spectrometers.

   b. Backup OAP software on a weekly basis to an external (i.e. portable) device.

   NOTE

   It is crucial the software is backed up externally as opposed to locally.

   c. Backup all Spectrometers assigned monthly. See applicable Spectrometer technical order for detailed instructions.

   d. Perform shift supervisor review (View and Print Supervisory Review)

      (1) A Supervisor will verify at the end of each shift that all analyses performed were correctly entered into the OAP Software. OAP qualified personnel, when a supervisor is not present, may perform the supervisor review. The Supervisor Review is an opportunity for the Laboratory to have Airmen with more extensive OAP experience and authority ensure all OAP Software inputs for accuracy and provide lab or personnel feedback where necessary.

      (2) Validate the DD Form 2026 and the information on the Supervisory Review match.

   e. Complete the Annual JOAP Laboratory Authorization Checklist between 1 January and 1 March of each year. See Figure 1.

      (1) The terms Certified, Uncertified, and Decertified refer to Spectrometers in the Correlation Program.

      (2) Completing the Annual JOAP Lab Authorization Checklist and answering honestly and accurately to all on the questionnaire (Figure 1, Page 3) will deem a lab Authorized or Unauthorized. Labs that answer NO to questions shall correct the issue immediately or contact the appropriate service program manager to request a waiver. Answering ‘Non-Applicable’ may warrant follow-up by the service's OA program manager.

ANNUAL JOAP LABORATORY AUTHORIZATION CHECKLIST					27-August-2021 ...v6 Date: 01-January-2022
FORM DUE TO AF.OIL.ANALYSIS@us.af.mil BY 1 MARCH EACH YEAR					
AIR FORCE	NAVY	MARINE CORPS	ARMY	FMS	
SPACE FORCE	Active Duty	Reserve	Guard	Contractor	

Home Base/Location		Backup Base/Location	
MAJCOM:		MAJCOM:	
Base/Location:		Base/Location:	
Squadron:		Squadron:	
DSN No.:		DSN No.:	
Comm. Tel. No.:		Comm. Tel. No.:	
Lab Org. E-mail:		Lab Org. E-mail:	

USPS Mailing Address		FEDEX Shipping Address			
Address Line 1:		Company:			
Address Line 2:		Contact Name:			
Address Line 3:		Address 1:			
Address Line 4:		Address 2:			
Address Line 5:		ZIP Code:		City:	
Comments:		State:		No.:	

ASSIGNED AIRCRAFTS & ENGINES

A/C 1:	Eng. Type:	A/C 6:	Eng. Type:
A/C 2:	Eng. Type:	A/C 7:	Eng. Type:
A/C 3:	Eng. Type:	A/C 8:	Eng. Type:
A/C 4:	Eng. Type:	A/C 9:	Eng. Type:
A/C 5:	Eng. Type:	A/C 10:	Eng. Type:

AER SPECTROMETERS & EXPEDITIONARY FLUID ANALYSIS SYSTEMS

Serial No.:	Status:	Eqpmt.:	Age:	Year Mfrd.:
Serial No.:	Status:	Eqpmt.:	Age:	Year Mfrd.:
Serial No.:	Status:	Eqpmt.:	Age:	Year Mfrd.:
Serial No.:	Status:	Eqpmt.:	Age:	Year Mfrd.:
Serial No.:	Status:	Eqpmt.:	Age:	Year Mfrd.:

WEAR DEBRIS ANALYSIS EQUIPMENT

Serial No.:	Status:	Eqpmt.:	Age:	Year Mfrd.:
Serial No.:	Status:	Eqpmt.:	Age:	Year Mfrd.:
Serial No.:	Status:	Eqpmt.:	Age:	Year Mfrd.:
Serial No.:	Status:	Eqpmt.:	Age:	Year Mfrd.:
Serial No.:	Status:	Eqpmt.:	Age:	Year Mfrd.:

JOAP METRICS/PERFORMANCE RECORD

Average JOAP Sample Response Time:	
Total Aircraft Samples Processed Annually:	
Total Oil Cart Samples Processed Annually:	

Figure 1 – Annual JOAP Laboratory Authorization Checklist - Page 1

Standard Laboratory Codes Recommended Annually:	H:	B:	F:	Q:	X:
	R:	C:	G:	J:	A:
	T:	E:	P:	W:	D:
Total Inspection Recommendations (e.g., H, R & T)?					
Total JOAP "HITS"?					
Total JOAP "MISSES"?					

QUALITY ASSURANCE OFFICERS

POCs	RANK/NAME	E-MAIL	DSN/Comm. Tel. No.
QA Superintendent:			
QA Chief Inspector:			
QA Inspector:			

LABORATORY ADDITIONAL CONTACTS

POCs	RANK/NAME	E-MAIL	DSN/Comm. Tel. No.
Lab Equipment Custodian:			
Technical Order Distribution Office (TODO):			
Logistics Readiness Squadron (LRS):			
Production Superintendent (Pro. Super.):			
Aerospace Ground Equipment (AGE):			

AF JOAP LABORATORY ASSISTANCE/ASSESSMENT VISIT

POCs	RANK/NAME	E-MAIL	DSN/Comm. Tel. No.
MAJCOM Functional:			
MXG Commander:			
MXG Chief:			
Flight Chief:			
Lab/Section Chief:			
Lab Asst./Section Chief:			
Lab JOAP Monitor:			

Commercial Service Airport(s)

(1) IATA Airport Code:		(1) Name:	
(2) IATA Airport Code:		(2) Name:	
Comments:			

Base Lodging Facility (On Base)

DSN No.:		Address:	
Comm. Tel. No.:			
Comments:			

Commercial Lodging Recommendation (Off Base)

Name:		Address:	
Comm. Tel. No.:			
Comments:			

Navigation/Lab Directions

(1) Near City:		(2) Near City:	
Lab Street Address:		Landmark/Cross Street:	
Comments:			

Figure 1 (Continued) – Annual JOAP Laboratory Authorization Checklist - Page 2

LABORATORY AUTHORIZATION QUESTIONAIRE

Do ONLY members who've completed technical training course operate Spectrometers (i.e., AFSC 2A7X2)?	
Do ONLY members who've completed technical training course & on-the-job-training (OJT) perform trend analysis?	
Does the lab ONLY utilize Spectrometers Certified in the Correlation Program?	
Does the lab utilize and adhere to current Technical Manual 33-1-37-1? Manual Dated:	
Does the lab utilize and adhere to current Technical Manual 33-1-37-2? Manual Dated:	
Does the lab utilize and adhere to current Technical Manual 33-1-37-3? Manual Dated:	
Does the lab utilize and adhere to current Technical Manual 33-1-37-4? Manual Dated:	
Does the lab adhere to AF JOAP Office applicable Memorandums For Record (i.e., Messages)?	
Does the lab utilize current AF OAP Software ; Revision ?	
Does the lab report all recommendation code H, R and T's to af.oil.analysis@us.af.mil?	
Does the lab submit Keypunch data to AFCR@us.af.mil the first duty day of EACH Week?	
Does the lab have sufficient bench space to accommodate and operate the oil analysis Spectrometer and workload?	
Does the lab use approved Atomic Emission Rotrode (AER) instruments (e.g., Model M, M/N & M/N-W); or FieldLab 58MA?	
Does the lab use a booster fan to ensure adequate ventilation for exhaust systems longer than 25 feet in length?	
Does lab maintain no more than 6-mos. usage level of oil standards & order replacement stock 30-45 days in advance?	
Does the lab have sufficient quantity of bottle caps?	
Does the lab operate Spectrometers & Expeditionary Fluid Analysis Systems in accordance with the applicable manuals? (e.g., 33B4-2-29-1, -33B4-2-29-11, 33B4-2-29-21, 33B4-2-29-22, 33B4-2-29-31 & 33B4-2-29-32)	
Does the lab stabilize at 75 degrees Fahrenheit +/- 10 degrees?	
Does the lab maintain a relative humidity between 20% - 60% approximately?	
Does a Supervisor verify that all analysis performed for the shift were correctly entered into the AETC software?	
Does lab ensure all aircraft tail numbers consist of 2 digit year, 4 digit tail & 1 digit position number (e.g., 86-0027-1)?	
Do Oil Cart names consist of Wing and Oil Cart (e.g., Langley - 001001, Holloman - 049002 & Hickam - 154003)?	
Does the lab utilize DD Form 2026, dated AUG 2014 and keep hard copies for required retention time?	
Does the lab backup AETC software to an "EXTERNAL" device on a Weekly basis?	
Does the lab backup all assigned Spectrometers Monthly?	
Does sampling of oil servicing carts happen first flying day of each week?	
Does the lab perform a Complete Standardization Weekly to ensure the instrument is operating correctly?	
Does the lab place tape around the end of the rod electrode handled by the operator to avoid contamination?	
Does the lab place Spectrometers in STANDBY MODE when not being used?	
Does the lab routinely analyze & submit Monthly Correlation Samples within 5-duty days of Start Date annotated on bottles?	
Does the lab review "All Received Statement" NLT the 21st of each month to confirm OAPCorr receipt of Correlation submittal(s)?	
Does the lab complete Annual JOAP Laboratory Authorization Checklist between 1 January - NLT 1 March of each year?	
Does the lab check OAP SharePoint to verify current Annual JOAP Laboratory Authorization Checklist is utilized?	

IF YOU'VE ANSWERED "NO" TO ANY OF THE ABOVE QUESTIONS, CONTACT THE AF JOAP OFFICE IMMEDIATELY!!!	DSN: 339-7773 Comm.: 405-739-7773	oapcorr@us.af.mil
	DSN: 884-0158 Comm.: 405-734-0158	af.oil.analysis@us.af.mil

Comments:			
Checklist Completed By:		Lab/Section Chief Verified:	

*** Add Base Name to completed form (e.g., Tinker_2022_Lab Authorization Checklist). E-mail to AF.OIL.ANALYSIS@us.af.mil ***

AF JOAP Office Reviewed:	

Form Details | Location: https://cs2.eis.af.mil/sites/13234/OAP/JOAP%20LAB%20AUTHERIZATION%20CHECKLIST/Forms/AllItems.aspx | *Designed By: MSgt Marcel J. Wiltz*

Figure 1 (Continued) – Annual JOAP Laboratory Authorization Checklist - Page 3

(3) The Annual JOAP Lab Authorization Checklist provides Oil Analysis PMs with much relevant information. In addition, the questionnaire helps ensure a high-level standard process across the field in lieu of an on-site OAP assistance/assessment visit. The combination of an Authorized JOAP Lab and Certified Spectrometer can support Oil Analysis operations. Labs shall ensure they are using the most recent version of the Annual JOAP Lab Authorization Checklist. AF may verify the current version on the AF OAP SharePoint. Other Services checklists may differ and will be validated by their Service Program Manager.

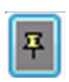
2. OAP software:

a. AF Laboratories will first update the “General Lab Data” contained within Option D “File Table Maintenance”

b. To ensure data integrity and uniformity all aircraft tail numbers will consist of the 2 digit year, 4 digit tail number, and 1 digit position number (ex. 81-0062-2) If single engine aircraft, position number is not required.

c. Oil cart information will consist only of numerical digits and will be comprised of the numerical Fighter Wing and oil cart number (ex. The 33rd FW will have Serial Number: 033001, End Item Serial: 033001).

d. For uninstalled engines the End Item Serial will not accept alpha characters (“Spare”) therefore the End Item Serial will be comprised of the numerical Fighter Wing and 999 (ex. The 57th FW will be 057999).

e. Use the  button on the upper right of the menu screen to increase/decrease the size of the screens, this will allow for the full screen view.

f. For automatic transfer from spectrometer to the external OAP software follow procedures located on the OAP Share Point site, see WP 004 01 paragraph 3 below.

3. AF OAP Share Point (See Figure 2):

a. https://cs2.eis.af.mil/sites/13234/oap/sitepages/home.aspx can be accessed with a DoD CAC for OAP related information to include:

- Monthly correlation scores/reports
- SEM/EDX quarterly reports
- AF OAP Memorandums/Messages
- DoD OAP Directory
- MSDS’s
- Software Information

b. AF OAP SharePoint will send an alert to the lab operator whenever a folder is changed in the SharePoint library, such as when a new Monthly Correlation Report or AF OAP Memorandum has been added. See Figure 3 and follow these steps to set up Alerts:

Figure 2 – USAF Oil Analysis Program Share Point Home Page

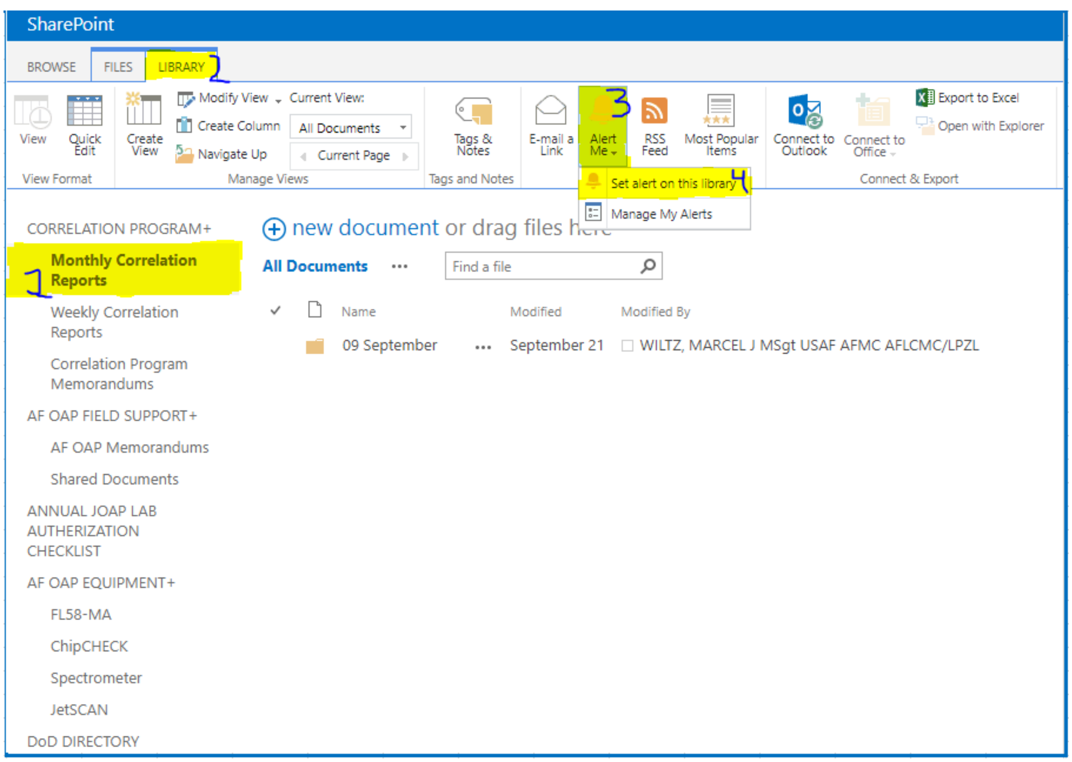


Figure 3 – Setting Alerts for a SharePoint Folder

a. Go to the USAF Oil Analysis Program Share Point.

b. Select Monthly Correlation Reports or AF OAP Memorandums.

c. Select the LIBRARY

d. Select Alert Me and set alert on this library.

e. Enter or change the options you want and select OK.

4. Oil Servicing Carts. Sampling of oil servicing carts is required the first flying day of each week. The oil servicing cart maximum limit table is based off current military specification.

5. Sample Turnaround Requirements. During regular working hours, each laboratory shall analyze samples, evaluate results, and transmit recommendations to the customer within 75-minutes. When the OAP lab is not manned, they shall provide results to the customers NLT 2 hours after the beginning of the next shift. These response time requirements do not apply to equipment geographically separated from the supporting OAP lab.

6. Normal samples. Air Force Oil Analysis Laboratories perform only wear metal analysis via rotrode atomic emission spectrometer. Volume 2 WP 001 00 contains the basic laboratory operating procedures to be followed when performing the task of wear metal analysis on oil samples submitted to a laboratory.

7. Special engine and gearbox lubricant samples. On occasion it may be necessary to have a more detailed analysis of oil samples such as when contamination from jet fuel, hydraulic fluid, water are suspected or there is an apparent loss of viscosity. When such special oil samples become necessary, following instructions apply:

a. Ensure samples are taken properly.

b. Send two 5 dram oil sample bottles. If possible, retain a larger sample bottle for possible further testing requirements. Ensure they are tightly sealed, taped and adequately packed. Include a DD Form 2026 with all pertinent information. Give reason for test(s) and point of contact with DSN number. If analysis requirement is immediate, send by overnight express. If not, send first class to the following address:

AFRL/RQTM
ATTN: Patrick Hellman (785-3332)
BLDG 490 AREA B
1790 LOOP ROAD N
WRIGHT PATTERSON AFB OH 45433-7103
DSN: 785-3100
Commercial: (937) 255-3332

c. On a case-by-case basis, the AF OAP Office may approve requests for local laboratory purchase and use of specialized testing equipment. The lab supervisor shall establish lab training guidelines to ensure all personnel operating equipment and performing specialized testing analysis are qualified. Labs approved will receive concurrence in writing from the AF OAP Office. Labs disapproved will continue to send samples to off-site testing facilities as instructed per 33-1-37-2. Follow all further correspondence received from the AF OAP Office regarding Specialized Testing when it supersedes lab guidelines. No formal training is required when specialized sample testing is deemed Mission Essential, and qualified personnel utilize and adhere to all equipment operation and maintenance manual instructions. It is highly recommended that when local funding permits, Air Force personnel requiring Physical Properties Testing attend Defense Joint Oil Analysis Program Physical Properties Testing Training Course J3AZP2A752-003.

8. Special hydraulic fluid samples. The following instructions apply to suspected problems with hydraulic fluid. Common problems are contamination from particulates, water and other fluids.

   a. Refer to MIL-HDBK-3004 for area laboratory locations.

   b. If further information is required, a point of contact is WL-POSL at the numbers provided above.

      Aerospace Fuels Laboratory (FP2070)
      AFPA/PTPLA
      2430 C Street, Bldg. 70, Area B
      Wright Patterson AFB OH 45433-7632
      COMM: (937) 255-2106 DSN: 785-2106

9. JOAP Training.

   a. Training courses available.

      (1) Air Force Non-Destructive Inspection (NDI) course, JCABP2A732-048C (or equivalent), includes evaluator training and operation/maintenance of the Model M and M/N spectrometers: The JCABP2A732-048C course is NOT meant for Career fields without Oil Analysis as a primary component of their duties (e.g., Sheet Metal, Fuels, etc.). Non-NDI labs servicing DoD assets shall report such to the applicable Service Program Manager for further deliberation

      (2) A model M spectrometer maintenance training course is available from Spectro Scientific, Inc.

NOTE

It is highly recommended that personnel scheduled for spectrometer maintenance training possesses an electronics background. This training is meant to be a complementary course for JOAP qualified personnel and does NOT permit individuals to perform Oil Analysis.

10. Annual OAP Personal Evaluations (PEs)

   a. The AF OAP Office does not recognize Oil Analysis or Wear Debris Analysis (i.e., JetSCAN; ChipCHECK; etc.) as a traditional nor advanced Nondestructive Inspection Method (e.g., Fluorescent Penetrant; Radiography; etc.).

b. Routine operator evaluations such as Annual Personal Evaluations (PEs) performed by internal or external Quality Assurance (QA) shall not be required.

c. If operator improficiency is suspected, the Shop/Laboratory Supervisor or designated personnel shall provide the essential knowledge and training to assess and remedy the proficiency gap(s).

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AIR FORCE OIL ANALYSIS PROGRAM - LABORATORY EQUIPMENT AND CONFIGURATION REQUIREMENTS

1. Each laboratory shall have a Spectroil M or Spectroil M/N Rotrode Atomic Emission Spectrometer (RAES) and the ancillary equipment and supplies necessary for operation.

2. The lab shall have sufficient bench space to accommodate and operate the oil analysis spectrometer as well as manage the oil sample workload anticipated for the specific laboratory.

3. The oil analysis spectrometer shall be properly ventilated in accordance with applicable spectrometer equipment manual and technical order.

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AIR FORCE OIL ANALYSIS PROGRAM – DATA RECORDING, PROCESSING, AND WAREHOUSING

NON-AUTOMATED LABORATORY DATA SUBMISSION

1. The following instructions apply to all Air Force laboratories but may be directed for use by other Service Program Managers for their non-automated laboratories or for automated laboratories experiencing ADP equipment malfunctions, to transmit manually accumulated data into the JOAP Data Base.

2. Laboratories shall use DD Form 2026 or AF approved AF OAP Analysis Request Forms as a source document for completing 220+ column detail records. The resulting data will be forwarded to AFCR@us.af.mil the first duty day of EACH week.

   a. Open OAP Software

   b. Select tab E “Keypunch Routines”

   c. Enter keypunch dates and click query.

   d. Click on email button. Once Outlook opens ensure the subject line states Base Name and date (i.e Nellis23Nov14)

   e. Select send.

3. Retention of Records:

   a. Use the following table as the required retention time for OAP records:

Table 1. OAP Records Retention Requirements

DD Form 2026	Correlation Records Hard Copy or Digital	Daily Standardization Records Hard Copy or Digital	Supervisory Review Records Hard Copy Only
3 months	3 months	1 month	1 month

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AIR FORCE OIL ANALYSIS PROGRAM – MAGNETIC CHIP DETECTOR SAMPLE PROCESSING PROCEDURES

NOTE

This work package is new and being added to the JOAP Manual for the first time via Change 1 to this Volume. Changes are not marked with a line in the right margin.

1. This Work Package is for use by those Air Force laboratories required to perform wear debris analysis on Magnetic Chip Detectors (MCD). Air Force laboratories are to use the AF OAP Form 1000 for Magnetic Chip Detector (MCD) (See Figure 1) when processing requests for MCD analysis. This MCD Analysis Request form has been engineered by the Air Force Oil Analysis Program (AF OAP) Office to improve wear metal debris data collection.

2. PREPARING MCD SAMPLES FOR LABORATORY DELIVERY. Activities preparing MCD Samples for laboratory delivery are to complete the following sections of the AF OAP Form 1000 as shown in Figure 2.:

   a. To

   b. From

   c. Source

   d. Equipment: Model / Application

   e. Equipment: Component Serial Number

   f. End Item Model / Ship Name and Hull Number

   g. End Item Serial Number

   h. Date Sample Taken

   i. Local Time Sample Take

   j. Sortie/Flight Hours

   k. Time Since Overhaul (hrs)

   l. Time Since Oil Change (hrs)

   m. Reason for Sample

   n. Remarks

   o. A/C Engine Position

   p. MCD Visual Inspection of Debris

NOTE

The operating activity submitting the MCD shall enter the most accurate form data available at the time of sample preparation. Some activities will enter approximate sortie/flight hours, time since overhaul, and time since oil change based on previously known data. When necessary, laboratories may request updated/debriefed times from the activity submitting the MCD for analysis.

3. AF Personnel are responsible for completing all required information below “FOR LABORATORY USE ONLY.”

   a. Entry of analysis wear debris levels on the AF OAP Form 1000 by the laboratory is required. Air Force laboratories do not need the processed forms to be returned to the customer.

NOTE

The DD Form 2026 may also still be utilized IAW 33-1-37-1/2. In addition, some Engine Maintenance Activities, such as F110-GE-100/129, who have transitioned to MCD only as their primary engine analysis equipment, may use the AF OAP Form 1000 exclusively.

   b. Disposal of Magnetic Chip Detector (MCD) Analysis Records. The original copy of an MCD analysis record (AF OAP Form 1000) may be destroyed by the laboratory three (3) calendar months after receipt.

MCD ONLY RECORD. THIS FORM MUST ACCOMPANY THE MCD.

MAGNETIC CHIP DETECTOR (MCD) ANALYSIS REQUEST

TO	ANALYSIS LABORATORY:
FROM	MAJOR COMMAND:
	OPERATING ACTIVITY NAME:
	POC:RANK/NAME/EMP #:
	POC:PHONE/EMAIL:

SOURCE: ☐ AERONAUTICAL ☐ GROUND ☐ SHIP EQUIPMENT ☐ OTHER

EQUIPMENT MODEL/APPLICATION:

EQUIPMENT/COMPONENT SERIAL NUMBER:

END ITEM MODEL/SHIP NAME & HULL NUMBER *(with Dash)*:

END ITEM SERIAL NUMBER:

DATE SAMPLE TAKEN *(DAY/MO/YR)*: | LOCAL TIME SAMPLE TAKEN:

Sortie/Flight Hrs: | Time Since Overhaul (hrs): | Time Since Oil Change (hrs):

REASON FOR SAMPLE
☐ ROUTINE ☐ LAB REQUEST ☐ TEST CELL ☐ OTHER *(Specify)*

REMARKS | A/C ENGINE POSITION

MCD VISUAL INSPECTION OF DEBRIS ☐ WITHIN LIMITS ☐ EXCEEDS LIMITS ☐ UNKNOWN/NA

POC SIGNATURE:

FOR LABORATORY USE ONLY

Analysis Equipment: ☐ ChipCHECK ☐ JetSCAN ☐ JEMM ☐ eXtreme

LEVEL 1 - WEAR DEBRIS MATERIAL

9310/4340	Unclassified	M50	M50 NIL	17-4	410	347	REMARKS
A286	Inco 718	LA Steel	Ag	W Carbide	Cr Plate	Ni Plate	

LEVEL 2 - WEAR DEBRIS MATERIAL

9310/4340	Unclassified	M50	M50 NIL	17-4	410	347	REMARKS
A286	Inco 718	LA Steel	Ag	W Carbide	Cr Plate	Ni Plate	

LEVEL 3 - WEAR DEBRIS MATERIAL

9310/4340	Unclassified	M50	M50 NIL	17-4	410	347	REMARKS
A286	Inco 718	LA Steel	Ag	W Carbide	Cr Plate	Ni Plate	

MCD HIGHEST LEVEL: | WEAR DEBRIS MATERIAL:

AF OAP FORM 1000, JAN 2022 | OPERATOR INITIALS

Figure 1. – AF OAP Form 1000 – Magnetic Chip Detector (MCD) Analysis Request Form

MCD ONLY RECORD. THIS FORM MUST ACCOMPANY THE MCD.

MAGNETIC CHIP DETECTOR (MCD) ANALYSIS REQUEST

TO	ANALYSIS LABORATORY:	HOLLOMAN AFB
FROM	MAJOR COMMAND:	ACC
	OPERATING ACTIVITY NAME:	49 MXS
	POC:RANK/NAME/EMP #:	MSgt Marcel J. Wiltz
	POC:PHONE/EMAIL:	575-572-7583

SOURCE: ☑ AERONAUTICAL ☐ GROUND ☐ SHIP EQUIPMENT ☐ OTHER

EQUIPMENT MODEL/APPLICATION: F110-GE-100

EQUIPMENT/COMPONENT SERIAL NUMBER: 649554

END ITEM MODEL/SHIP NAME & HULL NUMBER *(with Dash)*: F-16

END ITEM SERIAL NUMBER: 91-0470-1

DATE SAMPLE TAKEN *(DAY/MO/YR)*: 01-Jan-2022 LOCAL TIME SAMPLE TAKEN: 0030

Sortie/Flight Hrs: 1.5 Time Since Overhaul (hrs): 1244.6 Time Since Oil Change (hrs): 102.8

REASON FOR SAMPLE: ☑ ROUTINE ☐ LAB REQUEST ☐ TEST CELL ☐ OTHER *(Specify)*

REMARKS: N/A A/C ENGINE POSITION: 1

MCD VISUAL INSPECTION OF DEBRIS: ☑ WITHIN LIMITS ☐ EXCEEDS LIMITS ☐ UNKNOWN/NA

POC SIGNATURE:

FOR LABORATORY USE ONLY

Analysis Equipment: ☑ ChipCHECK ☐ JetSCAN ☐ JEMM ☐ eXtreme

LEVEL 1 - WEAR DEBRIS MATERIAL

9310/4340	Unclassified	M50	M50 NiL	17-4	410	347	REMARKS
1							
A286	Inco 718	LA Steel	Ag	W Carbide	Cr Plate	Ni Plate	

LEVEL 2 - WEAR DEBRIS MATERIAL

9310/4340	Unclassified	M50	M50 NiL	17-4	410	347	REMARKS
	2						
A286	Inco 718	LA Steel	Ag	W Carbide	Cr Plate	Ni Plate	

LEVEL 3 - WEAR DEBRIS MATERIAL

9310/4340	Unclassified	M50	M50 NiL	17-4	410	347	REMARKS
		3					
A286	Inco 718	LA Steel	Ag	W Carbide	Cr Plate	Ni Plate	

MCD HIGHEST LEVEL: 3 WEAR DEBRIS MATERIAL: M50

AF OAP FORM 1000, JAN 2022 OPERATOR INITIALS: MJW

Figure 2. – Example Completed AF OAP 1000 Form

TOTAL ACID NUMBER (TAN) BY COLOR-INDICATOR TITRATION LABORATORY OPERATING PROCEDURE

1. Scope. This method, based on ASTM D974, determines Total Acid Number (TAN) in petroleum products due to processes such as oxidation.

2. Summary of Method. In the procedure, a weighed amount of lubricant sample is dissolved in a mixture of toluene and isopropyl alcohol and p-Naptholbenzein indicator is added. The mixture is then titrated with potassium hydroxide of known normality, until a stable color change is observed. The acidity, or Total Acid Number (TAN), of the sample is then calculated based on the milliliters of potassium hydroxide required to neutralize the known weight of sample.

3. Equipment/Apparatus/Material.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Jencons Digitrate Pro - 50ml	Jencons	JENC182-026	
Toluene (ACS Reagent Grade)	Fisher Scientific	T-324-SK4 (4L)	
Isopropyl Alcohol (ACS Reagent Grade)	Fisher Scientific	A464-4	6810-01-448-9253
P-Naptholbenzein 1%w/v Titrating Solution	Fisher Scientific	SN1-500	
0.1N KOH alcoholic KOH (ACS Reagent Grade)	Fisher Scientific	ST110-500	
Erlenmeyer flasks, 250 ml	Fisher Scientific	S63271	
Graduated cylinder, 100 ml	Fisher Scientific	MS35943-7	6640-00-420-0000
Graduated cylinder, 500 ml	Fisher Scientific	S328561B	
Bottle, Amber Glass Safety Coated w/Cap (4L)	Fisher Scientific	06-451-323	
apron, laboratory	GSA	021-758	8415-00-634-5023
goggles, chemical splash	GSA	ANSIZ87 1.1989	4240-00-190-6432
gloves, nitrile; medium	GSA		8415-01-492-0179
gloves, nitrile; large	GSA		8415-01-492-0178
gloves, nitrile; extra large	GSA		8415-01-492-0180
kim wipes	GSA	A-A-1432A	7920-00-721-8884
paper towels	GSA		7920-00-823-9773
Flashlight, explosion proof	GSA	MIL-F-3747	6230-00-161-6422

Notes: For HAZMAT items See Volume II WP HMWS for handling information.
The manufacturer's name is provided as an example. Equivalent product obtained from another sources is acceptable.
Before running a test, ensure there is no presence of crystals on the inside walls of the amber chemical storage bottle or inside the automatic burette. Crystallization will affect the proper operation of the unit.

4. Operation/Procedures.

a. Prepare titrating solvent. Using the 500 ml graduated cylinder, mix together 500 ml of Toluene, 495 ml of Isopropyl Alcohol and 5 ml of water into a properly labeled amber chemical storage bottle. Gently shake bottle to ensure proper mixing of solvents.

b. Tare an Erlenmeyer flask by placing it on the balance and adjusting the readout to zero.

c. Add sample to the flask until approximately 20 grams of sample has been added. If the sample appears dark, use 10 grams of sample. **NOTE:** Sample size may be decreased to as small as two 2ml for extremely dark samples. Some POE oils have leak-detecting dye in them and require a smaller sample.

d. Record the weight of the sample to two decimal places.

e. Add 100 ml of the toluene/isopropyl alcohol titrating solvent and mix by swirling the sample to ensure the sample is completely dissolved.

f. Carefully add five (5) drops of the Naphtholbezein Indicator Solution to the sample solution. The solution should appear light orange at this point. If unable to see clearly through the sample, discard the sample and repeat steps b thru e using a smaller sample weight.

g. Fill the automatic burette with the 0.1N alcoholic potassium hydroxide (KOH) solution.

NOTE: Make sure to purge any bubbles present inside the automatic burette before running ant test.

h. Ensure the KOH solution is at the zero line of the burette.

i. Add the KOH solution in small increments to the sample mixture. Swirl the flask after each addition and note the color of the mixture. Add in decreasing increments as green swirls start to appear.

NOTE: for darkly colored samples, observation of the color change may be assisted by side illumination of the sample using an explosion proof flashlight.

j. STOP when a distinct color change from orange to green that lasts for 15 seconds is observed. Color should be a grass green, possibly overlaid with brown but not a yellow brown.

k. Record the amount of KOH used.

l. Prepare a blank by adding 100 ml of titrating solvent and five (5) drops of Naphtholbenzein Indicator Solution to another Erlenmeyer flask.

m. Titrate the blank following steps e through j.

n. Record the ml of KOH required obtaining a color change in the blank.

o. Calculate TAN as follows:

(1) Subtract the ml of KOH required to titrate the blank in step l from the ml of KOH required to titrate the sample recorded in step k. Record this number as NET ML of KOH.

(2) Compute TAN by multiplying net ml of KOH by 5.61 then dividing the result by the grams of sample. TAN (mg KOH gm) = (net ml KOH) x 5.61 grams of sample.

p. Record the TAN for the sample and enter it into OASIS/LARA.

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BROOKFIELD SCANNING VISCOMETER LABORATORY OPERATING PROCEDURES

1. Brookfield Method Using Small Sample Adapter With #18 Spindle. (See paragraph 2 below for operation without the Small Sample Adapter).

   a. Scope. This method is used by the U.S. Navy and is performed on various non-aeronautical equipment fluid samples.

   b. Summary of Method. The Syncro-Lectric Viscometer is a rotational viscometer which measures torque necessary to overcome the immersed element, which is a spindle attached to a beryllium copper spring. The degree to which the spring is wound is proportional to the viscosity of the fluid at the test temperature for any given speed and spindle.

   c. Apparatus. Viscometer, Brookfield Syncro-Lectric-Models LVF, LVDV-E, LVDV-1+, LVDV-2+, small sample adapter with the #18 spindle, and water bath capable of temperatures between 10 degrees Celsius and 60 degrees Celsius.

   d. Consumables and Hazardous Materials

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Viscometer	Brookfield	LDV-II+	
calibration fluid, #50	Brookfield		
kim wipes	GSA	A-A-1432A	7920-00-721-8884
paper towels	GSA		7920-00-823-9773
gloves, nitrile; medium	GSA		8415-01-492-0179
gloves, nitrile; large	GSA		8415-01-492-0178
gloves, nitrile; extra large	GSA		8415-01-492-0180
spidle #18	Brookfield		
Electron	Ecolink	0296-5	6850-01-375-5553

Notes: For HAZMAT items See Volume II WP HMWS for handling information.
The manufacturer's name is provided as an example. Equivalent product obtained from another sources is acceptable.

   e. Standards. The standard recommended for viscometer calibration, Fluid #50, is available from Brookfield Engineering Labs, Inc., 11 Commerce Blvd., Middleboro, Massachusetts, 02346, U.S.A., 800-628-8139.

   f. Procedure.

      (1) Assemble the Model A laboratory stand. Place the upright rod into the base (refer to assembly instructions in the manufacturer's manual). The rack gear and clamp assembly should face the front of the base. The upright rod is held in place with the jam nut, which is attached from the bottom of the base. Tighten this nut with a suitable wrench. Attach leveling feet.

(2) Insert the mounting handle on the back of the viscometer into the hole on the clamp assembly. Be sure that the clamp screw is loose.

(3) Tighten the clamp screw. Adjust the viscometer to be as close to level as possible while tightening the clamp screw.

(4) Level the viscometer. The level is adjusted using the three leveling screws on the base. Adjust so that the bubble level on top of the viscometer is centered within the circle. Check level periodically during use.

(5) Ensure water bath is filled to the level recommended by the manufacturer.

(6) Connect the tubing from the water bath to the inlet and outlet connectors on the water jacket of the small sample adapter.

(7) Adjust the water bath temperature.

g. Instrument Start-Up. (LVDV-E, LVDV-1+, LVDV-2+)

NOTE

Before a reading can be taken, the viscometer must be auto-zeroed. This action is performed each time the power switch is turned on. The display window on the viscometer displays a guide through the procedure.

(1) Turn the power switch (located on the rear panel) to the ON position. This will result in the following screen display:

BROOKFIELD RV VISCOMETER

The model type will be displayed in the upper right-hand corner of the screen (DV-1+, DV-2+, etc.).

After a few seconds, the following screen appears:

BROOKFIELD VERSION 5.0

(2) After a short time the viscometer will instruct you to remove the spindle and that any key be pressed. The viscometer will begin to auto-zero itself.

NOTE

Ensure that the viscometer is level before initiating auto-zero.

(3) After the viscometer has completed its auto-zeroing, follow the directions to replace the spindle and press any key. Pressing any key at this point will result in the display of the default screen.

CP 0.0	S01
0.0RPM	%0.0

The display will vary slightly depending upon the status of the last spindle entry.

(a) Pressing the SELECT Spindle key will cause the characters on the top line of the display to begin to blink.

(b) By pressing the up or down arrow keys, the characters will start to cycle through the different types of spindles. When the desired spindle is reached, press the Select Spindle key once again. This will cause the characters to stop blinking and the new spindle will be accepted for use in the viscometer calculations.

(4) Speed Selection can be accomplished by pressing the **Select Speed** key. Once the key is depressed, scroll through the different speeds by pressing the **Up** or **Down** arrows. Pressing the **Select Speed** key again after the desired speed was reached will allow the viscometer to accept the new speed for its calculations.

h. Calibration Procedure.

NOTE

The laboratory shall annotate on the viscosity standard bottle a 1-year shelf life, expiration date effective the day the standard is initially opened. At the 1-year expiration date, the laboratory shall discard the outdated standard in accordance with local directives and replace it with a more current one.

(1) Warm up the viscometer in accordance with the Instrument Start-up procedure.

(2) Put the proper amount of standard (8 ml) in the sample chamber, allowing the fluid to cover the spindle with chamber in place.

(3) Place the number 18 spindle on the viscometer and attach the extension link, coupling nut, and free hanging spindle.

(4) Ensure the temperature of the water bath is at the temperature at which the standard's known viscosity was determined.

(5) Place the sample chamber into the water jacket.

CAUTION

The coupling shaft is a left-hand thread, and proper care must be taken in order not to damage the viscometer bearings.

(6) Allow 3 minutes for the viscosity standard, sample chamber and spindle to reach test temperature.

(7) Measure the viscosity and annotate the viscometer's reading on the QA chart (see table 2). The

factor of the spindle and fluid accuracy determines the total tolerance of the fluid. Table 3 provides the various factors for spindles.

NOTE

Instrument tolerance is equal to spindle factor. If the spindle factor is 10, then the viscometer's tolerance will be 10.

TABLE 2. Brookfield Viscometer Quality Assurance Chart

Date	
Temperature	
Viscometer Model	
Manufacturer:	Brookfield
Part Number	
Lot Number	
Certified Viscosity	
Expiration Date:	(1 year after opening)

SPINDLE LV 1

Rpm	Factor	% Torque	Min Accept	Actual Reading in Cp	Max Accept	Instrument Accuracy	Fluid Accuracy	Total Tolerance
30	2							
12	5							
6	10							

SPINDLE LV 2

Rpm	Factor	% Torque	Min Accept	Actual Reading in Cp	Max Accept	Instrumen t Accuracy	Fluid Accuracy	Total Tolerance
30	10							
12	25							
6	50							

SPINDLE 18

Rpm	Factor	% Torque	Min Accept	Actual Reading in Cp	Max Accept	Instrumen t Accuracy	Fluid Accuracy	Total Tolerance
30	1							
12	2.5							
6	5							

TABLE 3. Brookfield Spindle Factors

RPM	SPINDLE NUMBER				
	18	LV1	LV2	LV3	LV4
60	0.5	1	5	20	100
30	1	2	10	40	200
12	2.5	5	25	100	500
6	5	10	50	200	1M
3	10	20	100	400	2M
1.5	20	40	200	800	4M
0.6	50	100	500	2M	10M
0.3	100	200	1M	4M	20M

Example: Spindle factor for spindle 18 at 30 rpm is 1 and fluid accuracy is +/- 1% of the known viscosity (for Standard at 45 centipoise, fluid accuracy is +/- .45 cp). Total tolerance would equal +/- 4.5 cp of standards known viscosity. (1 + .45 = 1.45)

CAUTION

The spindle must rotate at least five (5) times before readings are taken.

i. Sample Procedure.

(1) Preparation of Sample. Agitate the used oil sample in the original container until all sediment is homogeneously suspended in the oil.

NOTE

Ensure that the viscometer speed is at 12 rpm for all testing.

(2) Warm up the viscometer in accordance with the Instrument Start-up procedure.

(3) Put the proper amount of used oil (8 ml) in the small sample chamber, which will allow the spindle to be completely immersed in the oil.

(4) Put the number 18 spindle in the used oil and attach the extension link, coupling nut and free hanging spindle.

(5) Adjust water bath temperature to 104 degrees Fahrenheit.

(6) Allow 3 minutes for the viscosity standard, sample chamber and spindle to reach test temperature.

(7) Place the sample chamber in the water jacket.

CAUTION

Protect alignment by taking care to avoid putting side thrust on the shaft.

(8) Measure the viscosity and record the viscometer reading.

NOTE

On LVF model viscometers, multiply the dial reading by the spindle factor to obtain the centipoises of the fluid.

Centipoise = dial reading * spindle factor

355cp = 35 (DR) * 10 (SF)

CAUTION

The spindle must rotate at least five (5) times and torque value must be above 10% before readings can be taken.

(9) If desired, convert centipoise to centistokes by dividing by specific gravity:

Centistokes = Centipoise/Specific Gravity

The average specific gravity of in-service diesel lubricating oil is approximately 0.92; synthetic gas turbine oil is 1.0. Refer to Table 4 below for the specific gravity of various oils used.

TABLE 4. Specific Gravity for Type Oil

Specific Gravity	Oil Type
0.92	MIL-L-9000G MS-9250
0.880	MIL-L-17331 MS-2190 TEP
1.0	MIL-L-23699
0.880	MS- 2075TH
0.863	MS-2110TH
0.867	MS-2135TH
0.859	MIL-H-5606
0.834	MIL-H-83282
1.40	MIL-H-19457 FYRQUEL

j. Cleaning. Clean the small sample chamber with cleaning solvent and wipe dry with a non-abrasive cloth.

CAUTION

Electron should be used with adequate ventilation. Prolonged breathing of vapors should be avoided. The solvent should not be used near open flame or heat, as the products of decomposition are toxic and very irritating.

NOTE

The black insulating bottom of the sample chamber should not be exposed to strong solvents such as methanol, toluene, ammonia, and 111-trichloroethylene. Do not totally immerse the chamber in any cleaning solution. Improper cleaning may result in separation of the black insulation from the chamber.

2. Brookfield Method without Small Sample Adapter.

a. Scope. This method is used by the U.S. Navy and is performed on various non-aeronautical equipment fluid samples.

b. Summary of Method. The Syncro-Lectric Viscometer is a rotational viscometer which measures the torque necessary to overcome the immersed element, which is a spindle attached to a beryllium copper spring. The degree to which the spring is wound is proportional to the viscosity of the fluid at the test temperature for any given speed and spindle.

c. Apparatus. Viscometer, Brookfield Syncro-Lectric-Models LVF, LVDV-E, LVDV-1+, LVDV-2+, 100 ml beaker, oven and a digital thermometer capable of temperature ranges between -40 to 250 degrees Fahrenheit.

d. Standards. The standard recommended for viscometer calibration, Fluid #50, is available from Brookfield Engineering Labs, Inc., 11 Commerce Blvd., Middleboro, Massachusetts, 02346, U.S.A., 800-628-8139.

e. Procedure.

(1) To assemble the Model A laboratory stand, place the upright rod into the base (refer to assembly instructions in manufacturer's manual). The rack gear and clamp assembly should face the front of the base. The upright rod is held in place with the jam nut, which is attached from the bottom of the base. Tighten this nut with a suitable wrench. Attach the leveling feet.

(2) Insert the mounting handle on the back of the viscometer into the hole on the clamp assembly. Be sure that the clamp screw is loose.

(3) Tighten the clamp screw. Adjust the viscometer to be as close to level as possible while tightening the clamp screw.

(4) Level the viscometer. The level is adjusted using the three leveling screws on the base. Adjust so that the bubble level on top of the viscometer is centered within the circle. Check level periodically during use.

NOTE

Before a reading can be taken, the viscometer must be auto-zeroed. This action is performed each time the power switch is turned on. The display window on the viscometer displays a guide for the procedure. Refer to Paragraph 1.f for complete instructions.

f. Calibration Procedure.

NOTE

The laboratory shall annotate on the viscosity standard bottle a 1-year shelf life, expiration date effective the day the standard is initially opened. At the 1-year expiration date, the laboratory shall discard the outdated standard in accordance with local regulations and replace it with a more current one.

(1) Warm up the viscometer in accordance with the Instrument Start-up procedure.

(2) Place the number 1 or 2 spindle on the viscometer. In order to use the smaller beaker, the spindle guard cannot be used. Take care not to bump the spindle.

CAUTION

The coupling shaft is a left-hand thread, and proper care must be taken in order not to damage the viscometer bearings.

(3) Put the proper amount of standard in a 100 ml beaker allowing the fluid to reach the groove imbedded on the spindle.

(4) Allow the fluid to reach the temperature at which the standard's known viscosity was determined.

(5) Measure the viscosity and annotate the viscometer's reading on the QA chart (Table 2). The factor of the spindle and fluid accuracy determines the total tolerance of the fluid. Table 3 shows the various factors for spindles. Example: Spindle factor for spindle 18 at 30 rpm is 1 and fluid accuracy is +/- 1% of the known viscosity (for Standard at 45 centipoise, fluid accuracy is +/- .45 cp). Total tolerance would equal +/- 5.5 cp of standards known viscosity (1 + .45 = 1.45).

CAUTION

The spindle must rotate at least five (5) times before readings are taken.

g. Sample Procedure.

(1) Warm up the viscometer in accordance with the Instrument Start-up procedure.

(2) Place the number 1 or 2 spindle on the viscometer. To determine the proper spindle, a known range of viscosity should be determined for the fluid (see table 5).

NOTE

Ensure the spindle speed is set at 60 RPM.

TABLE 5. Spindle/Range Information

SPINDLE	RANGE
LV-1	15-20K
LV-2	50-100K
SCV4-18	1.2-30K

CAUTION

The coupling shaft is a left-hand thread, and proper care must be taken in order not to damage the viscometer bearings.

(3) Put the proper amount of used oil with in the container, allowing the fluid to reach the groove imbedded on the spindle.

(4) Place the sample in the oven and allow the fluid to reach 104 degrees Fahrenheit.

(5) Measure the viscosity and annotate the viscometer's reading.

CAUTION

The spindle must rotate at least five (5) times before readings are taken.

(6) Convert centipoise to centistokes by dividing by specific gravity, and record the viscosity of the sample.

NOTE

On LVF model viscometers, multiply the dial reading by the spindle factor to obtain the centipoises of the fluid.

Centipoise = dial reading * spindle factor

355cp = 35 (DR) * 10 (SF)

Centistoke= Centipoise/Specific Gravity

The average specific gravity of in-service diesel lubricating oil is approximately 0.92; synthetic gas turbine oil is 1.0. Refer to Table 4 for the specific gravity of various oils used.

h. Cleaning. Clean the spindle with cleaning solvent and wipe dry with a non-abrasive cloth.

CAUTION

Electron should be used with adequate ventilation. Prolonged breathing of vapors should be avoided. The solvent should not be used near open flame or heat, as the products of decomposition are toxic and very irritating.

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CAMBRIDGE VISCOMETER LABORATORY OPERATING PROCEDURES

1. Scope. This method is to be used for analysis of lubricating oils with viscosity in the range of 12 to 250 centistokes (10 to 200 centipoise) at a preset temperature.

2. Summary of Method. In this test method the kinematic viscosity of an oil sample is measured using a piston-acuated, temperature-controlled sensor. Approximately 2 ml of sample are added to the sample chamber, and the magnetic piston is introduced into the sample. The time required to move the piston through the sample is then automatically converted to viscosity by the viscometer.

3. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Viscolab 3000 Viscometer	Cambridge Applied Systems		
Viscolab piston (10-200cP)	Cambridge Applied Systems		
Isopropyl Alcohol (ACS Reagent Grade)	Fischer Scientific	A464-4	6810-01-448-9253
Foam tip swabs	Fisher Scientific	14-960-3J	
Paper towels	GSA		7920-00-823-9773
Forceps	Fisher Scientific	10-316A	6640-00-100-7235
Chem-wipes or other lint free wipes	GSA	A-A-1432A	7920-00-721-8884
Cannon Viscosity Standard (S60)	Fisher Scientific	22-288-556	
plastic pipettes	Samco	H56822533	
Compressed Air Duster (12 Oz. Can)	GSA		7045-01-482-9818
Desk Fan (9 inch)	GSA		

Notes: For HAZMAT items See Volume 2 WP HMWS for handling information.
The manufacturer's name is provided as an example. Equivalent product obtained from another sources is acceptable.

4. Applicable Standards. ASTM D7483 “Determination of Dyndamic and Derived Kinematic Viscosity of Liquids by Oscillating Piston Viscometer”

5. Operation/Procedure.

a. Instrument Setup.

(1) Unpack the viscometer. The package should contain a control unit, sensor, instruction book, fan, printer, swabs, plastic pipettes, forceps and a piston.

NOTE

The piston is precision machined to mate with the chamber. They are a matched pair. The piston must not be scratched or damaged in any way. Keep the piston in its plastic case when not in use.

(2) Place the control unit and sensor unit on the table.

(3) Connect the sensor connector to the back of the control unit. The large green connector attaches to the sensor connector seen at the upper right when facing the back of the control unit. The small green connector attaches to the time Proportional control into the small green connector in the center bottom of the unit. Plug the serial cable for the printer into the RS232 connector adjacent to the sensor connection. Connect the power cord and plug into a 12V or 240V/60 Hz outlet. Plug in the printer power cord.

(4) Remove the thermal jacket from the sensor assembly unless viscosity measurement will be performed at a temperature higher than 60 degrees C.

(5) Position the fan 7” to 12” from the sensor assembly. Adjust the fan position as necessary to maintain the required temperature setting.

(6) Ensure the measurement chamber is clean and dry.

b. Calibration verification.

(1) Calibration. Calibration is performed by the OEM. The instrument may need to be re-calibrated if it fails the verification procedure. If the verification procedure is failed then contact the NOAP Office for assistance.

(2) Calibration verification. The instrument must be checked with a viscosity standard, preferably S60S, prior to first use of the day.

(a) Turn on the Viscolab 3000 using the power switch on the right hand side of the control module. Turn on the printer using the power switch located on the left side of the printer, and the fan if you will be operating the viscometer at temperatures of 60 °C or less.

(b) After a few seconds the main menu will appear. The first entry in the menu is OPERATE. Select the TEMPERATURE CONTROL option by using the arrow keys to move the “select arrow” to the option. Press the ENTER button to open the TEMPERATURE CONTROL menu.

(c) Select HEATER ON and set the temperature to 40 degrees C. If the temperature set point is correct press ENTER twice. (If a change in temperature is needed use the ESCAPE and ENTER buttons and left and right buttons respectively. The arrow buttons will change the numerals.)

(d) Once a temperature is selected and the heater is on, the instrument will display “Sensor in standby.” At this point allow the instrument time to reach the temperature set point and stabilize until the uncertainty in the temperature reading is less than or equal to +/- 0.1 °C. (For example, before moving on to the next step a 40 °C set point should have a reading of 40.0 °C +/- 0.1 °.)

(e) After the instrument temperature has stabilized, fill the bottom chamber (narrow portion) of the sample probe with the viscosity standard using a disposable dropper. Approximately 2 mL are needed.

(f) Use forceps to carefully insert the piston into the sample chamber with the conical side facing down. There should be no resistance. Push the piston just below the level of the sample, and leave it in the sample chamber.

(g) Place the cap on top of the sample probe.

(h) Select OPERATE on the main menu and press ENTER. Select MEASURE VISCOSITY and press ENTER again.

(i) When the instrument has finished, the words “Measurement Complete” will appear at the top of the screen along with the data for the sample. The data should also automatically printout on the printer.

(j) Press ENTER to return to the OPERATE menu.

(k) Select the REMOVE PISTON option and press ENTER. The instrument will return to standby mode. Carefully remove the piston using locking forceps. Little force should be required. Clean the piston using Kimwipes and isopropanol.

(l) Press ENTER when done.

(m) Return to the OPERATE menu, select the PURGE SENSOR option, and press ENTER. The instrument will display purge sensor on the screen. At this point, dump the sample out of the sensor into a waste beaker and wash the sensor with isopropanol. Use the swabs provided and more isopropanol if necessary to clean the lower portion of the sample chamber. Use Kimwipes to clean the upper portion as needed.

(n) To ensure complete removal of any residual isopropanol, gently blow compressed air into the sample chamber until the chamber appears completely dry.

(o) If the viscosity standard is within the accuracy limits indicated by the manufacturer then proceed with sample measurement. If the measured viscosity is outside the accuracy limits then contact the NOAP Office for assistance. For the S60S viscosity standard at 40 degrees C, the measured value should be within 0.35% of the value indicated on the bottle in order to proceed with sample measurement (For example if the bottle reads 54.06 mm2/s the measured value should be between 53.87 mm2/s and 54.25 mm2/s).

(3) Processing Samples.

(a) Press the down arrow until the choice for "Units of Measure" can be selected. Select the Units of measure and set the viscosity units to Centistokes. The instrument will prompt for a density entry. If possible, enter the measured density of the fluid being tested. Otherwise, use table 2 and enter the density of the fluid being tested.

TABLE 2. Fluid Densities

NAVSEA Designation	Density
MIL-PRF-9000 (9250)	0.90
MIL-PRF-17331 (2190 TEP)	0.90
MIL-PRF-23699	1.00
MIL-PRF-17672 (2075)	0.86
MIL-PRF-17672 (2110)	0.87
MIL-PRF-17672 (2135)	0.87
MIL-PRF-2104 (15W-40)	0.88
MIL-PRF-5606	0.86
MIL-PRF-83282	0.83
MIL-H-19457	1.40
MIL-H-22072	1.04
MIL-PRF-2105 (J2360)	1.00
MIL-DTL-32353 (2190 S)	0.84
A/C Reefer Oils	1.00

(b) Select the TEMPERATURE CONTROL option by using the arrow keys to move the "select arrow" to the option. Press the ENTER button to open the TEMPERATURE CONTROL menu.

(c) Select HEATER ON and set the temperature to 40 degrees C. If the temperature set point is correct press ENTER twice. (If a change in temperature is needed use the ESCAPE and ENTER buttons and left and right buttons respectively. The arrow buttons will change the numerals.)

(d) Once a temperature is selected and the heater is on, the instrument will display "Sensor is standby." At this point allow the instrument time to reach the temperature set point and stabilize until the uncertainty in the temperature reading is less than or equal to +/- 0.1 °C. (For example, before moving on to the next step a 40 °C set point should have a reading of 40.0 °C +/- 0.1 °.)

(e) After the instrument temperature has stabilized, fill the bottom chamber (narrow portion) of the sample probe with the viscosity standard using a disposable dropper. Approximately 2 mL are needed.

CAUTION

Ensure that the sample is free from particulate matter and bubbles.

(f) Use forceps to carefully insert the piston into the sample chamber with the conical side facing down. There should be no resistance. Push the piston just below the level of the sample, and leave it in the sample chamber.

(g) Place the cap on top of the sample probe.

(h) Select OPERATE on the main menu and press ENTER. Select MEASURE VISCOSITY and press ENTER again.

(i) When the instrument has finished, the words “Measurement Complete” will appear at the top of the screen along with the data for the sample. The data should also automatically printout on the printer.

(j) Press ENTER to return to the OPERATE menu.

(k) Select the REMOVE PISTON option and press ENTER. The instrument will return to standby mode. Carefully remove the piston using locking forceps. Little force should be required. Clean the piston using Kimwipes and isopropanol.

(l) Press ENTER when done.

(m) Return to the OPERATE menu, select the PURGE SENSOR option, and press ENTER. The instrument will display purge sensor on the screen. At this point, dump the sample out of the sensor into a waste beaker and thoroughly wash the sensor with isopropanol. Use the swabs provided and more isopropanol if necessary to clean the lower portion of the sample chamber. Use Kimwipes to clean the upper portion as needed.

(n) To ensure complete removal of any residual isopropanol, gently blow compressed air into the sample chamber until the chamber appears completely dry.

(o) Record the sample viscosity in Centistokes in LARA.

6. Troubleshooting

a. If the viscosity standard verification fails, contact the equipment vendor and the NOAP office for support.

b. The Equipment Logistics Support Supplement (ELSS) for the Viscolab 3000 provides additional information, including points of contact, and processes for instrument calibration or replacement. The ELSS is available at https://www.jtdi.mil/group/noap.

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CRACKLE TEST

1. Scope of Test. The crackle test is a simple test used to identify the presence of free and emulsified water that is suspended in oil. Water contamination refers to the presence of free water in used lubricating oils, and is usually performed on non-aeronautical samples. The crackle test indicates whether water is present. If the exact amount of water is desired, the Karl Fischer test for water shall be conducted.

2. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
no chemicals required for test			
kim wipes	GSA	A-A-1432A	7920-00-721-8884
paper towels	GSA		7920-00-823-9773
hot plate	Thermo Scientific [1]		6640-01-125-3765
oil dropper	Samco	H56822533	
thermometer	PTC Instruments [1]	Model 572FM	
goggles, chemical splash		ANSIZ87 1.1989	4240-00-190-6432
gloves, nitrile; medium	GSA		8415-01-492-0179
gloves, nitrile; large	GSA		8415-01-492-0178
gloves, nitrile; extra large	GSA		8415-01-492-0180

Notes: [1]The manufacturer's name is provided as an example. Equivalent product obtained from another sources is acceptable.

3. Applicable Standards. None

4. Summary of Method. Water held in suspension by emulsifiers becomes audible (crackles) and visible as bubbles and steam when drops of oil are place on a heated surface of 300 deg F.

   a. The method is non-quantitative.

   b. Hot plate temperatures above 300 degrees F induce rapid scintillation that may be undetectable.

   c. The method does not measure the presence of chemically dissolved water.

5. Safety Considerations.

   a. Protective eyewear is suggested.

   b. Long sleeves are suggested.

   c. Testing must be performed in a well-ventilated area or inside of a fume hood.

WARNING

Persons performing test must wear protective goggles and clothing and avoid direct contact with hot plate surface.

6. Interferences.

   a. Refrigerants and other low boiling-point suspensions may interfere.

   b. Different base stocks, viscosities, and additives will exhibit varying results.

   c. Certain synthetics, such as esters, may not produce scintillation.

7. Operation/Procedures.

   a. Achieve surface temperature on a hot plate of 300 degrees F (135 degrees C). Always use the same temperature.

   b. Violently agitate oil sample to achieve homogenous suspension of water in oil.

   c. Using a clean dropper, place a drop of oil on the hot plate.

   d. Observe the drop of oil:

      (1) Record the reaction as positive (1), meaning bubbles were present; or negative (0), meaning bubbles were not present.

AQUATEST 2010 (KARL FISCHER WATER TEST)

1. Scope. Karl Fisher (KF) titration is an accurate method of measuring moisture that utilizes the quantitative reaction of water with iodine, which can be measured electrolytically at the anode. One molecule of iodine reacts quantitatively with one molecule of water. Consequently, 1 mg of water is equivalent to 10.71 coulombs. Based on this principle, the water content in the sample can be determined by the quantity of electricity required for the electrolysis.

2. Summary of Method. After the instrument is prepared for use, operation is accomplished in three quick steps:

   a. Depress the FILE key and verify all the parameters are set in accordance with TABLE 3, page 7, and the weight of oil being tested.

   b. Introduce a measured quantity of sample; and

   c. Wait for the results of the sample to be displayed and/or printed with the amount of moisture present.

3. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
AquaTest 2010	Photovolt		6630-01-293-4324
Grease, Sealing	Photovolt	2091001	9150-01-558-8043
Pyridine-Free Vessel Solution	Photovolt	2791013	6810-01-459-0999
Generator Cartridge	Photovolt	4090103	6630-01-415-1588
Generator Solution	Photovolt	2791003	6810-01-442-9883
Standard Solution (4x200MLs)	Photovolt	0891-002	6810-01-443-2937
Standard Solution (500MLs)	Photovolt	0891-013	6810-01-459-1003
Methanol	Photovolt	2712803	6810-01-064-6484
Nitric Acid (ACS Reagent Grade)	Fisher	A200-500	
Desiccant			6850-01-558-8134
Syringe, 10 Microliter	GSA		6640-01-583-4739
Paper Towels	GSA		7920-00-823-9773
Kim Wipes	GSA	A-A-1432A	7920-00-721-8884
Gloves, Nitrile; medium	GSA		8415-01-492-0179
Gloves, Nitrile; medium	GSA		8415-01-492-0178
Gloves, Nitrile; medium	GSA		8415-01-492-0180

Notes: For HAZMAT items See Volume II WP HMWS for handling information.
The manufacturer's name is provided as an example. Equivalent product obtained from another sources is acceptable.

4. Preparation of Sample. No special sample preparation is required; however, particulate matter should be allowed to settle as much as possible and syringe needle should be immersed in top portion of sample in an effort to prevent syringe plugging from large particles.

5. Operation/Procedures. AQUATEST 2010 analysis for detection of water in oil.

   a. Proper Use.

      (1) Do not use this product for any purpose other than for which it was intended.

      (2) When storing or moving the instruments refer to operating manual for proper storing of this equipment.

      (3) Use only those accessories recommended by the manufacturer in order to avoid risk of fire, shock, or other hazards.

      (4) Unplug all equipment exposed to rain, moisture, or strong impact and have the instrument inspected by qualified service technician before use.

      (5) Disconnect all equipment from the line power source during a lightning storm or before leaving unused for extended periods of time.

      (6) Unplug all equipment before cleaning. Then use a clean, dry, chemically untreated cotton cloth to wipe the unit. Use no cleaning fluids, aerosols or forced air that could over spray or soak into the unit and cause electrical shock.

   b. Setting Up for Operation.

      (1) The AQUATEST 2010 has Type T line voltage fuses in series with the power supply. These fuses are located on the rear panel. To replace the fuses, unplug the line cord and remove the fuse cover from the power-input module. Remove the fuse/selector cover. (Newer models of the Aquatest 2010 typically have an external power with the fuses in them). Do not remove or change the setting of the voltage selector. Pull out each fuse drawer and replace both fuses with two of the identical rating. Always change both fuses.

IMPORTANT NOTE

The AQUATEST 2010 is shipped without fuses installed. Prior to applying power, verify that the appropriate fuses are installed and that the voltage selection switch is set to the correct voltage.

WARNING

For protection against fire, replace both fuses with two of identical rating. Refer to TABLE 2 for proper fuse ratings for the selected voltage.

TABLE 2. Fuse Ratings for Selected Voltage

Voltage Rating	Fuse Description
100/115	Type T, 0.4 amp. 250V, Slow Blow UL Listed
220/240	Type T, 0.2 amp. 250V, Slow Blow IEC Approved

(2) The AQUATEST 2010 is designed to operate at nominal line voltages of 100/115/220/240 VAC, depending upon the setting of the voltage selection switch located on the back of the instrument. The red notch on the voltage selection switch indicates the selected operating voltage. To change the voltage, first unplug the line cord. Open the fuse drawer and check the fuse ratings compared to the desired voltage setting. Change the fuses if necessary. If the voltage is being changed from 110/115V to 220/240V or 220/240V to 110/115V, the fuses must be changed. Both fuses must be replaced together.

(3) Using a flat bladed screwdriver, move the rotary dial so that the new voltage is indicated on the switch.

c. Assembling the Titration Cell. The titration cell for the AQUATEST 2010 consists of a titration vessel, generator cartridge, sensing electrode, injection port, vent tube, stir bar, and gas port stopper. The titration cell is assembled as follows:

IMPORTANT NOTE

Before assembling the titration cell, all parts must be properly lubricated with Photo volt Sealant to prevent seizing of parts to the generator vessel.

(1) Place the stir bar into the vessel.

(2) Lubricate the ground glass portion of the sensing electrode and insert into the proper port on vessel. (newer units have greaseless glassware and do not require lubrication.)

(3) Place a septum inside the 2-pice injection port assembly and gently tighten the threaded portions.

(4) Lubricate the ground glass portion of the gas port stopper and the rounded sides of the sample injection port.

(5) The injection port can occupy one of two positions on the titration vessel. Select the preferred position for the injection port and insert the stopper into the remaining port.

(6) Fill the vent tube with silica gel desiccant. A plug of glass wool may be used under and over the desiccant. Lubricate the slotted stopper and the ground glass joint at the bottom of the tube. Insert the vent tube into the proper port on the vessel. Insert the slotted stopper into the vent tube.

NOTE

The silica gel desiccant must be replaced periodically. If the blue indicating beads are no longer blue through more than 50 percent of the tube, replace the desiccant.

(7) Remove the generator cartridge from the packing. Remove the foam insert. Lubricate the solid stopper and ground glass joint on the body of the generator. Assemble the pieces and insert into the proper port on the vessel.

WARNING

Proper personal protective equipment (PPE) should be used with all hazardous chemicals. Refer to the MSDS for the hazards involved with each chemical being used.

d. Filling the Vessel with KF Reagents. Selection of reagents is an important factor in the overall performance of a coulometric titration. Photovolt provides reagents designed to provide optimal performance in the analysis of the wide variety of materials. Photovolt Pyridine Free KF Reagent is the most popular reagent currently in use. Pyridine is replaced by a proprietary amine, which has a reduced odor and toxicity compared to pyridine.

WARNING

Dispose of Karl Fischer reagents, solvents and cleaning solutions in a proper manner. Refer to the MSDS sheets for the chemicals to identify chemical hazards. Follow all applicable regulations regarding disposal of chemical waste.

(1) Remove the stopper from the gas tube port of the vessel and pour approximately 150 ml of Photovolt Coulometric KF vessel solution into the cell using a large polyethylene funnel supplied. Replace the stopper.

NOTE

Take care to avoid getting water into the vessel when filling with the reagents. Make sure the vessel is free from water.

(2) Remove the stopper from the top of the generator.

(3) Carefully crack the top off one 5 ml ampoule of Photovolt Coulometric KF generator solution.

(4) Pour the full contents of the ampoule into the generator using the small polyethylene funnel supplied with the reagent.

(5) Replace the stopper.

NOTE

For best results, maintain the level of the solution in the generator well below the level of the solution in the vessel.

(6) Set the slide lever on the left side of the instrument approximately half way through its range to achieve a moderate rate of stirring. Avoid setting the lever to high to reduce “tumbling”. This action could damage the electrode.

(7) When facing the AQUATEST 2010, connect the sensing electrode to the BNC connector on the right denoted by the letter D for detector. Connect the generator to the BNC connector on the left denoted by the letter G for generator.

e. Achieving Set Point. Generally, after filling the vessel with solution, the AQUATEST 2010 will need to be equilibrated before beginning analysis of samples or standards. This process is referred to as “bringing to set point.” In most cases, the AQUATEST 2010 will come to set point in less than 10 minutes. The exact amount of time required for the process, generally depends upon how “wet” the vessel solution is during filling. A very small amount of water present in the vessel, before the addition of reagent, can add a great deal of time to the process. For this reason, it is best to ensure that the components of the vessel are reasonably free of moisture before assemble.

WARNING

The AQUATEST 2010 sensing electrode can be damaged by exposure to high heat. DO NOT place the sensing electrode in an oven.

(1) Turn on the power switch. The following message should be displayed:

S T B Y

Where the # # are present indicates potential.

NOTE

If the potential shows a negative value, this indicates that the vessel solution contains a large amount of free iodine. Excess iodine may be present in the vessel solution as a result of the reagent manufacturing process. If this is observed, add approximately 2 uL of pure water until the potential becomes positive.

(2) Press the [STANDBY] key. The display indicates the titration rate (ug H2O/sec), current demand sign (*), status and total moisture, for example:

12 . 5 * WET 765 .8 ug

After titration of residual moisture from filling the vessel with the solutions, the titration stops, the beeper will sound three times and the following will be displayed:

END

After a few seconds and if the background is above 0.1 ug H2O/sec., the display will read:

RDY

If the background is below 0.1 ug H2O/sec., the display will read:

DRY

If the indicated titration rate (background) is 0.2 (ug H2O/sec) or higher, moisture is still present or remains on the inner walls of the vessel. In this case press the [STANDBY] key again to stop the electrolysis and set the stirrer speed to zero. Lift the vessel and swirl it gently to mix any moisture in the vessel with the reagent. Do not shake the vessel hard enough to cause the solution to exit through the vent tube. After swirling, replace the titration cell, adjust the stirrer speed, and press [STANDBY] to restart electrolysis. Repeat this procedure a few times if necessary. Again wait for display to indicate [RDY].

NOTE

When the titration rate falls below 0.2 (ug H2O/sec), the AQUATEST 2010 is ready for analysis of most samples or standards. Testing should not be conducted before this. The performance of the AQUATEST 2010 can be verified through the injection of a small amount of pure water (2 ul of pure water injected from a 5 ul syringe is suggested).

f. Programming the Aquatester for Variety of Oils. The conditions under which a sample measurement is performed can be selected through use of the [FILE] key. A sequential menu of setting will be displayed by pressing this key. Eight files can be programmed into the AQUATEST 2010 to perform test on a variety of oils.

(1) Pressing [FILE] key will give the following display:

FILE#: X

Where X is the number of the presently active analysis file. To begin using a different file for a sample measurement, enter a number from 1 to 8 using the keypad. Press [ESCAPE] if the new file is not to be altered before analyzing a sample. To check the contents of the new file, press the [ENTER] key to display each of the settings. Pressing the [ENTER] key allows viewing of the contents of a file without changing them. Entering a number into a field then pressing [ENTER] will change that setting. For a complete list of settings for each type of oil commonly used in the Navy refer to TABLE 3

TABLE 3. Settings for Type Oil

	A/C Reefer oils	23699	2190	2135	2110	MIL-H-5606	MIL-H-83282	MIL-H-19456	QA Check
File	*	*	*	*	*	*	*	*	*
Delay	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Min Time	Blank	Blank	Blank	Blank	Blank	Blank	Blank	Blank	Blank
Stop Time	Blank	Blank	Blank	Blank	Blank	Blank	Blank	Blank	Blank
End Point	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Print Form	2	2	2	2	2	2	2	2	1
Calc Form	3	3	3	3	3	3	3	3	0
Units	1 (%)	2 (PPM)	2 (PPM)	1 (%)	1 (%)	1 (%)	1 (%)	1 (%)	
Prod	*	*	*	*	*	*	*	*	*
Test	*	*	*	*	*	*	*	*	*
Blank	Blank	Blank	Blank	Blank	Blank	Blank	Blank	Blank	Blank
Volume	1	0.25	1	1	1	1	1	1	
Density	1	1	0.88	0.867	0.863	0.859	0.834	1.4	
NOTE: * Any entry 1 to 99 can be entered.									

(2) Delay. A titration delay time is used when a sample requires an extraction time period in the vessel solution before it can be analyzed. It is also used to allow time for moisture to be carried into the vessel from the optional vaporizer accessory. After pressing the [START/STOP] key, the titration sequence will not begin until the selected time has elapsed.

(3) Min. Time (Minimum Titration Time). The titration will proceed for a minimum time equal to this value regardless of the status of the sensing electrode circuit. This setting is used in the analysis of samples having only a trace of moisture where the peak moisture value may not exceed the detection threshold of the AQUATEST 2010.

(4) Stop Time (Titration Maximum Stop Time). The titration will be forced to stop at the selected time regardless of the status of the sensing electrode circuit. By bypassing the normal endpoint detection algorithm, this function can be used to terminate a titration at a selected time. The titration will stop if the detection algorithm senses that all of the moisture has been titrated before the stop time is reached.

(5) End Point (End Point Sensitivity). This setting is used to determine the endpoint of titration through the sensing electrode circuit. The sensitivity is increased. If the endpoint sensitivity is set at zero, the AQUATEST 2010 will continue to titrate indefinitely or until the Titration Stop Time is reached or until the Start/Stop key is depressed.

(6) Print FRM (Print Format). There are four different print formats possible for reports generated by the AQUATEST 2010. As the value set for print format increases so does the information that the printout generates. A zero value for print format deactivates the printer and no printout will be generated. To printout a completed history with the average of all samples conducted since last time the test number has been reset to 1, press [MEMORY] and [PRINT] keys.

(7) Calc. FRM (Calculation Report Form). Many calculations can be performed on the measured data to yield a final concentration value. The selection of calculation format determines how the final value will be calculated. A zero value entered into the calculation format setting forces all data to be presented in total ug H2O only. To get a complete list of Calculation values refer to Manufacturer's manual. It is recommended that moisture content when a liquid sample is taken by volume. (Calc. Form 3).

(8) Units. If an appropriate calculation formula is selected for the "Calc. FRM" parameter, the AQUATEST 2010 will automatically prompt the user for units. Units determine whether the final value will be given in PPM (parts per million) or percent. Depending on the type of oil units 1 and 2 will most commonly be used.

(9) Samples. The AQUATEST 2010 can accept and use information about the samples to be measured. Sample information is entered before starting a titration or after completed a measurement. Press [SAMPLE] key and the following should be displayed:

PROD: X

The product code number can be used to identify the sample being tested. It is printed on the analysis report when print format 2, 3 or 4 is selected. A product code number can be any number between 1 and 9999.

(10) Test Number. The AQUATEST 2010 has a memory capacity for up to 99 sample measurements. The 99 measurements can split in any fashion among a series of product code numbers. Each product code number may have a different number of sample results.

(11) Blank. The AQUATEST 2010 will display an upper case "B" when a blank value is to be entered. The blank value will be subtracted from the final result of moisture test. This is used to compensate for moisture that is introduced into the vessel from sources other than the sample. (For example, when using a cleaning solvent to dissolve a sample, the solvent usually contributes a small amount of moisture that must be subtracted from the final result).

(12) Sample Volume. The AQUATEST 2010 will display:

VOLUME:

If liquid volume rather than mass are measured, the AQUATEST 2010 will prompt you to enter a volume in liters. Enter the value using the number keys then press [ENTER].

(13) Specific Gravity (Or Density). Density of the oil being tested must be entered in order for the AQUATEST 2010 to determine the end result. For a complete list of Navy oil specific gravity values refer to Work Package 006 00, Brookfield Scanning Viscometer, Table 3, page 7..

(14) Set Clock. The "set clock" function allows the time and date to be set. Press [OPTION] key once followed by the right arrow key twice. The following message will be displayed:

SET CLOCK

Press enter key and the current date will be displayed in the following format:

DATE: YYYY/MM/DD

Use the number keys to change the date. Press the right arrow [>] key to past the slash mark or press the minutes (-) symbol. Press the [ENTER] key to set the value into the instrument clock.

15. Reagent Use. The AQUATEST 2010 maintains a running count of the amount of water that has reacted with the reagents in the vessel. This count is maintained even when the power is interrupted. The "reagent use" function should be reset each time that the reagents are changed. Press the [OPTION] key once, followed by the right arrow [>] key until the following display:

REAGENT USE

Press the enter key to view the current reagent usage. The display will read:

REAG USE: VVV-GGG

The (VVV) is the consumption value in mg H2O for the vessel solution and (GGG) is the consumption value of H2O for the generator solution.

(a) When replacing both solutions press the [CLEAR] key to reset both values.

(b) When replacing the vessel solution only. Enter zeros for the digits of the first value and press the [ENTER] key.

(c) When replacing the generator solution only, use the arrow [>] key to the digits of the second number and enter zeros.

Refer to manufacturer's specifications for the capacity data of the solutions.

6. Standards/Standardization/Calibration.

   a. A calibration check that verifies the accuracy of titration of the instrument and reagent can be performed, as needed, using de-ionized (DI) water.

   b. Place the AQUATEST 2010 in the proper file for Q.C. verification (paragraph 5f., items 1-15)

   c. Setup sample, first press the [SAMPLE] button. Next enter the serial number for the product. Enter 1 for test and press [ENTER].

   d. Use a 10 micro-liter (ul) syringe. Clean the syringe by drawing 10 ul of test fluid. Discharge the fluid into a suitable waste container.

   e. Draw 10 ul test fluid past the 10 ul mark on the syringe. Place the needle in the upward position allowing the bubble to float to the top of syringe chamber. Discharge all air bubbles until fluid has reached the 10 ul mark on the syringe.

NOTE

Do not inject fluid with visible bubbles. Start each injection when the display says that the titration rate is 0.20 or less.

   f. Press start on the AQUATEST 2010 and inject 2 ul into the generator vessel. Repeat step 3 times for a total 3 injections.

NOTE

An injection of 2 ul should get a result of 2000±100 ug. If erratic readings occur, replace generator and vessel solution after you place Aqua tester in standby.

   g. Print a data report and average of the 3 injections by pressing the [MEMORY] and then the [PRINT] button.

7. Sample Testing Procedure.

   a. Condition syringe by drawing 1cc of oil into a 5cc syringe (for 23699 samples draw 0.5cc of sample into a 1cc syringe). Discharge oil into a suitable waste container. Repeat step “a” no less than 3 times to flush last oil residue from syringe.

   b. Draw 1.25cc of sample (for 23699 draw 0.5cc) into syringe. Invert syringe and ensure air bubbles rise to the top of syringe. With syringe inverted depress plunger to the 1cc mark (for 23699 depress to the 0.25cc mark) to remove air and excess oil. Wipe oil from end of needle.

   c. When the machine displays “RDY” press the “START” button, insert syringe below the solution level and inject sample. Remove syringe. When test is completed the results will be printed.

8. Maintenance.

a. The AQUATEST 2010 has been designed to provide years of operation under normal laboratory use. The appearance and operation of your AQUATEST 2010 can be maintained by providing proper routine care.

(1) Spills of reagents or sample on the outer surface of the case should be removed quickly using a slightly damp cloth. In the event of a large spill, immediately unplug the instrument until the excess liquid can be removed.

(2) The desiccant in the vent tube should be changed when more than 50 percent of the blue indicting beads are no longer blue.

(3) The injection port septum should be changed whenever it has been pierced to the extent that it will no longer maintain a good moisture tight seal.

(4) Check the ground glass joints of the titration cell at least once a week by trying to rotate them. If they do not move smoothly, clean the joint and reseal with sealing grease.

(5) When replacing reagents, always lubricate the ground glass joints with sealing grease.

(6) If the instrument will not be used for an extended period of time (more than 3 to 4 weeks), the solutions should be removed and the titration cell rinsed with methanol. Never allow the reagents to evaporate totally from the titration cell.

b. Maintaining the Printer Unit. The printer should be cleaned of paper dust periodically. Use a soft brush or clean compressed air to remove dust particles from the printer mechanism. Any accumulation of material in the printer housing can be removed with a vacuum.

NOTE

Do not insert sharp objects into the printer unit. Portions of the mechanism may fail to operate properly if they are scratched or cut.

c. Cleaning the Titration Cell. The titration cell can be cleaned with methanol or ethanol to remove waste material. If samples are greasy, octanol, or other solvents can be used as degreasing agents before final cleaning.

WARNING

Proper personal protective equipment (PPE) should be used with all hazardous chemicals. Refer to the MSDS for the hazards involved with each chemical being used.

It is not generally necessary to remove all traces of waste material from the cell. The Coulometric titration method can be used in the presence of many foreign substances. Wiping waste material with a soft paper towel should clean the sensing electrode. It can be rinsed with solvents.

NOTE

Never heat the sensing electrode or place it in a drying oven. The sealed glass envelope may crack.

d. Cleaning and Maintaining the Generator. Over a period of time, contaminants may accumulate in the frit of the generator cartridge. Many of the contaminants can be removed by periodically rinsing the frit with dry reagent grade methanol or other solvents. When the contaminants build up to the extent that they begin to impair the performance of the AQUATEST 2010, the instrument may display an error message.

e. Reagents and Equipment for Cleaning the Generator.

(1) Alcohols. Methanol or ethanol, reagent grade, should contain a low amount of water. Alcohols are used to rinse the frit after nitric acid cleaning and water rinsing.

NOTE

Ketones such as acetone, aldehydes and very acidic or basic solvents should not be used to clean the components of the titration vessel. Some of these solvents can interfere with the Karl Fischer reaction when present at elevated levels.

(2) Other Solvents. A wide variety of solvents may be used to remove sample build up on the frit. Oils can best be removed with petroleum solvents – xylenes, toluene, chloroform, methylene chloride, etc. With other samples, the analyst is usually aware of solvents in which their samples are soluble. Use these solvents to remove any build up on the frit. Rinse the frit with water to remove the solvents before cleaning with nitric acid. The frit material and the platinum anode and cathode are relatively inert to most solvents and acids. Strong alkalis should be avoided especially when hot, for they may damage the frit.

(3) Nitric Acid. ACS reagent grade nitric acid is suggested for thorough cleaning of the frit. Technical grades can be used if ACS reagent grade is not available. Nitric acid is preferred to other acids and can be obtained from any chemical supply house.

(4) Containers for Cleaning the Generator. Any acid and solvent resistant glassware or plastic-ware may be used. Glass or polyethylene containers are suitable.

(5) Vacuum Apparatus. Some means of drawing a slight vacuum on the generator cartridge is necessary. The PHOTOVOLT titration cell cleaning kit (part number 4091004), is quite useful for providing a sufficient vacuum. A plug for the vent hole is included with the kit.

(6) Explosion Proof Oven. An oven can be used to dry the generator cartridge after rinsing with alcohol. Maintain the oven at 40-60 degrees Celsius. Use of a drying oven is optional.

f. Cleaning Procedure.

(1) The AQUATEST 2010 should be in [STANDBY] mode or the power should be turned off before unplugging the generator cartridge from the instrument.

(2) Remove the generator cartridge and siphon or pour off the generator solution.

(3) Rinse the generator cartridge with methanol followed by clean water to remove any remaining Karl Fischer solutions.

(4) Insert a plug into the vent hole on the generator cartridge if vacuum is to be used to aid in the cleaning process.

(5) Immerse the generator cartridge in a small container of 75 percent nitric acid and 25 percent water. Draw about 5-10 ml of acid into the generator cartridge. It will probably come through the frit very dark brown due to iodine's and other containments. Discard the darkened acid and draw more acid through the frit until it comes through clear.

(6) Replace the acid container with one containing water and repeat the process of drawing water through the frit. Draw up enough water to completely remove all traces of the nitric acid.

(7) Replace the water container with one containing the driest alcohol available (methanol is preferred) and repeat the process of drawing alcohol through the frit.

(8) Place the generator cartridge in an explosion proof oven to dry

WARNING

Dispose of Karl Fischer reagents, solvents and cleaning solutions in a proper manner. Refer to the MSDS sheets for the chemicals to identify chemical hazards. Follow all applicable regulations regarding disposal of chemical waste.

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AQUATEST VIII

1. Introduction. This procedure describes the method for measuring the water content of silicate ester based coolant with the Karl Fischer Coulometric Titrator (Aquatest VIII). The Aquatest VIII uses both the dead stop electrode and the coulometric generation of iodine in a closed vessel system. The coulometric addition of iodine makes the Aquatest an absolute instrument. When a sample is added to the vessel reagent, the voltage rises across the sensing electrode to indicate the wet state. This triggers the coulometer and a constant current flow through the generator producing iodine in the vessel reagent. The iodine reacts with the water from the sample and the vessel solution. When all the water has reacted, the voltage at the sensing electrode drops. This signals the coulometer to stop. The electrical charge produced during the titration is measured coulometrically and is displayed as the total water content. Since the reagent in the vessel is returned to an initial state at the end of each sample addition, sequential analysis can be performed until the vessel reagent is exhausted.

2. Equipment and Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Titrator, Karl Fischer Coulometric	PhotoVolt	02-128-10	
Generator Solution Pyridine Free (50 ml)			
Vessel Solution Pyridine Free			
Isopropyl Alcohol TT-I-735			
Methanol O-M-232			
Sodium Hydroxide, 1 Normal Solution		0S598	
Kim Wipes			
Syringe, Hamilton Series 7000, 2 microliter, gastight 4.5 inch round point needle with Chaney Adapter		26-122-55	

3. Test Information.

   a. The referenced Karl Fischer Coulometric Titrator consists of an Aquatest VIII Titrator and a printer. The Aquatest VIII is a microprocessor-controlled, automated Karl Fischer Coulometric Titrator, which is manufactured by Photovolt, a division of Seradyn, Inc. (FSCM 47125). It is comprised of a base unit, which houses the microprocessor, a titration vessel assembly.

   b. The sample is inserted into the Titractor by means of a sample syringe. The sample will be taken from the sample container and injected into the Titrator's vent hole or its septum opening. At this point, test parameters and other data are input to the Aquatest VIII Titrator via a spill-resistant keypad on the base.

The titration is then initiated, via the keypad, and the Aquatest VIII proceeds to automatically perform the titration. Upon detection of the titration end-point, the results are displayed on the base's sixteen character alphanumeric display. This value can be given in terms of micrograms, percent water, or PPM (parts per million). The printer that is provided with the Aquatest VIII can then be used to obtain hard copies of the test results.

c. The silicate in the SEBD will react with the reagent to produce water over an extended period of time. The addition of water to the solution will give inaccurate results. In order to remedy the situation, new solution and reagent will be used every 48 hours.

d. Specifications for the Aquatest VIII are as follows:

(1) Accuracy:	1 microgram or 0.05 percent whichever is greater.
(2) Capacity:	Readouts to 999,999 micrograms of water.
(3) Range:	1 PPM to 100 percent moisture.
(4) Rate:	2540 micrograms of water per minute.
(5) Electrical:	110 V, 50/60 Hz, 40 Watts

4. Test Procedures.

a. Instrument Set-Up.

(1) Place the Aquatest VIII instrument on the laboratory bench in an area away from direct sunlight and sources of heat such as ovens.

(2) Handle the generator assembly by the Teflon collar.

(3) Holding the vessel cover with the thumbscrews facing away from you, feed the generator plugs and wires through the larger threaded opening. While gently pulling the wires out of the way of the threads, insert the end of the generator that is opened into the cover. Carefully screw the generator into cover.

NOTE

Do not over tighten generator in the vessel cover.

(4) Lightly and evenly grease the ground glass rim of the Pyrex vessel jar with the Photovolt special sealant. Check to see that the three thumbscrew fasteners on the cover are fully unscrewed and extended.

(5) Place a clean and dry magnetic stir bar into the vessel jar.

(6) Carefully join the titration vessel jar and cover with the generator assembly. Twist the cover gently to spread the sealant. Finger tighten the thumbscrew grasps the lip of the vessel jar securely.

(7) Install a membrane septum.

(8) Lightly grease the ground glass collar area of the sensor electrode. Insert the electrode into the small opening of the vessel cover. Carefully and gently seal the collar into the cover. Assure the two circle platinum rings at the end of the electrode are parallel to each other and to the side area of the vessel jar closest to them.

(9) Enter the test parameters into the Aquatest VIII via the keypad.

b. Pyridine-Free Reagent Set-Up.

(1) In an exhaust hood or well ventilated area, remove the septum holder cap and membrane from the vessel cover, place the funnel supplied into the septum support, and add the entire contents of a bottle of vessel reagent. Remove the funnel and replace the septum and cap.

(2) Remove the generator cap and using a glass syringe, add approximately 3-4 ml of pyridine-free generator solution to the generator. Replace the generator cap.

(3) Place the vessel jar onto the Aquatest VIII inside the plastic retaining ring.

(4) Plug the two banana plugs from the generator into the two banana jacks on back of the Aquatest VIII, black-to-black and red-to-red for proper polarity. Plug the sensing electrode plug into the smaller two jacks; the larger sensor plug goes into the small red jack.

(5) Plug the power cable of the Aquatest VIII into a 110-vac grounded receptacle.

NOTE

Assure the Aquatest VIII does not share its power line with devices capable of causing power line disturbances such as motor, compressors, refrigerators and ovens.

(6) Switch on power. The Aquatest VIII will perform internal diagnostics, then display select mode.

NOTE

Once the Aquatest VIII is first turned on, wait 30 minutes before performing a sample assay. This time allow the instrument and vessel assembly to stabilize in its new working environment. Photovolt pyridine-free reagent does not require the use of any neutralizing reagent.

(7) Dipswitch setting should be 1, 2, 4, 8, UP and 3, 5, 6, 7, DOWN.

(8) Turn on the Aquatest VIII, and when SELECT MODE is displayed press MONITOR.

(9) Press the first key on the left of the upper 4 keys that correspond to SEN.

(10) At this time you will see wet/dry status which will usually show the reagent being at set point or slightly wet; this will be displayed on the Aquatest VIII as follows:

WET….!..^…….DRY.

(11) When the vessel is at set point a caret (^) on the dotted line will appear. The instrument is ready to perform assays.

c. PPM Moisture Assay.

(1) Press set-up.

(2) Press the fourth white function key under WT.

(3) Press the fourth white function key under NO to enter in a single sample weight.

(4) Press the fourth white function key under NO to allow manual entry of sample weight.

(5) Press clr to remove the weight value stored in memory.

(6) Key the 1800 mg as the weight of the sample and press enter. The Aquatest VIII will beep as it stores the value in memory.

NOTE

In order for the Aquatest VIII microproccessor to compute water content in ppm by weight, it must know the weight of the fluid sample. SEBD has a specific gravity of 0.9, weighing 0.9 grams per ml.

he sample size of 1 ml, therefore, represents a sample weight of 0.9 grams or 900 milligrams (mg). A sample size of 2 ml, therefore, represents a sample weight of 1800 mg.

(7) Again press set-up and this time press the first function key to choose unit.

(8) MCG PCT PPM will be displayed. Press the third function key to choose ppm.

CAUTION

If the test set has not been used for 12 hours or more, initial test results may tend to be inaccurate. Perform two or three analysis, using spare SEBD to allow the test set to stabilize.

NOTE

Since the weight analysis is to be based on the weight transferred, care must be taken to remove all air bubbles from both the syringe and the needle.

Careful wiping of the liquid clinging to the needle is required for precision. Do not draw the tissue all the way over the end of the needle. Wipe to just the edge of the needle tip and then stop. Blot the membrane septum between samples.

(9) Remove the cap from the sample bottle. Using a clean, dry 10 ml glass hypodermic syringe fitted with 4½-inch needle, slowly draw approximately 1 ml of sample fluid from the sample bottle into the syringe. Withdraw the plunger past the 8 ml mark. Coat the interior walls of the syringe with the SEBD. Depress the plunger and expel the 1 ml of SEBD into a waste container. Wipe needle clean.

(10) Using the same 10 ml glass hypodermic syringe fitted with 4½-inch needle, slowly draw approximately 7 ml of sample of fluid from sample bottle into the syringe.

(11) With the needle pointed up, allow the air bubbles to rise to the tip. Place the wiping material halfway over the needlepoint and slowly expel into wiping material any air trapped in the syringe and any fluid in excess of 6 ml. Syringe should now contain exactly 6 ml of sample fluid and no air. Clean the needle with wiping material.

(12) Press set-up. The third option is dly; press the white pad. Next menu will display mcg time. Press the second pad correlating to time. Press the clr key on the keypad and enter 0.3. This is 0.3 minutes or 18 seconds of a delay in the titration. Finally press enter. Now the instrument will delay the start of the titration by 18 seconds after the initial 7-second injection period has elapsed.

(13) Press start. Introduce sample immediately and add sample 7 sec is displayed as follows: Insert needle through membrane septum on sampling port in vessel cover until it is below the level of the vessel solution and discharge precisely 2 ml of fluid directly into the vessel solution. Remove the needle from sampling port. After 7 seconds, the display will show delay for 0.3 minutes and be automatically followed by titration.

(14) At the end of the titration, the weight that is in memory will be displayed as a confirmation test. If it is the correct weight, merely press enter and the results of the assay will be displayed in parts per million water.

NOTE

If the sample weight displayed after titration is incorrect, press clr and enter the correct weight followed by enter. If you are assaying a number of samples of the same weight, you will only need to enter this weight once. Results of water analysis should be reported as an average of at least three runs. Results are considered to have good repeatability if they are within 11 ppm of each other.

(15) Repeat step 13 above for next injection of the same sample. If a different sample is to be injected, repeat step 12 above.

(16) Thoroughly clean the syringe, attached needle and plunger with methanol and allow them to air dry. If an explosion-proof oven is available, place the syringe with plunger out of the barrel into the oven at 150-185 degrees F or 65-85 degrees C. After 5 minutes, remove the apparatus from the oven using protection for the hands and insert the plunger into the syringe barrel. Allow it to cool to room temperature (approximately 2 to 3 minutes).

5. Cleaning Generator for Silicate Diester.

a. The bottom end of the generator assembly consists of a porous Pyrex glass frit. With use, the minute fluid passages in the frit will become clogged, retarding the transfer of generator solution to vessel solution during titration. This condition may be indicated by the error display gen overvoltage and can be corrected by cleaning the frit. (This display does not always occur).

WARNING

Do not get sodium hydroxide (NaOH) solution in eyes, on skin, or on clothing; it causes severe burns. Do not take it internally. Wear gloves and wear goggles (or face shield) when handling. Continuously stir solution while adding compound; add it slowly to surface of solution to avoid violent splattering. Limit the heat rise to 50 °F (10 °C) per minute. Do not allow temperature of solution to exceed 194 °F (90 °C) when mixing. Do not use on aluminum parts; reaction with aluminum forms large volumes of hydrogen gas. Flush area of spillage or leakage with water spray.

b. The generator frit is cleaned by soaking it in a sodium hydroxide (caustic) solution and applying a vacuum to the top of the generator assembly. The vacuum pulls the caustic solution through the frit, opening up the pore structure. To clean frit, proceed as follows:

(1) Remove power from the Aquatest VIII by switching the power off in back of the instrument.

(2) Disconnect the generator and sensing electrode cables from the jacks.

(3) Loosen the three thumbscrews on the vessel cover and swing pawls away from the titration vessel. Use gentle twisting motion to loosen grease seal and remove cover.

(4) Remove generator cap from generator assembly and pour used generator solution into an approved waste container.

(5) Pour used vessel solution into the same waste container used in step (4). Be careful not to pour out the magnetic stirring bar. Seal the waste container. Next transfer the magnetic stirrer bar from titration vessel onto a clean wiping cloth. Wipe and dry stirring bar.

CAUTION

Do not separate the sensor and generator assembly from the Teflon cover.

(6) Grasp Teflon mounting collar on generator assembly and remove from vessel cover by carefully unscrewing threaded section. Remove sensing electrode and wipe it clean.

(7) Using the empty titration vessel, stand sensor and generator assembly to be cleaned in empty vessel. Pour technical grade one Normal (1N) sodium hydroxide (NaOH) solution into the empty vessel jar until a level of approximately 2 inches is reached.

(8) Pour additional solution into top opening of generator assembly, just enough to cover the frit.

(9) Allow generator assembly to soak 4 hours, or longer, in the sodium hydroxide solution. Periodically observe fluid level inside generator. An increase in level will indicate partial clearing of the frit; the open frit allows fluid to transfer from the vessel into the generator. Upon completion of soaking,

discard used NaOH solution into an approved waste container, or dispose by approved methods.

(10) Expedite cleaning of porous frit after soaking procedure by the application of a vacuum (not to exceed 15 inches mercury (Hg)) to the generator assembly. Required vacuum can be obtained using the syringe and valve provided with contamination Analysis Kit, part No. 57L414. Locally fabricate required adapters to connect vacuum source to generator, using modified rubber or cork stopper to connect vacuum line to open end of generator.

(11) Place fresh sodium hydroxide solution in emptied titration vessel, enough to partially cover the generator assembly when it is placed in the titration vessel. Apply vacuum to generator assembly until caustic cleaning solution flows freely from the vessel jar to the inside of the generator. Carefully observe fluid level in generator and assure that fluid is not sucked into vacuum line. A filtering flask may be installed as a trap between the generator and the vacuum pump. If required, pour excess fluid from generator assembly to waste.

(12) When frit has been cleaned, remove sensor and generator assembly from vessel jar and discard caustic solution into an approved waste container, or dispose by approved methods. Rinse generator assembly and vessel jar using generous amounts of water, preferably hot.

(13) Return generator assembly to the vessel jar and partially fill vessel with water (tap or deionized). Using vacuum procedure specified in steps (10) and (11), flush frit with water to remove residual caustic solution.

(14) Remove generator assembly from vessel jar and discard water.

WARNING

Methanol is flammable - Do not use near open flames, near welding area, or on hot surfaces. Do not smoke when using it, and do not use it where others are smoking. Prolonged or repeated inhalation of vapor can cause eye irritation, drowsiness, and headache. Ingestion may be fatal or may cause eye damage. If vapor contacts eyes, immediately flush eyes with large amounts of water. Immediately remove solvent-saturated clothing. If vapor cause drowsiness, remove affected person from area and expose to fresh air. When handling or applying liquid at air-exhausted workbench, wear approved goggles and gloves. When handling or applying liquid at unexhausted workbench, wear approved respirator, goggles and gloves.

(15) Remove residual water from generator assembly by pulling Methanol through generator with vacuum, as described in steps (j) and (k), and then drying in oven (if available) at 150 to 185 °F (65 to 85 °C) for a period of 2 hours. If no oven is available, allow to air dry before use. Store generator in desiccator if available, until needed.

(16) In some cases, because of lack of equipment, it may not be possible to clean the frit in shipboard laboratories. In these cases the laboratory should change the generator assembly. The assemblies which need cleaning of the frits should be retained and subsequently taken to a shore based laboratory where cleaning can be accomplished.

5. Calibration.

NOTE

The Aquatest VIII does not require calibration. However, a user calibration procedure is provided so that the user can quickly confirm that the instrument is indeed titrating water accurately. User calibration is generally done every 6 months or as needed (whenever erroneous results are suspected).

a. Set Aquatest VIII to mcg mode (page 4, sections C.(7) and C.(8) Moisture Assay).

NOTE

In preparation for the following, fill beaker or other clean container with small amount of tap or deionized water. Set adapter on syringe to 1.0 microliter mark on syringe barrel. Pump syringe several times while needle is submerged in water to remove air. Remove membrane from sample port to enable needle (shorter length) to be below vessel solution.

b. Press start. Introduce sample immediately after add sample 7 sec is displayed as follows: Insert needle of a gas tight 2 micro liter syringe with built in Chaney adapter (Section 2, page 1) directly through the septum on the sampling port in the vessel cover until it extends below the level of the vessel solution and discharge precisely 1.0 micro liter of water into the vessel solution. After a brief moment, remove syringe and needle from sampling port and replace membrane. After 7 seconds, the display will show delay and be automatically followed by titration. Established that; you obtain 1000±50 micrograms of water. Repeat additions until you have 5-10 replicates to determine precision (standard deviation less than or equal to 50 mcg is acceptable). Flush needle several times with water prior to storing to remove chemicals from Aquatest that will cause corrosion.

PALL WATER TEST

1. Scope. This test method covers the determination of the total of dissolved water in hydraulic, transmission, and electronic cooling system fluids.

2. Summary of Method. The Pall Water Sensor is a small portable device that provides an electronic display reading of percent dissolved water through the use of in-system, bottle, or dipstick probes.

3. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Water Sensor	Pall	WS04B04	
Probes	Pall		
Battery Charger			
Isopropyl Alcohol			
kim wipes		A-A-1432A	7920-00-721-8884
paper towels			7920-00-823-9773

4. Standards/Standardization/Calibration. A calibration validation procedure is used to ensure that the unit is operating properly and within calibration tolerances.

5. References/Guidelines. Pall TD513 Water Sensor Manual

6. Quick Use Instructions to Monitor Fluid Water Content.

   a. Charge unit. Plug power adapter into a 110V wall outlet for 24 hours (see battery, page 6 of the manual).

   b. Connect sensor. Attach the sensor to the display cable by rotating the outer ring clockwise.

   c. Press “PWR” to turn unit “on”.

Measure? Yes Next

   d. Press “YES” to accept measurement mode.

I.D.# Next Yes No

   e. Press “YES” to continue without entering a sample identification number.

      (1) Press “FLUID TEMP” to select a different fluid to be measured.

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(2) Press “NEXT WATER” to change fluid type.

Use PRF-87252?
Yes No Next

(3) Press “YES” to accept the fluid type.

Fluid Selected

OR

(4) Press “NO” to go back to step e without changing the fluid type.

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f. Press “YES” if proper measurement has been displayed.

Store this data?
Yes No

g. Press “YES” to save measurement and return to step c.

Measure?
Yes Next

OR

h. Press “NO” not to save and return to step c.

Measure?
Yes No

i. Press “PWR” to turn unit off.

NOTE

The Pall Water Sensor information has been included in the JOAP Manual with permission from Pall Aerospace.

BLOTTER SPOT TEST LABORATORY OPERATING PROCEDURES

1. Scope. This method provides a qualitative test for amount of insoluble contaminants and/or dispersant ability of used lubricants from diesel engines.

2. Summary of Method. After vigorous shaking, one drop of the used lubricant is placed in the center of filter paper. The oil spot is allowed to develop for 15 minutes, and the resulting spot is evaluated for total contaminants, coolant contaminants, and dispersant effectiveness.

3. Definitions.

   a. Dispersancy. Dispersancy is a measure of the ability of the oil to support debris. Dispersancy additives in most modern lubricants keep contaminants suspended in the oil rather than allowing them to be deposited on engine surfaces.

   b. Contaminants. Contaminants are soluble and insoluble materials that accumulate in used oils from many sources and, that if allowed to accumulate beyond recommended guidelines, may become harmful to the equipment. Some examples are fuel, oxidation products, soot, dust, wear debris, water and coolant.

4. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
filter pape (circles or sheets)r			
Kim wipes		A-A-1432A	7920-00-721-8884
paper towels			7920-00-823-9773
paper clips 1⁄16-inch diameter			

5. Standards/Standardization/Calibration. It is recommended that the operator prepare blotter spots of new oils to become familiar with normal spot sizes and patterns. Although wire size is not critical, it is important that the same size wire is used each time to drop the oil on the filter paper.

6. Operation/Procedures.

   a. Shake sample vigorously to ensure homogeneity.

   b. Using a suitable wire, place one drop of the oil sample in the center of the filter paper.

   c. Allow 15 minutes for the oil spot to spread and dry.

   d. Evaluate the oil spot for the following characteristics: solids contamination, dispersancy, and coolant contaminants.

7. References/Guidelines.

   a. Solids Contamination. Distinctive patterns develop after placing the oil on the filter paper. Evaluation of solids contamination becomes obvious after experience is gained for a given type of equipment. Solids contamination is evaluated as being light, medium, or heavy. Care should be exercised if solids suddenly disappear and an oil or oil filter change has not been reported. This condition can indicate a loss of dispersion and a “drop out” of solids that cannot be detected by any of the available test methods. When heavy solids are confirmed or in the case of solids “drop out”, a recommendation to change the oil and the oil filter should be issued.

   b. Dispersancy. Dispersancy is evaluated as good, fair, or poor. The spots for oils with good dispersion are characterized by fuzzy or lacy patterns, with solids carried well out in the paper. Generally, the greater the size of the spot and spread of the solids as compared with the initial spot, the better the dispersion. As the oil’s dispersion is reduced, the spot becomes smaller. The spots for oils with poor dispersion have sharp and distinct peripheries and the spots after 15 minutes are not much larger than the initial spots. A recommendation to change oil should be issued if dispersion is poor.

   c. Coolant Contaminants. Water and other coolant contaminants will reduce or destroy dispersant additives. Spots that form are similar to those described for the dispersion guidelines. In addition, these spots will often appear to be wet long after normal spots are dry.

8. Reports. Record test results as follows.

   a. Total Contaminants - (1) Light, (2) Medium, (3) Heavy.

   b. Coolant Contaminants - (1) Not Detected, (2) Present.

   c. Dispersion- (1) Good, (2) Fair, (3) Poor.

   Using the numerical codes above, the best quality oil would be rated 1, 1, 1, while the worst possible case is 3, 2, 3. When numerical coding is used, it is not necessary to save the actual blotter spot record, since data can still be trended.

FERROGRAPHIC ANALYSIS LABORATORY REQUIREMENTS AND OPERATING PROCEDURES

1. Army CH-47D Helicopter Swash Plate/Scissors and Sleeve Assemblies.

   a. Scope. This procedure is used to determine the size, shape and type of wear metal particles being generated by a piece of equipment as well as the mode of wear (e.g., spalling, rubbing and cutting) producing the particles.

   b. Summary of Method. The grease sample is diluted with a fixer solution to break down the bonding material of the grease. The liquid is then allowed to flow across a substrate mounted over a magnetic field gradient. The magnetic field aligns the particles in strings along the slide and the fixer solution is passed across the substrate to remove the residual grease. After drying, the substrate is analyzed under a Ferroscope. Laboratory grease evaluation procedures are contained in Volume III.

   c. Equipment/Apparatus/Materials. The equipment required is the analytical Ferrograph and Ferroscope.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
kim wipes		A-A-1432A	7920-00-721-8884
paper towels			7920-00-823-9773
tetrachloroethane			
Ferrograph			
Ferroscope			
tygon tubing			
turret tubing			
vials			
pipette			

   d. Standards. None

   e. Operation/Procedures.

WARNING

Repeated or prolonged contact with liquid tetrachloroethylene or inhalation of vapors can cause skin and eye irritation, dermatitis, narcotic effects, and liver and kidney damage. After prolonged skin contact, wash the contacted area with soap and water. Remove contaminated clothing. If vapors cause irritation, get to fresh air. For prolonged over-exposure, get medical help. When handling liquid in vapor-degreasing tanks with hinged cover and air exhaust, or at air-exhausted workbench, wear approved gloves and goggles if contact with liquid is likely.

When handling liquid at open, unexhausted workbench, wear approved respirator, gloves, and goggles. Dispose of liquid-soaked rags in approved metal containers.

(1) Measure 1 cubic centimeter (cc) of grease and place it into a 16x150 millimeter (mm) test tube. Add approximately 7 milliliters (ml) of tetrachloroethylene and shake until thoroughly dissolved.

(2) Remove the glass substrate from the package. With the dot in the lower left hand corner, position the substrate so that the top edge is elevated and resting on top of the magnet assembly. The drain tube supports the bottom edge of the substrate.

(3) Cut a 4-inch long piece of Tygon tubing and two pieces of turret tubing, one piece 2 inches long and one piece 8 inches long. Cut both ends of the turret tubing at a 45-degree angle and insert an end of each piece into the Tygon tubing. Place the 2-inch long piece of turret tubing in the delivery arm with the 45-degree angle open end facing the drain tube.

(4) The sample and rinse vials are supported at least 3½ inches above the peristaltic pump. The pump itself is not used. The end of the 8-inch piece of turret tubing is inserted into the sample vial, supported by a double-notched stopper (one notch for the turret tube and one to equalize pressure).

(5) A screw clamp is placed on the Tygon tubing. A slight suction is applied at the delivery arm end of the tubing and the clamp is loosened long enough to allow the sample to flow halfway through the tube. The clamp is tightened, the suction removed, and the delivery arm is lowered until the exit end of the turret tube touches the substrate. The delivery arm is then backed off slightly.

(6) The clamp is released very slowly allowing the sample to flow evenly down the substrate. When the volume in the sample bottle reaches approximately ¼ inch, the Tygon tube is clamped and the end of the turret tube is placed in the rinse vial. The clamp is then released and the substrate rinsed with fixer solution. Allow several air gaps in the turret tube by opening and closing the clamp several times to ensure that the oil does not back up into the rinse.

(7) Allow the substrate to dry. Remove the substrate by lifting upon the exit end and pulling it straight out of the holder so as not to break the completed Ferrogram. Number the Ferrogram and the Ferrogram cover with the component serial number and sample number. This can be done using thin typewriter correction tape or a glass-marking pen.

(8) The Ferrogram is then analyzed using the Ferroscope. The wear metal debris is compared to the guideline photographs for degrees of severity. The results are recorded on the Ferrograph worksheet (see Ferrogram Analysis Report Sheet, page 11,), and filed by component serial number along with the substrate. Worksheets and substrates will be kept on file for a minimum of one year.

2. Supplemental Ferrographic Oil Analysis Procedures (Army). This is a supplemental procedure used by the Army in the analysis of suspect aeronautical oil samples. Suspect oil samples are defined as those for which one or more of the following diagnostic indicators are observed: chip light; vibration; metal on screens or filters; oil of unusual color, odor, or high solids content; and oil samples having abnormal spectrometric trends or wear metal content.

a. Scope. This procedure captures information relative to the size, shape, and types of wear metal particles and debris too large to be detected by spectrometric analysis.

b. Summary of Method. The oil sample is diluted with a fixer solution to increase the rate of flow. The sample is then analyzed using the Direct Reading (DR) Ferrograph and appropriate guidelines, to quantify both large and small wear particles. If the established DR guidelines are exceeded, the development of a Ferrogram and its examination under the Ferroscope is required.

c. Equipment/Apparatus/Materials. The equipment required is the DR Ferrograph, analytical Ferrograph or Ferrograph Machine III (FMIII), and the Ferroscope.

d. Standards. None.

e. Operation/Procedures.

WARNING

Both the fixer reagent and filtered oil contain a nonflammable chlorinated hydrocarbon. Its vapor however is harmful if breathed. Ensure adequate ventilation. Avoid contact with skin. Do not take internally. Serious injury may result if these cautions are not followed.

f. Direct Reading (DR) Ferrograph.

(1) Press the on/off switch on the rear of the DR unit to the on position. At this time the “INSERT TUBE LED” lights, and both windows display 0.0. This is a standby state during which the DR warms up. NOTE: The DR should be turned on at least 30 minutes before testing is begun.

(2) Heat the sample oil to approximately 149 °F (65 °C) and vigorously shake the sample in the original container until all sediment is homogeneously suspended in the oil.

(3) Turn the drain pump knob so that the white indicators line up.

(4) Using the dispenser assembly on the fixer reagent bottle, pump exactly 2 ml of fixer reagent/solvent into a new test vial.

(5) Using a pipette dispenser, add exactly 1 ml of sample lubricant to the same test vial and mix thoroughly.

(6) Place the vial in the holder and prepare the DR for testing by:

(a) Remove the precipitator tube from its shipping bag.

(b) Carefully raise the clamp assembly and place the glass section of the precipitator tube in the groove provided. Be sure not to touch the glass tube with your fingers. This could interfere with zeroing the instrument (see paragraph (9)). As you slide the tube in, note the small lever at the rear as you position the tube (you will hear a slight click).

(c) When the precipitator tube is correctly positioned the “INSERT TUBE LED” goes off and the “PRIME LED” lights: Gently lower the clamp to lock the tube into position on the magnet.

(d) Place the Tygon end of the tube on the inlet nipple.

(e) Run the opposite length of the tube around the tube guide at the left of the DR. It fits behind a lip.

(f) Run the tube through the two spring supports up to the sample vial. It is better to have the excess length near the vial and a relative length down to the guide.

(g) Place the opposite end of the tube into the vial. This should touch the bottom of the vial so that the entire sample will be drawn out during the test.

(h) Make sure that the waste bottle is placed in the well, and place the drain tube permanently attached to the outlet nipple into the waste bottle.

(7) Confirm that the "INSERT TUBE LED" is off, and that the "PRIME LED" is on. If the opposite occurs, readjust the precipitator tube against the actuator arm.

(8) Press the PRIME pushbutton. This action causes the PRIME LED to go off and both the DL ZERO and DS ZERO LEDS to come on for approximately 2 seconds (at this time the DR circuitry automatically zeros on the empty precipitator tube). When zeroing is complete, the DS LED goes off, and only the DL LED is on, indicating the DR is functioning correctly.

(9) Create a suction in the precipitator tube by slowly turning the drain pump knob in a clockwise direction. This action draws the mixed fluid from the sample vial. When the fluid level is drawn at a level below the sample vial, the siphoning action takes over, and the oil flows by itself. Stop turning when the white line on the knob lines up with the other line of the DR. When the fluid passes the second light path in the test area, the auto-zero sequence is initiated. Again, both the DL and DS LEDS are on. When the DR has zeroed on the sample, the 2 LEDS go off; the windows display 0.0; and the RUN LED lights. This indicates that the test is in progress and typically requires about 5 minutes to complete. As the solution flows over the test area, the display increments from 0.0, indicating that residual wear particles are dropping into the 2 light paths. When the liquid stops flowing, record the readings.

(10) Turn the drain pump knob slowly in a clockwise direction after all the oil has passed over the test area. This action empties the pumping system into the waste bottle.

(11) Remove the precipitator tube from the test area.

(12) Discard the precipitator tube, sample vial, and pipette tip before doing another test.

g. Ferrogram Preparation. There are three different methods of preparing ferrogams; the standard method, the fast method that employs the older model Analytical Ferrograph, and the new method that employs the newer model FMIII.

h. The Standard Method.

(1) Remove the Ferrogram substrate from the sealed bag and protective envelope.

CAUTION

Avoid touching the surface of the substrate with the fingers. Always handle the substrate by the edge.

(2) Install the substrate in the substrate-holding fixture by retracting the spring-loaded positioning pin and inserting the substrate into the holding fixture as far as possible. When positioning the substrate, make sure that the black dot appears in the lower left-hand corner.

(3) Remove the turret tube from the sealed bag and cut one end at a 45-degree angle. This will become the exit end of the tubing.

(4) Press the exit end of the turret tube with the 45-degree angle facing the operator into the delivery arm holding groove. Notice the index mark on the delivery arm and observe the distance from the index mark to the end of the arm. Now extend the turret tube an equal distance beyond the end of the delivery arm.

(5) Press the turret tube into the exit notch on the downstream side of the pump.

(6) Release the pump turret arm locking screw by turning the knurled nut counterclockwise. Open the pump turret arms, thread the tube around the turret and then partially close the turret arms.

(7) Press the turret tube into the pump entry tube clamp on the upstream side of the pump and secure it by turning the knurled eccentric clamp lever counterclockwise. Tighten the turret arms.

(8) Inspect the drain tube to make sure no sections of it are liquid filled. Draw out any liquid with a cotton swab.

(9) Insert the drain tube into the drain tube holder and rotate the drain tube holding fixture counterclockwise until it is centered on the substrate.

(10) Lower the notched end of the drain tube until the tip touches the substrate.

(11) Prepare the sample by first heating it to 149 °F (65 °C) and then shaking vigorously until all sediment is homogeneously suspended in the oil.

(12) Discharge 5 ml of fixer reagent into a sample vial (to be used as a wash), and place the vial in the rack slot nearest the magnet assembly.

(13) Discharge 1 ml of fixer reagent into a second sample vial and place it in one of the empty vial rack slots. Add 3 ml of oil sample to the vial containing 1 ml of fixer reagent and mix thoroughly. This can be done with a mechanical shaker or by hand if care is taken to cover the mouth of the vial with a non-contaminating material or stopper.

(14) Place the sample vial back into the rack. Because of the influence of the field strength of the magnet, place the vial containing the sample mixture in the position farthest away from the magnet assembly.

(15) Install the spring clip assembly on the oil sample vial.

(16) Insert the suction end of the turret tube into the bottom of the sample vial and press the tube into the spring clip.

(17) Lower the delivery arm until the exit end of the tube touches the substrate. Then, back off the delivery arm approximately 1 mm so that the liquid does not drip, but flows freely onto the substrate.

(18) Place the power switch to the ON position, set the timer to 15 minutes, and depress the red timer START button to start the sample cycle.

(19) When the sample vial is empty, reset the timer to 10 minutes and depress the red timer START button to start the wash cycle.

(20) Remove the spring clip and turret tube from the empty vial and transfer both to the vial containing the fixer reagent wash solution.

(21) Introduce three air gaps into the flow in the turret tube by removing the end of the turret tube momentarily from the wash solution and then reinserting it back into the solution. This prevents the oil from diffusing back into the wash solution.

(22) Immediately after the pump shuts off, lift the turret tube off of the ferrogram by raising the delivery arm.

(23) When flow through the drain tube has stopped (approximately 1 minute) lift the drain tube holder with the drain tube in it, and rotate it 90 degrees clockwise.

(24) Allow sufficient time for the ferrogram to dry; do not remove the ferrogram until all of the fixer reagent has evaporated.

(25) Release the spring-loaded positioning pin and lift the ferrogram up vertically.

CAUTION

Do not drag the ferrogram across the magnet as this could disturb the particles on the ferrogram.

(26) Label the ferrogram and ferrogram cover with the component serial number and sample number. This can be done using typewriter correction tape or a glass marking pen.

(27) Discard the turret tube and the sample and fixer reagent vials.

i. The Fast Method.

(1) Measure 5 ml of sample and place into a 16x150 mm test tube. Add approximately 7 ml of fixer reagent/solvent and shake until thoroughly mixed.

(2) Follow steps (3) through (4) of the Standard Method above.

(a) Follow step (2) from the Standard Method above.

(b) Cut a 4-inch long piece of Tygon tubing, a 2-inch long piece of turret tubing, and an 8-inch piece of turret tubing. Cut the ends of the turret tubing at a 45-degree angle to the axis of the tubing. Insert an end of each piece of turret tubing into the Tygon tubing. Place the 2-inch long piece of turret tubing into the delivery arm with the 45-degree angle open end facing the operator.

(c) Follow step (4) from the Standard Method above.

(3) The sample and rinse vials are supported 3½ inches above the peristaltic pump. The pump itself is not used. The free end of the turret tubing is inserted into the sample vial, supported by a double-notched stopper (one notch for the turret tube and one to equalize the air pressure).

(4) A screw clamp is placed on the Tygon tubing section. A slight suction is applied at the delivery arm end of the tubing and the clamp is loosened long enough to allow the sample to flow halfway through the tube. The clamp is tightened, the suction removed, and the delivery arm is lowered until the exit end of the turret tube touches the substrate. The delivery arm is then backed off slightly.

(5) The clamp is initially released very slowly allowing the sample to establish a path down the substrate. Once the path is established, the sample is allowed to flow at a faster rate. When the volume in the sample vial reaches approximately ¼ inch, the tube is clamped and the end of the turret tube is placed in the rinse vial. The clamp is then released and the substrate rinsed with the fixer solution. Allow several air gaps in the turret tube by opening and closing the clamp several times. This will ensure that the oil does not back up into the rinse.

(6) Follow steps (25) through (27) for the Standard Method above.

j. New Method (FMIII). Automatic Cycle: The automatic cycle button initiates the flow of liquid across the ferrogram at a controlled rate and will automatically switch to a rinse cycle and a drying cycle to give you a properly prepared ferrogram. Machine set up instructions and the semi-automatic and fixer cycles are described in the manufacturer's users manual.

NOTE

The instructions provided below describe the processing of a single sample. The design of the FMIII provides the ability to process two samples simultaneously if desired.

(1) Using the dispenser assembly on the fixer reagent bottle, pump exactly 1 ml of fixer reagent into a new test vial.

(2) After heating the sample to 149 °F (65 °C), using a pipette dispenser, remove slightly more than 1ml of sample lubricant from a sample bottle.

(3) Add exactly 1 ml of sample lubricant to the same sample vial.

(4) Repeat steps (2) and (3) until you have a total of 3 ml of sample lubricant in the sample vial.

(5) Mix these solutions thoroughly.

(6) Place the sample vial under the sample head assembly and seal it into position by pushing the bottom of the vial into the detente. Swing the delivery arm/sensor assembly outward over the magnet assembly cover.

(7) Place the notched end of the FMIII sample tube through the sample head assembly all the way to the bottom of the vial.

(8) Place the other end of the FMIII sample tube through the delivery arm/sensor assembly until the sample tube bottoms out onto the surface of the magnet assembly cover. This will properly locate the right height for the FMIIII sample tube when being placed into operating position.

(9) Unpack a glass substrate from its protective envelope.

(10) Carefully holding the substrate by the edges, place the entry end of the substrate on the lip of the magnet assembly cutout with the exit end resting on the vacuum drain assembly (the exit end is defined by the black dot).

NOTE

The black dot viewed on the left hand side indicates the substrate is in the proper position for sample lubricant to flow down the non-wetting barrier.

(11) Push down the vacuum drain assembly into operating position.

(12) Swing the delivery arm/sensor assembly over the glass substrate and center it by the detente for proper position.

(13) Press the auto cycle button. This action causes the SEMI-AUTOMATIC CYCLE LED switch to go off and the SAMPLE LED to go on initiating the pumping action in the sample vial. Soon the sample lubricant will go through the sample tube and deposit wear debris on the glass substrate with the excessive fluid and fumes being vacuumed away by the vacuum drain assembly. Once all the sample fluid is gone indicated by our sensor, the pumping action will still occur removing any residual sample lubricant for about two minutes. The FIXER LED will come on indicating fixer is now washing the glass substrate for about 8 minutes.

NOTE

The delay time and fixer cycle can be adjusted. See manufacturer's users manual. Afterwards, the fixer wash will stop and the vacuum drain will still be on, removing any residual fixer and fumes until the ferrogram is dry. The COMPLETE CYCLE LED and the sound of beeper indicate this.

(14) Check to make sure that the ferrogram is dry by swinging the delivery arm/sensor assembly outward, and visually inspecting the ferrogram for any remaining fixer.

(15) Carefully pull the vacuum drain assembly upwards. Position your fingers so that you are controlling the ferrogram by the edges and carefully lift straight up.

NOTE

Do not move ferrogram side-to-side near the magnetic field. This may relocate the wear debris and give misleading information.

(16) Place the ferrogram into its protective envelope and mark with the component serial number and sample numbers.

(17) Remove the FMIII sample tubing and the sample vial from the FMIII and discard them.

k. <u>Evaluation</u>. At this point the ferrogram is ready for optical examination using the Ferroscope operating instructions for the Ferroscope are found in the manufacturers users manual. The sample has already been determined to be suspect based on spectrometric results and DR readings. The evaluation process then is primarily concerned with determining the size, shape, and type of wear being generated. Techniques and guidelines for the ferrogram evaluation process are found in the Wear Particle Atlas prepared for the Advanced Technology Office, Support Equipment Engineering Department, Naval Air Engineering Center, Lakehurst, NJ. A copy of the Wear Particle Atlas is furnished with each ferrograph system.

l. <u>Recording Results</u>. The results are recorded on the Ferrogram Analysis Report Sheet, page 11, and filed by component serial number along with the substrate. Worksheets and substrates will be kept on file for a minimum of 1 year.

m. Ferrography is performed on aeronautical fine filtration equipped components or when units report debris found during routine inspection. Also, if abnormal wear particle analysis readings are obtained from the oil sample then further testing is required.

n. Oil analysis of the servicing oil is the first step in the analysis process using the atomic emission spectrometer wear particle readings that are noted on the component historical record. The second step is to prepare a ferrogram for which the oil has been pre-heated to 60 degrees Centigrade, using a pipette and dispenser to withdraw 1 ml of the component's oil sample, which is then diluted, with 1 ml of Fixer oil. Using a 100 ml glass vial, shake vigorously. Procedures for Direct Read (DR) III instrument are prescribed in the instrument's manual. Enter the component results on the DR Analysis Report Register, page 12 and the unit's submitted DD Form 2026/DA Form 5991-E, Oil Analysis Request. The component analysis results from the spectrometric and AR analysis readings are used to determine if further ferrographic tests are necessary. If no further ferrographic test is deemed necessary, evaluation is based on spectrometric and physical property test results.

FERROGRAM ANALYSIS REPORT SHEET

Ferrogram Number:___________________ Date:____________________

Organization: ___________________ Sample No.:____________________

Equipment Type: ___________________ Equipment Serial No.:____________________

Sample Date: ____________________ Total Operating Hours:____________________

D.R. Reading (per mL)	L:________________
	S:________________

Oil Type: ____________________

Time on Oil:____________________

Volume of Undiluted Sample to Make Ferrogram:___________________

TYPES OF PARTICLES	NONE	FEW	MODERATE	HEAVY
Normal Rubbing Wear Particles				
Severe Wear Particles				
Cutting Wear Particles				
Chunks				
Laminar Particles				
Spheres				
Dark Metallo-Oxide Particles				
Red Oxide Particles				
Corrosive Wear Debris				
Non-Ferrous Metal Particles				
Non-Metallic Birefringent } Inorganic				
Non-Metallic Birefringent } Organic				
Non-Metallic, Amorphous				
Friction Polymers				
Fibers				
Other, Specify				

Considered Judgement of Wear Situation:

☐ Normal ☐ Caution ☐ Very High (Red Alert)

COMMENTS:

Figure 1. Ferrogram Analysis Report Sheet

DIRECT READ ANALYSIS REPORT REGISTER

DR NUMBER: ______________________ DATE: ______________________
ORGANIZATION: ______________________ SAMPLE #: ______________________
EQUIPMENT TYPE: ______________________ TAIL NUMBER: ______________________
SAMPLE DATE: ______________________ TOTAL OVERHAUL HRS: ______________________
REASON FOR D/R: ______________________ TIME ON OIL: ______________________
FERRO DONE: YES________ NO__________ OIL TYPE: ______________________
DR READING L: ______________________
(PER ML) S: ______________________
RECOMMENDATION/COMMENTS: ____

DIRECT READ ANALYSIS REPORT REGISTER

DR NUMBER: ______________________ DATE: ______________________
ORGANIZATION: ______________________ SAMPLE #: ______________________
EQUIPMENT TYPE: ______________________ TAIL NUMBER: ______________________
SAMPLE DATE: ______________________ TOTAL OVERHAUL HRS: ______________________
REASON FOR D/R: ______________________ TIME ON OIL: ______________________
FERRO DONE: YES________ NO__________ OIL TYPE: ______________________
DR READING L: ______________________
(PER ML) S: ______________________
RECOMMENDATION/COMMENTS: ____

DIRECT READ ANALYSIS REPORT REGISTER

DR NUMBER: ______________________ DATE: ______________________
ORGANIZATION: ______________________ SAMPLE #: ______________________
EQUIPMENT TYPE: ______________________ TAIL NUMBER: ______________________
SAMPLE DATE: ______________________ TOTAL OVERHAUL HRS: ______________________
REASON FOR D/R: ______________________ TIME ON OIL: ______________________
FERRO DONE: YES________ NO__________ OIL TYPE: ______________________
DR READING L: ______________________
(PER ML) S: ______________________
RECOMMENDATION/COMMENTS: ____

Figure 2. Direct Read Analysis Report Register

FOURIER TRANSFORM INFRARED (FT-IR) ANALYSIS LABORATORY REQUIREMENTS AND OPERATING PROCEDURES

1. Scope. FT-IR or Fourier transform infrared spectroscopy is an analytical measurement method used to characterize and identify the structure and relative quantity of organic lubricant molecules. The FT-IR can detect water, fuel, anti-freeze, by-products formation (oxidation, nitration, and sulfates), foreign fluid contamination, lubricant breakdown and additive depletion.

2. Summary of Method. Oil is drawn by vacuum into a transmission cell that is transparent to infrared (IR) energy detector. As the infrared light beam is transmitted through the cell, the oil and its contaminants absorb some of the light; the remaining light exits to a detector producing an infrared transmission spectrum. The instrument software creates an absorption spectrum to classify specific and repeatable spectral peaks corresponding to the molecular bonding characteristics of the oil.

3. Equipment/Apparatus. The Varian and Digilab Oil Analyzers are currently used in the JOAP. Refer to the Varian and Digilab Oil Analyzer Operation Manuals and the corresponding user interface software guides for operation and maintenance of the FT-IR spectrometer.

4. Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Heptane			
Hexane			
Kim wipes		A-A-1432A	7920-00-721-8884
Paper Towels			7920-00-823-9773
Wash beaker with wash solvent (n-heptanes or hexane)			
Wash bottle with wash solvent			
Waste beaker			

5. Standards/Standardization/Calibration. Use the calibration function in the oil analysis mode to check alignment, voltages, cleanliness, water vapor, and cell path-length. The software will issue warnings for any parameter out of limit. If any function is beyond preset limits, instrument operation cannot continue until the condition is corrected.

   Following are the recommended timing parameters for JOAP oil analyzers with and without the auto sampler:

AUTOSAMPLER SPECIFIC PARAMETERS

Maximum Load Time (seconds)	90
Wash Time (seconds)	12
Drying Time (seconds)	20
Fill-to-Scan Delay Time	0
Maximum Retries	2
Consistent Loads	2
Auto Start Wash/Dry	0

GENERAL PARAMETERS

Number of Scans	20
Rescan Background (minutes)	2
Right Monitor Window (Wave Numbers)	3000
Left Monitor Window (Wave Numbers)	1500
Start Scanning at Absorbance	1.4
Valid Sample (Absorbance)	2.1
Cell Clean (Absorbance)	3
Background Clean (Absorbance)	2

6. Operation/Procedures. The sample is taken directly from the sample container. The JOAP FT-IR computers running all versions of the user interface software are configured with 10 analysis methods that can be applied to the different JOAP oil classes or specific fluid applications (and limits). The methods are listed below:

Method Name	Lubricant Type (example)
Run_All_Test	Unknown
Petroleum_Ground	Diesel Crankcase (MIL-L-2104)
Synthetic_Turbine	Polyol Ester (MIL-L-23699)
Syn-Ground_Hyd	Ground Equipment Synthetic Hydraulic (MIL-H-6083)
Syn_Ground_Hyd (M1)	Fire Retardant Hydraulic (MIL-H-46170)
Petroleum_Hydraulic (10W)	Ground Equipment Petroleum Hydraulic (MIL-L-2104, 10W)
Syn_Aero_Hyd	Aircraft Hydraulic (MIL-H-83282)
Mil-L-17331	Steam Turbine (MIL-L-17331)
Mil-L-9000	Marine Diesel Crankcase (MIL-L-9000)
Syn_Aero_Hyd (350)	Aircraft Hydraulic (MIL-H-83282, 350 PPM limit for water)

The Petroleum Diesel Engine Oil FT-IR method is called “petroleum ground”. It is designed primarily for analyzing Mil-L-2104 type lubricants. Many diesel engine lubricants and some gear oils (MIL-L-2105) and transmission oils fit this application. Polyalphaolefins (PAO) and synthetic/petroleum blends should be analyzed using this method. A similar method is used to analyze marine diesel crank case MIL-L-9000 fluid but with different limits.

The Gas Turbine Oil FT-IR method is called “synthetic_turbine”. This method is designed primarily for MIL-L-23699, MIL-L-7808 and DoD-L-85734 type lubricants. These lubricants are polyol esters.

Listed below are the methods developed for hydraulic fluids along with the primary fluid and examples of equipment use:

Method Name	Primary Fluid	Equipment Example
Syn-Ground_Hyd	MIL-H-6083	M109 A6
Syn_Ground_Hyd (M1)	MIL-H-46170	M1A1
Petroleum_Hydraulic (10W)	MIL-L-2104, 10W	M578, 113A3
Syn_Aero_Hyd	MIL-H-83282	Helicopter hydraulic systems
MIL-L-17331	MIL-l-17331	Steam Turbine
Syn_Aero_Hyd (350)	MIL-H-83282	UH60 hydraulic systems

a. Turn on the instrument and allow it to warm up for 30 minutes. If possible the instrument should never be powered off.

b. Boot the instrument computer, log into Windows and open the Varian or Digilab Oil Analysis software.

c. Calibrate the instrument at the beginning of each work day/shift. (Note: The pump must be running and engaged during calibration. This removes any oil and solvent from the hose and the cell.) Press **“Calibrate”**. The system will check the calibration, alignment, cell cleanliness, take a background, ensure background integrity, and measure the cell path-length. Once completed, the screen will display the results. The following is a typical screen display:

   Calculated Cell Path-length: _______ (typically 0.1mm, range 0.09 to 0.14mm)

   Signal voltage: _______ (typically -6 volts, range -5 to -7 volts)

   Alignment Quality: _______ (typically 15%, range 10% to 50%)

   CH Absorbance Intensity: _______ (typically less than 0.2, range 0 to 0.2)

   Results should be within the limits specified. Keep a log of these results. If the cell is dirty, a message will appear: **“Warning - Cell Requires Cleaning!”** Clean cell and **“Calibrate”** again. If problems continue, notify the supervisor. Also reference the “Operator Mode Error Messages and Actions” in the Oil Analysis Software Operator’s Guide.

d. After internal calibration, click on **"OK"**. The original User screen returns. Now click on **"Analyze"**. A final check of the cell will be made and then the **"Sample Information Entry Form"** appears.

Laboratory ID Number: _ _ _ _ _

TEC:_ _ _ _

Component Model #: Undefined

Component Serial Number: _ _ _ _ _ _ _ _ _ _ _ _

End Item: Undefined

End Item Serial Number: _ _ _ _ _ _ _ _ _ _

Fluid Type: Undefined

Time Since Fluid Change: _ _ _ _

Check Info **Cancel**

Fill in the items with the spaces by clicking on them or press the **Tab** key to move down the screen. Do not press Enter. The other items will auto-fill when **"Check Info"** is pressed (if the TEC code is valid.)

If the TEC is unknown, type **YYYY** for the TEC. A screen will occur asking you to chose the correct lubricant type, e.g., synthetic aeronautical. If known, arrow down to the correct fluid and hit Enter. If oil type is unknown, the **"scan and search"** method may be used. In this mode, the FT-IR scan will be performed. After the scan, a library of spectra will be searched to find the best match. The name of the lubricant matched will be given on the report along with the quality of the match presented as a percentage.

e. The "Sample Information Entry Form" screen will re-display once. "Check Info" is pressed, with an extra button "Analyze Sample":

Check Info *Analyze Sample Cancel*

Check all the entered information against the sample submission one more time, then either use the mouse to click on the **"Analyze Sample"** button or just press Enter on the keyboard. The system will now wait for the sample to fill the cell.

f. Fill the sample cell by pressing the pump rocker switch to the right position, marked **FILL/RINSE**, insert the sipper tube into the same bottle such that the end is completely immersed below the level of the oil sample (but do not sip from the bottom of the bottle).

When the cell is full, the system will **"Beep"** twice and display a message to **"Stop Pumping"** (or stop when oil exits the bottom tubing.) NOTE: For aeronautical synthetic lubricants with low viscosity, release the pressure on the pump or keep the sample probe in the oil sample bottle. The backpressure on the pump will continue to sip the oil through even though the pump is turned off.

g. Allow the FT-IR to collect data. The number of scans will count down in the bottom right hand corner of the screen and the name of the sample will appear at the top of the screen. Once the system has acquired and signal averaged the spectrum, a message **"Please Empty Cell"** will appear.

h. Press the rocker pump switch to the left **"EMPTY"** position. Hold the waste beaker under the sample probe. Once the cell is empty, the system will **"Beep"** twice and the message **"Please Clean Cell"** will occur.

i. Rinse the sample probe with solvent (from the wash bottle). While still holding the waste beaker below the sample probe catch the waste solvent as you rinse. The waste solvent will later be added to the lab's waste oil.

j. After the sample probe is washed, press the rocker pump switch to the right, the **"FILL/RINSE"** position. Clean the cell and hosing by pulling the solvent through the system. Continue rinsing until the solvent exiting the bottom tubing appears clean. Leave the pump running to pull air through the system. The solvent should be exiting into a waste container. NOTE: Viscous fluids, e.g., ground equipment, will clean faster and easier with an air/solvent mixture to "scrub" the walls of the tubing rather than just plain solvent.

k. Observe the display in the bottom left corner of the screen and continue the cleaning process until the displayed absorbance is less than 0.30. The system will continuously check the cell cleanliness. The Oil Analysis software automatically determines the cleanliness of the cell. The system will eventually return to the **"Sample Information Entry"** screen.

l. Repeat steps f. through k. for additional samples.

m. Shut down the system by clicking the button labeled **"Cancel"** in the **"Sample Information Entry"** screen.

n. Release the pressure on the pump tubing to extend the tubing life.

o. Shut off the pump (center position). The screen will go blank after 10 minutes.

p. **<u>Do not turn off power to the FT-IR</u>**. The heat from the system will assist in keeping the internal KBr beam splitter from fogging and extend the life of the desiccant. The spectrometer should be powered on at all times keeping it warm and stable.

7. <u>Safety Precautions</u>. The solvent, N-heptane, is flammable. Store in a flammable locker and dispose of the oil/solvent waste according to local regulations. (N-heptane is a petroleum distillate.) Gloves and lab coat should be worn, especially for any oil spill cleanup.

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SETAFLASH LABORATORY OPERATING PROCEDURES

1. Scope. This method covers the determination of oil dilution by diesel fuel or gasoline in engines and is to be conducted when screening tests indicate the presence of fuel contamination. Two methods are available for determining fuel dilution, the flashpoint method and the Fuel Sniffer method.

2. Summary of Methods. The Setaflash Tester low/high temperature, closed cup models, is used to determine fuel dilution of used lubricating oils in diesel or gasoline fueled engines by measuring flashpoint depression.

3. Equipment/Apparatus/Materials. One of the following is used, depending on oil tested.

   a. Model 01SF Lo Temperature, closed cup, used for measuring fuel dilution in lubricating oils of gasoline engines.

   b. Model 03SF, Hi Temperature, closed cup, used for measuring fuel dilution in lubricating oils of diesel engines.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
kim wipes		A-A-1432A	7920-00-721-8884
paper towels			7920-00-823-9773
LPG			

4. Standards/Standardization/Calibration. Prepare calibration standards of diesel fuel or gasoline in MIL-L-2104 (OE 30 weight) or in MIL-L-9000 (grade 9250) oil at concentrations of 0, 5.0, and 10.0 percent by volume. Fuel standards should be made of the same fuel available to the majority of customers of the oil lab. Standards should be prepared a minimum of once each month and stored in tightly capped glass bottles.

5. Preparation of Sample. No special sample preparation is required; however, particulate matter should be allowed to settle as much as possible and syringe needle should be immersed in top part of sample in an effort to prevent syringe plugging from large particulates.

6. Operating Instructions.

NOTE

Detailed instructions are also found in ASTM Test Method D-3828.

   a. Filling Gas Supply System. It is recommended that the Setaflash tester be connected to the laboratory gas supply wherever possible.

SAFETY NOTE

Connection to the laboratory gas supply must NOT be made with flexible tubing.
Connect ONLY with stainless steel or copper tubing and permanent attachments.

b. The following applies only when liquefied petroleum gas (LPG) must be used.

(1) Fully charge the tank ONLY when the instrument is at ambient temperature. Do not recharge the tester tank with the pilot test jet lit nor in the vicinity of any ignition source.

CAUTION

The Setaflash Tester contains LPG which may present a safety hazard unless directions are followed explicitly.

(2) Shake the container of LPG to make sure it contains fuel. If empty, it will exhaust the remaining fuel from the Setaflash tester integral tank. Hold the cylinder with the valve nozzle straight down. The valve nozzle requires an adapter that is supplied with the container. Do not twist or bend the nozzle on the cylinder as this may damage its main valve.

(3) Press the nozzle firmly into the valve of the Setaflash integral tank. A hissing sound indicates that fuel is entering the tank.

(4) When the tank is full, a spray-back occurs. Remove the container from the tank valve immediately.

(5) Wipe off excess fuel from the tank or adjacent areas with absorbent paper.

(6) Regular laboratory gas may be used with an adapter - SEE SAFETY NOTE ABOVE.

c. Determination of Flashpoint by FLASH/NO FLASH Method.

(1) Inspect sample well and lid/shutter for cleanliness, and freedom from contamination.

(2) Switch instrument to SUPPLY.

(3) Turn the temperature dial fully clockwise causing the RED signal light to glow.

(4) When the thermometer reads approximately 295 °F (140 °C), slowly return the temperature dial to the point at which the signal light is just extinguished.

(5) The sample well temperature is stable when the signal light slowly cycles ON/OFF. Slight adjustments may be necessary to obtain precise temperature. Numbered divisions are used as a guide to temperature settings.

(6) Charge the syringe with 4 ml of sample, transfer to the filling orifice, taking care not to lose any sample.

(7) Set the timer by rotating the knob clockwise to its fullest extent. DO NOT FORCE AGAINST THE STOP.

(8) Meanwhile, open the gas control valve and light the pilot/test flame. Adjust the test flame size with the pinch valve to match the 4mm dial gauge ring.

(9) When the time has elapsed, slowly and uniformly open and close the slide completely over a period

of 2½ seconds - watch for flash at 300 °F (150 °C). Report results as less than or more than 300 °F (150 °C) as applicable.

(10) Close the Gas Control Valve.

(11) To prepare for the next test, unlock the lid and shutter assembly. Lift to hinge stop. Soak up sample with tissues to remove any traces of contamination (if necessary use moistened tissues). Allow the sample well to cool below 212 °F (100 °C) before using moistened tissue. Clean the underside of the lid and filling orifice. A pipe cleaner may be of assistance in cleaning the orifice.

(12) Any further cleaning necessary may be carried out by complete removal of the lid and shutter assembly. To remove this, disconnect the silicon rubber gas tube and slide the assembly to the right. Unscrewing the retaining nut by hand and removing the plunger assembly should also clean the syringe.

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Q600 FUEL DILUTION METER LABORATORY PROCEDURE

1. Scope. This method covers the determination of oil dilution by diesel fuel or gasoline in engines and is to be conducted when screening tests indicate the presence of fuel contamination. Two methods are available for determining fuel dilution, the flashpoint method and the Fuel Sniffer method. The Fuel Sniffer offers a new capability for engine condition monitoring. It can be used in the laboratory or in the field to give rapid and precise measurements of fuel contamination in engine oils. The Fuel Sniffer is a non-destructive test that requires only a small oil sample. The results of the analysis are reported in percent fuel dilution.

2. Summary of Method. The Fuel Sniffer indirectly measures percent fuel dilution using a surface acoustic wave sensor that analyzes the air in the top of the sample bottle. Oil samples should be collected in glass or plastic bottles. The quantity of oil collected should be a representative sample and at least 25 ml. The sample should remain capped and properly labeled before use. It is important that the type of fuel being used in the engine is noted, as this will affect the calibration standard used. It is important to prepare the calibration standard using the same fuel and oil contained in the samples to be analyzed. The Fuel Sniffer is menu driven. Interaction with the Fuel Sniffer software, LCD and sample inlet is accomplished through the control panel. The sample inlet is a ⅛-inch Swagelok compression fitting. The tubing that connects the Fuel Sniffer to the sample bottle attaches at this location using a ⅛-inch Swagelok nut provided on the tubing assembly. Turn clockwise to attach the tubing, ensure that the fittings on both ends of the tube are tight

CAUTION

Do not over-tighten. The fluid is drawn into the unit, and a measurement of percent fuel from 0 to 10 percent is determined.

3. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Q600 Fuel Dilution Meter	AMETEK Spectro Scientific	Q600	
Diesel Fuels	Samples from Ship Supply		9140-01-485-8991
Gasolines	Samples from Ship Supply		2805-01-505-1613
JP-5	Samples from Ship Supply		9130-00-273-2379
JP-8	Samples from Ship Supply		9130-01-031-5816
Kim Wipes		A-A-1432A	7920-00-721-8884
Paper Towels			7920-00-823-9773

Notes: For HAZMAT items See Volume II WP HMWS for handling information.
The manufacturer's name is provided as an example. Equivalent product obtained from another sources is acceptable.

AMETEK Spectro Scientific, Inc.
160 Ayer Road, Littleton, MA.
Phone: 978-486-0123
Fax: 978-486-0030
Email: sales@spectroinc.com

Spectro, Inc. Fuel Dilution Meter Specifications (Fuel Sniffer):

Dimensions:	9 cm x 20 cm x 28 cm (3.5"x 8" x 11")
Weight:	2.7 Kg (6 pounds)
External Power:	85 to 265 VAC, 47 to 440 Hz
Sensor:	SAW Chemical Microprocessor
Display:	LCD, with LED backlight
Serial Output:	RS232C @ 9600 Baud
Measurement Range:	0 to 10 percent fuel dilution
Measurement Time:	60 seconds
Accuracy:	±0.2 percent
Data Log Memory:	500 measurements

The Fuel Sniffer is designed for general-purpose laboratory use. The Fuel Sniffer is **not** designed for use in areas containing explosive atmospheres and should not be operated in these environments. It is recommended that a clean and dedicated circuit be provided in an earth ground configuration to power the Fuel Sniffer. A 110 or 220V power cord is supplied for this purpose.

CAUTION

Always connect the IEC plug into the back of the Fuel Sniffer before plugging into the main power source.

4. Standards and Calibration. Calibration standards may be prepared using any widely available fuel such as gasoline, diesel fuel, JP5 or JP8 mixed in the same type oil as the samples to be analyzed (for example MIL-L-2104 OE 30 weight, or MIL-L-9000 Grade 9250). The FDM is calibrated at the midpoint of detection which is 5% fuel. Therefore, only one calibration standard is needed which is 5% fuel in oil. NSWCCD procedures require the preparation of an additional 2% standard which is a calibration check for that concentration.

   FDM laboratories should have on hand a supply of clear glass, round graduated bottles with PTFE lined lids. The appropriate standard jar volume should be 240ml (8 ounces) and no more than 60% full when prepared according to the following procedure. Standards should be prepared at a minimum of once each month and stored in the same tightly capped glass bottles. NSWCCD procedures require that standards are blended in a glass graduated mixing cylinder with a stopper (at least 100 ml) and then transferred to the glass sample bottle after mixing.

   a. Prepare 5 % calibration standard:

      (1). Label a clean glass sample bottle as “5% FDM Calibration Standard” and include the date.

(2). Into a clean graduated glass jar (NSWCCD requires a glass mixing cylinder) pour 50 ml engine oil.

(3). Into the same glass bottle (or graduated cylinder) add 5 ml of fuel.

(4). Finally add an additional 45 ml of engine oil to the glass bottle (graduated cylinder) making 100 ml total volume.

(5). Tightly cap the bottle (stopper on the graduated cylinder) and gently shake the fuel/oil mixture for at least 1 minute.

(6). For NSWCCD laboratories the mixed standard is transferred to the labeled sample jar.

(7). Cap the sample jar and gently swirl for an additional 30 seconds. Set aside for now.

b. Prepare 2 % calibration standard

(1)Into another clean graduated mixing cylinder pour 50 ml engine oil.

(2). Into the same graduated cylinder add 2 ml of fuel.

(3). Finally add an additional 48 ml of engine oil to the graduated cylinder making 100 ml total volume.

(4). Place the stopper on the graduated cylinder and gently shake the fuel/oil mixture for 1 minute.

(5). Label a clean sample flask as "2% FDM Standard" and include date.

(6). Transfer the fuel/oil mixture to a clean sample flask.

(7). Cap the sample flask and gently swirl for an additional 30 seconds. Set aside for now.

c. Calibration:

(1). Rest the 5% sample flask on a level surface and remove the cap.

WARNING

The oil sample bottle should be 125 milliliters approximately ¾ full. Do not fill the sample bottle to the top. There must be a headspace between the sample and the top of the bottle for a proper measurement and to avoid the possibility of contaminating and damaging the Fuel Sniffer's sensor with the sample. The mouth of the bottle should be wider than the suction hole of the FDM instrument.

NOTE

To ensure a representative calibration sample, the standard should be mixed and allowed to equilibrate for at least one hour for diesel fuel and at least four hours for more volatile gasoline fuel or jet fuel. Make sure to use stock oil and fuel bought directly from HAZMAT solely for this purpose. Also, ensure the base plate is level and secure, otherwise air could be drawn in

CAUTION

Using a standard immediately after preparation will cause the instrument to under report values.

The flask should remain uncapped during the equilibration period to ensure a representative calibration sample. This is done to "off gas" the light end hydrocarbons that are present in fresh fuel samples. This is consistent with an actual engine oil sample, since it would have been exposed to heat during operation that drives off the light end gases. Hence using a standard immediately after preparation will cause the instrument to under report actual measured values because the light end gases have been included in the standard calibration. The following sequences of LCD screens illustrate the calibrate fuel dilution mode. The sample bottle clamp and seal must be connected by way of the sample tube to the “Sample Connect” before starting a measurement. By pressing the start button, the analysis cycle will begin, and the red calibrate LED will illuminate.

(2). Perform the Calibration steps required by the instrument.

(a). Select ″MIL-PRE-2104 (15W-40)″ from the FDM menu screen.

(b). Perform a ″Blank Purge.″ To make certain there is no memory effect between samples or any residual contamination, a measurement should be made of the tubing and cap without the flask attached.

i. The Fuel Dilution results should be 0% - 0.1%. If not, repeat blank purge up to 3 times.

ii. If the Fuel dilution results are still higher than 0.1% try replacing the flask cap and tubing. Any contamination in the cap or the sample lines can be detected as fuel vapors. If contaminated, the cap can be cleaned with hot soapy water and dried well. Tubing cannot be cleaned and shall be replaced.

iii. If Fuel Dilution Readings are still higher than 0.1%, contact the instrument manufacturer or contact NSWCCD Lubricants ISEA at lubricants.nswccd@navy.mil for further guidance as the instrument may be damaged.

(c). Remove the solid cap from 5% calibration flask and connect the standard to the FDM using the sample tubing with vented cap.

(d). To calibrate the FDM, follow the screen prompts. Be sure to select the proper calibration program depending on the fuel being used (F-76 or JP-5).

(e). To verify calibration, read the 5% calibration standard as a sample. Results should be within 0.3%.

(f). Perform a blank purge until results are satisfactory. Next read the 2% standard as a sample. Results should be within 0.3%. If standards are not reading within tolerance, verify cap and sample tubing are clear of any signs of contamination. Otherwise recalibrate and try again. If unable to obtain acceptable results, contact NSWCCD Lubricants ISEA for further guidance.

5. Sample Preparation. No special sample preparation is required; however, particulate matter should be allowed to settle as much as possible and syringe needle should be immersed in top part of sample in an effort to prevent syringe plugging from large particulates.

6. Operation/Procedures. Basic operation is covered here. Please refer to the manufacturer’s manual for more detailed information concerning theory of operation, accessories, data transfer, parts, maintenance, and troubleshooting.

a. Software Overview. The Fuel Sniffer is a menu driven instrument. The LCD display presents a series of menus, which allow operation of the instrument. The software prompts the user through each step to make a successful measurement analysis. There are four pushbuttons on the front panel, “Select”, “Down Arrow”, “Up Arrow”, and “Start” which are used to input information. Each menu function is discussed in detail.

b. Start-Up Screens. Upon power up, the LCD will indicate the following displays:

MICROSENSOR SYSTEMS INC. FDM METER VERSION 3.1.5

AUTOTEST UNDERWAY PLEASE WAIT

AUTOTEST SATISFACTORY PRESS SELECT TO CONTINUE

Upon successful completion of the power-up, the Fuel Sniffer will respond with a series of five tones and the front panel LED’S will each flash from top left to bottom right sequence with each audible tone. By pressing the “Select” button, the Fuel Sniffer will respond with the following main operating menu.

PROGRAM SELECTION PRESS ⇓⇑ FOR MENU

By pressing either “arrow” button, the Fuel Sniffer will display the menu selections. The primary Fuel Sniffer menus are below.

MEASURE FUEL DILUTION PRESS START OR ⇓⇑

CALIBRATE FUEL DILUTION PRESS START OR ⇓⇑

TRANSFER DATA TO OUTPUT PRESS START OR ⇓⇑

SET TIME AND DATE PRESS START OR ⇓⇑

c. Measuring Fuel Dilution.

(1) Basic Information. This mode allows the measurement of fuel dilution in oil samples. The results are reported in percent fuel dilution on the LCD. Each sample analysis requires 60 seconds to complete. The Fuel Sniffer must be in position on its stand with the sample inlet tubing connected to the tubing connector on the control panel. The Fuel Sniffer should be allowed to warm up and stabilize for at least 15 minutes after the power On/Off toggle switch has been turned to On.

(2) Procedure. Loosen the two screws that hold the sample bottle diameter adjustment bar and reposition so that the sample bottle is centered on the platform. Tighten the screws to hold the bar in position. Set the sample platform to the correct height by loosening the two captive adjustment screws. Set the table so that the sample bottle just clears the bottom of the sample cover with the sample bottle lever in the up position (towards the Fuel Sniffer). Tighten the adjustment screws. Place the sample bottle in position on the sample table. Move the sample bottle lever into the down (towards the operator) position. There should be some resistance as the lever is moved into the down position such that the sample bottle will be locked in place.

NOTE

Use the “MIL-PRF-2104 (15W-40)” program from the FDM menu for all oils being tested.

(3) Analysis Start. By pressing the start button, the analysis cycle will begin and the green measure LED will illuminate. The Fuel Sniffer will begin a pumping sequence to first purge the headspace, then reverse flow pulling the headspace sample into the detector and then reversing the flow purging the

detector expelling the sample in preparation for the next measurement.

(4) Results. The results will be reported in percent fuel dilution over the calibrated range of 0 to 10 percent. The user must acknowledge the result and push “Select” to begin the next measurement cycle. The following sequences of LCD screens illustrate the measure fuel dilution mode.

MEASURE FUEL DILUTION PRESS START OR ⇓⇑

MEASURE FUEL DILUTION MEAS. IN PROGRESS, WAIT

0.0% FUEL DILUTION PRESS SELECT TO CONTINUE

MEASURE FUEL DILUTION PRESS START OR ⇓⇑

Please refer to the complete Spectro, Inc. “System Description and Operations Manual” which comes with each unit

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MICROSCOPIC ANALYSIS

1. Scope. This method covers the microscopic examination of debris filtered from suspect spectrometric oil samples to determine the significance of debris with respect to wear, contamination, and component condition. Currently, this method is applicable to all US Army aircraft but may be specified for use on other equipment by the appropriate service oil analysis program manager. A precise methodology for the characterization and classification and the importance or implications of results of insoluble debris analysis has not been established.

2. Summary of Method. A measured quantity of the suspect oil sample is mixed with solvent and filtered through a 0.45-micrometer membrane filter. The insoluble debris and filter membrane are carefully rinsed with solvent to remove oil and then allowed to air dry. The dry membrane is transferred to a petri slide and the debris examined under a low-power microscope. The debris observed are characterized and related to the component's condition with respect to wear and contamination.

3. Definitions.

   a. Suspect Oil Sample. An oil sample from equipment for which one or more of the following diagnostic indicators are observed: chip-light, vibration, metal on screens or filter, oil of unusual color, odor, or solids contents, and oil having an abnormal spectrometric trend or level.

   b. Insoluble Debris. Refers to insoluble solid materials filtered from suspect oil samples that may consist of wear debris, corrosion products, and non-metallic debris generated by the component, or contaminants from external sources.

4. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Biotex Hisolv	Bio-Tek	134 Hi-Solv	
KIm Wipes		A-A-1432A	7920-00-721-8884
Paper Towels			7920-00-823-9773

   a. Millipore Filtering Equipment Set

   b. Microscopic Equipment Set

   c. Solvent. Biotek Hisolv or other high flash solvent is used as the solvent depending on local availability. Before use, the solvent shall be filtered through a 0.45-micrometer membrane filter.

5. Operation/Procedures.

   a. Loosen the cap on the suspect oil sample bottle and place the bottle in an oven at 65±5 °C (149±9 °F) for 30 minutes.

b. Prepare the vacuum filtering apparatus by installing a 0.45 micron membrane filter and start vacuum.

c. Remove the warm sample from the oven, tightly cap, and shake vigorously. Pour 10 ml of the sample into a 100 ml graduated cylinder with a stopper. Add 90 ml of pre-filtered solvent, install stopper and mix well.

d. With the vacuum still applied, carefully remove the spring clamp and upper section of the filter funnel carefully wash the edges of the filter membrane with a gentle stream of solvent using care not to wash debris off the filter membrane. Continue wash until membrane and debris are free of oil. Allow the membrane to dry. Transfer the membrane to a petri slide.

e. Inspect the debris using the microscope, identify the metal or alloy and record the findings.

PARTICLE COUNTER TEST

1. Scope. This work package provides references to the operating manuals used to perform particle counting tests

2. Equipment/Supplies. See Table 1.

3. Particle Counter Operating Manuals. Table 2 provides a list of the appropriate operating manuals to use depending on the particle counter being used.

Table 1 – Equipment/Supplies

Description	Manufacturer	Part Number	NSN
kim wipes		A-A-1432A	7920-00-721-8884
paper towels			7920-00-823-9773
PODS Type II	HIAC	2087323-02	4920-01-524-0858
Ultrasonic Bath	HIAC	690-500-0100	4920-01-519-7280

Table 2 – Particle Counter Operating Manuals

Particle Counting System	Applicable Manual
HIAC/ROYCO 8011-3	NAVAIR 17-15-521 - Operation Intermediate Maintenance Instructions for Particle Counting System, Part Number 8011-3
PODS Type I (OBVY1) Part number 2087323-01	NAVAIR 17-15BF-97 – Operating Instructions for Hydraulic Particle Counter
PODS Type II (OBVY1) Part number 2087323-02	NAVAIR 17-15BF-97 – Operating Instructions for Hydraulic Particle Counter

Notes: 1) NAVAIR Manuals are available on the NATEC Technical Data Website: https://mynatec.navair.navy.mil/

2) PODS Type II instruments are built with o-rings and elastomeric components that are compatible with phosphate ester hydraulic fluids. PODS Type I instruments cannot be used with these fluids, e.g. Skydrol and shipboard elevator hydraulic fluids.

NOTE

Ensure that the instrument is setup as detailed in 17-15BF-97 for Aviation oil samples.

Settings do not reset when the instrument is turned off.

Use sections 4. Procedure and 5. Sample preparation only for Ship Machinery oil samples.

4. Procedure.

   a. The particle counter for settings such as Mode, PC Standard, Pull Volume, and Flow can be adjusted using the following keypad sequence:

      (1) Press F1 (SETUP).

      (2) On the keypad, press the button corresponding to the setting of interest.

      (3) Press F1 (PRG).

      (4) Use the arrow keys to cycle to the correct setting.

      (5) Press F4 (ENTR).

   b. Set the VOL to 5 ml/R.

   c. Set the FLOW to 15 ml/min.

   d. Ensure Mode is set to Bottle.

   e. Ensure STD is set to NAS.

   f. Once the desired settings are chosen, press F4 (RTN) to return to the home screen.

   g. Prepare the sample as detailed in Section 5.

   h. Place the bottle in the bottle adapter and twist to secure in the instrument.

   i. Press Start to test the sample.

5. Sample preparation.

   a. Use the following sequence to prepare the sample for particle count testing.

NOTE

If enough sample is available, the sample bottle should be about ¾ full (up to the bottle shoulder).

(1) Place the sample bottle in the ultrasonic bath and secure to ensure it remains vertical during the sonication process. Water should be up to mid-height of the sample bottle.

(2) Loosen the bottle cap to allow air to escape, turn on the bath and sonicate the sample for 30 seconds.

(3) Securely tighten the cap and vigorously shake the sample by hand for 60 seconds.

(4) Place the bottle in the bath, loosen the cap, and sonicate for 90 seconds. Inspect the sample to ensure there are no large bubbles and small bubbles are on the side of the bottle, with none in the center of the sample.

(5) Take the bottle from the bath, remove the cap, and let sit for 45 seconds.

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15 March 2021

US AIR FORCE B-2 COOLANT TESTING PROCEDURES

Table of Contents

1. Introduction. This section defines the procedures, requirements, equipment and material needed for sampling and testing Silicate Ester-Based Dielectric (SEBD) coolant fluid used in operating systems such as radar cooling in the Environmental Control System of the B-2 Bomber.

2. General.

   a. The equipment cooling system of the B-2 aircraft incorporates three liquid cooling subsystems and five circulated air subsystems. The liquid cooling subsystems consist of the Ethylene Glycol-Water Subsystem (EGW), DMS/LC Subsystem and the Liquid Cooling Subsystem (LCS).

   b. The Liquid Cooling Subsystem (LCS) is composed of two independent closed cooling loops located in the left-hand and right-hand forward center section of the aircraft. The left side LCS loop (normally the transmitting radar side) is identical to the right side LCS loop (normally in standby). Each closed loop circulates liquid coolant through each of the radar packages to maintain the components at a controlled temperature. The fluid is then circulated through a three-fluid (coolant-EGW) heat exchanger for heat dissipation via the EGW coolant loop to the sink heat exchanger.

   c. Each loop supplies liquid coolant at a flow rate of 4.0 GPM to the liquid cooling passages of 55.0 degrees Fahrenheit and a maximum pressure of 175.0 psig. The maximum volume of fluid in each loop is 4.76 gallons.

   d. The LCS transports heat from both radar transmitters and antennas. The transmitters require a heat transport fluid with both high dielectric properties and thermal transport characteristics. The heat transfer fluid is a silicate ester-based dielectric (SEBD) coolant fluid, Coolanol 25R or Flocool 180.

   e. As the fluid cycles throughout the aluminum system lines, metal particles may be generated by the relative motion between metallic parts within the mechanical system. Friction and continuous wearing away of contacting surfaces will increase the amount of particulate contamination. As particulate size and quantity increase, the physical and chemical characteristics of the EGW and Coolanol 25R fluids may also be impacted. This document defines the requirements for sampling and testing coolants such as EGW and SEBD coolants in the operating systems of the vehicle, in filtering and fluid supply service carts, and in other liquid servicing equipment.

3. Equipment. Equipment identified to each specific test shall be maintained per manufacture's requirements. Records of maintenance and calibration of the equipment shall be maintained. Testing facilities shall be free of contaminates detrimental to test performance and shall be cleaned at intervals deemed necessary to maintain the cleanliness of the area.

4. Test Sequence. To minimize the quantity of fluid needed to perform the coolant fluid tests and to minimize the effects of sample handling, testing should be conducted in the following sequence:

.	Paragraph
Appearance	7
Dielectric Strength	8
Particulate Contamination	9
Volume Resistivity	10
Water Content	11

Table 1. Coolant Test Requirements

The SERD coolant will be tested for the following:	
A. Appearance	No evidence of separation, contamination or precipitates
B. Dielectric Strength	300 volts per mil, minimum
C. Particulate contamination per 100 milliliters, particulate size 10 thru 200 microns >200 microns (Including fibers)	Automatic counts 32,000 maximum
D. Volume resistivity	Automatic Count 5 maximum 4 X 1010 OHMS per centimeter
E. Water content	150 parts per million maximum.

5. Laboratory Safety.

a. Standard lab safety procedures should be followed. All chemicals should be treated as potentially hazardous and handled with care. Petroleum ether and methanol, which will be used to clean the sample containers on the instruments are flammable and should not be exposed to a flame, spark or high heat. Safety goggles and gloves impervious to organic solvents should be worn at all times. An eye wash station, fire blanket and fire extinguisher should be readily accessible at all times. Material Safety Data Sheets (MSDS) for all chemicals should be accessible to lab personnel while working in the lab. Never work in the lab alone-ensure there is someone else within easy calling distance.

b. Waste chemicals should be disposed of in approved marked waste containers. While the waste organic chemicals used in these procedures may be mixed in a single waste container, it may be more convenient to use one container for SEBD waste chemicals and another for EGW wastes. Remove waste chemicals from the lab on a regular basis.

6. Appearance Test.

a. Prior to the sample analysis, the unopened sample bottle shall be visually inspected for proper filling and sealing, as well as evidence of gross contamination. Properly filled bottles will be almost completely filled with fluid extending up to the bottom of the threaded neck section. The purpose of completely filling the bottle is to minimize the quantity of air present, which could contain large amounts of atmospheric moisture, and to assure that adequate fluid is available to perform all of the required tests. Activities submitting SEBD coolant samples in improper or inadequately filled bottles shall be advised to resample the equipment.

b. Gross particulate contamination, i.e., particles large enough to be seen with the unaided eye, will also be most visible when the fluid is allowed to stand motionless for a period of time. Like free water, such particles will generally settle to the bottom of the bottle. Gross particulate contamination is usually indicative of improper sampling technique. If either is suspected, the submitting activity shall be advised and requested to resample the equipment.

c. Fluid turbidity results in the SEBD fluid appearing cloudy as opposed to its normal clear, transparent appearance. Turbidity is most visible when the fluid is agitated and may be indicative of large amounts of air, free water or suspended foreign matter..

Allowing the fluid to stand stationary for a period of time will assist in identifying the probable cause. Turbidity caused by suspended semi-solid matter is of particular concern as it may be indicative of chemical degradation of the SEBD fluid. The contamination by-products of such degradation will also show up when performing the test for particulate contamination

d. Prior to sample analysis, fluid in the sample bottle shall be visually inspected for evidence of free water, turbidity or visible particles. This inspection is somewhat limited by translucent plastic bottles but can be remedied by using a glass bottle or positioning the plastic bottle in front of a strong light source. Free water when present, will collect in the bottom of the bottle and be readily visible. Allowing the bottle to stand stationary for at least 10 minutes prior to the inspection will cause any dispersed water droplets to settle out, rendering them more visible. Free water is cause for rejection and the submitting activity shall be requested to resample the equipment to confirm this indication.

7. Dielectric Strength.

a. Introduction. This procedure describes the method for performing dielectric strength of silicate ester base dielectric coolant fluid with the Hipotronics Model 0C60D, digital Oil Dielectric Test Set. All personnel should review the manufacture's instruction manual prior to using the equipment.

b. Equipment and Materials. Model 0C60D Oil Dielectric Test Set, Hipotronics Inc.

c. Equipment Information and Test Procedures. The referenced test set provides the means of applying, measuring, and displaying the value of the voltage required to electrically stress insulating liquids such as SEBD to a point where the insulating qualities break down and allow an electrical current to flow between and electrodes applying the voltage. The 0C60D is capable of applying 0 to 60,000 VAC between two electrodes that are spaced 2.5mm or 0.10 inches apart in a test cup that holds the test sample.

NOTE

During testing a safety cover is lowered to protect the test operator. The rate of applied voltage is determined by selecting the 3000 VPS (volts per second) setting on control panel energized by a facility power source of 115 VAC, 50/60 HZ. The breakdown voltage for SEBD is 300 volts per mil (minimum) and will require the test sample to be subjected to 30 kilovolts minimum to be considered sufficiently free of contaminating agents.

Specifications

Test Voltage: 0 to 60 kilo volts AC (50,000 VAC)

Power Rating: 115 VAC, 50/60 HZ, 15 amps

(1) Set-Up Procedures.

(a) Remove packing material, power cord, test cells, and any other components from the test cage.

(b) GROUND THE UNIT BEFORE CONNECTING INPUT POWER. The ground lug is located on the left side of the unit, below the plug receptacles.

(c) Insert the socket end of the power cord into the receptacle on the left side of the unit and connect it to a suitable power source. IF A TWO-PRONG ADAPTER IS USED, BE SURE TO GROUND THE PIGTAIL.

(2) Operating Procedures.

(a) ENSURE THAT THE UNIT IS PROPERLY GROUNDED BEFORE CONNECTING INPUT POWER. The ground lug is located on the left side of the unit, below the plug receptacle.

(b) Ensure that the power cord is properly plugged in as described in step c of the SET-UP PROCEDURE.

(c) Check and adjust the spacing of electrodes in the test cell using a 100 mil gage shim. Push electrodes tightly against gage shim. The distance between the two electrodes will be 100 mils (0.1 inches).

NOTE

Do not fill test receptacle inside test chamber.

(d) Fill the test cell with sufficient insulating liquid to completely cover the electrodes.

(e) Swirl the insulating liquid by rocking the test cell slowly. (Rapid agitation may create an excess of air bubbles in the liquid).

(f) Gently snap the filled test cell in place between the bushing(s) of the transformer and the test cage and close the safety glass cover.

(g) Before testing, allow the sample to stand for a minimum of three minutes to permit any accumulated air bubbles to escape. If a VDE test cell is used, plug the line cord into the receptacle on the left panel of the test cage.

(h) Turn the AC power switch ON.

(i) If the failure indicator lights, press the reset push-button until the voltmeter reading is zero.

(j) With the voltmeter reading zero, set the rate/rise rotary selector to 3000 VPS.

(k) Press the START push-button to activate the output voltage. Voltage is applied automatically at the specified rate until breakdown occurs, at which point the FAILURE indicator lights and the voltage is turned off.

NOTE

The voltage may be terminated before breakdown by releasing the test cage interlock switch (HV OFF ANYTIME). This is accomplished by opening the safety glass cover. Also, voltage may be maintained at any level prior to breakdown by setting the RATE/RISE selector to STOP (manual dwell).

(l) The voltmeter continues to display the breakdown voltage until the reset pushbutton is pressed. After reading and recording breakdown voltage, press the RESET push-button and allow the voltmeter to return to zero.

NOTE

Clean test cell between each test with methanol.

(m) Perform three (3) breakdown tests beginning with step k. If results are within + 10% of the average of the sample taken, test is complete. If results are not within + 10%, perform two additional tests. Discard the two- (2) high/low samples and average the remaining three (3) sample results. If results are within + 10% of the average, the test is complete. Five breakdowns may be performed on one cup filling with one-minute interval between breakdowns.

NOTE

Minimum instrument reading shall be 30 kv which is equivalent to the dielectric strength of 300 volts/mil using the prescribed sample volume.

(3) Calculations. Dielectric strength = volts/mil (volts/100mil).

NOTE

"mil" refers to gap between electrodes.

8. Particulate Contamination.

a. Introduction. This procedure describes how to perform the counting of particles suspended in SEBD using the Hiac/Royco Model 800A Particle Counter.

b. Equipment and Materials.

Model 8000A Hiac/Royco, Particle Counter with Printer

Automatic Bottle Sampler unit (ABS)

Methonol or Isopropanol (filter the solution through a 0.45 micron filter)

Petroleum Ether (reagent grade)

c. Equipment Information. The referenced particle counting system is comprised of several individual components. A counter, an automatic bottle sampler, and a sensor. Descriptions of each of the components are given below:

(1) The counter is equipped with a keypad, a 40 column 16-line liquid crystal display (LCD), and an internal 40 character per line graphics printer. Although wide ranges of contamination standards are resident in the unit, the operator has the option of storing a different standard, which better describes the desired application. Any of the standards can then be selected with a single keyboard entry. The Model 8000A is capable of acquiring count data for eight particle size ranges. The calibration graph for the sensor being utilized shows the actual values that must be input to the counter to set the size range limits for the test. Whenever a different size range is desired or when a different sensor is utilized the corresponding graph must be entered into the counter. The manufacturer supplies the calibration graph and the counter is calibrated every 5 months. Before a test can be run, the operator must input the number of sample runs to be performed. The counter automatically gives results for each sample data run as well as the average of the selected number of runs. The operator must also input the limit for the counter's audible alarm. After the test has been performed, the results can be displayed in either tabular or histogram format, and a hard copy can be obtained from the printer.

(2) The automatic bottle sample is a Hiac/Royco model ABS sampler (P/N BS-13). The sampler is comprised of three components: A sample holder, a volume measuring tube, and a control box. The sample to be analyzed is placed in a container inside the sample holder. This sample holder has a pressure rating of 60 PSI and is equipped with a magnetic stirrer, which keeps the sample particles in a uniform suspension. Positive pressure is then used to transfer the sample, at a constant flow rate, from the sample holder through the sensor (which will be discussed later) to the volume measuring tube. The pressure required for this transfer can be provided by either a facility air supply or by a separate pump. The sampler is equipped with a locking regulator to regulate the supply pressure down to the desired 5 to 60 PSI. Once the sample has passed through the sensor, it goes into the volume measuring tube. This tube is equipped with two moveable light sensors, which generate the "start count" and "stop count" signals to the counter. The volume of sample to be analyzed is determined by the positioning of these two light blocks. Upon completion of a test, the volume measuring tube is drained by means of an automatic valve and drain line.

(3) A ac/Royco mode HRLD-400 sensor (P/N 040 x 300-1) is provided with the particle counting system. This sensor, which detects particles in the sample by means of the light obscuration method, has the following specifications:

(a) Measurement Range: 2 - 400 microns

(b) Recommended Concentration Limit: 8,000 particles/ml

(c) Flow Rate: 10 - 200 ml/Min

(d) Pressure Limit: 1000 psi

(e) Temperature Limit:: 150 degrees Fahrenheit

(f) Frequency Response: To 250 kHz

(g) Precision: Coefficient of variation less than 1% for mean mounts greater than 1000 particles per ml.

(h) Accuracy: Traceable to NIST Standard Reference Materials.

(4) As mentioned previously, a calibration curve is provided with the sensor so that the operator can key the desired size range limits into the Model 8000A Counter. This sensor will be calibrated with glass spheres in oil or water with latex spheres (use the values from the curve).

d. Test Procedures.

(1) Turn on the particle counter and the automatic bottle sampler.

(2) Press any key on the key pad to access the main function menu.

(3) Place a container of the sample to be analyzed into the sample holder. Put a clean stirring rod into the container and turn the sample holder's magnetic stirrer on.

NOTE

Be extremely careful that the stir bar is "just" moving to eliminate the counting of bubbles as particles.

If a vortex appears in the center of the liquid, it is being stirred too rapidly. Adjust stir speed until vortex is no longer visible.

(4) Position the volume measuring tube light blocks. The volume of sample that is analyzed is determined by the positioning of these two blocks. Volume should be set for a 100 ml sample size.

(5) Set the locking regulator on the sample holder to the desired pressure. Desire pressure will provide a flow rate of 20 ml in 20 seconds, ≈ 14-20 PSI.

(6) Press start key.

(7) Once the test is complete obtain results from the display and/or printer.

(8) First flush the system with a total of 60 ml of Petroleum Ether, followed by flush with 120 ml of menthanol.

(9) Turn off the particle counter and automatic bottle sampler.

NOTE

If initial set-up data is lost, reenter data using the following calibration procedures.

e. Calibration Procedures.

(1) Turn unit on and press any key.

(2) Press the more key on the main function menu.

(3) Press the user STD key.

(4) Press the alter STD key.

(5) Enter the following data:

(a) Standard Name: Latex

(b) Number of Classes: 16

(c) Coml/Diff: Cumulative

(d) Class Limit Units: Counts

(e) Sample Volume: 20.00 ml

(f) Classify: Runs only

(g) Number of Channels: 3

(h) Class 1 thru 16: N/A

(i) Channel 1: 10

(j) Channel 2: 200

(k) Channel 3: 400

(6) Press exit key.

(7) Save standard in storage slot #1.

(8) Using exit key return to main menu.

(9) From the main menu, press Set-up.

(10)Press the global set-up key and enter the following data:

(a) Operator ID: Operators Initials

(b) Number of Runs: 3

(c) Delete Time: 00H, 00M, 10S

(d) Delay Time: 00H, 00M, 00S

(e) Transducer Units: English

(f) Quick-Adjust-Rate: 02H, 30M

(11)Press the exit key to return to the parameter set-up function menu.

(12)Press the control set-up key and enter the following data:

(a) Sample ID: 000

(b) Background: OFF

(c) Dilution Factor: 1.00

(d) Standard: Latex in Water

(e) Mode: Volume

(f) Sample Volume: 20.00 ml

(13)Press the exit key and return to the parameter set-up function menu.

(14)Press the exit key to return to the main menu.

(15)From the main menu, press the cal key.

(16)Press the set cal key.

(17)Press the alter cal key and enter the following data:

(a) Sensor Model: HRLD-400

(b) Serial Number: 9306-003

(c) Calibration Date: dd/mm/yr

(d) Material: Latex in Water

(e) Flow Rate: 60 ml/Min

(f) Sensor Type: Extinction

(g) Algorithm: Interpolation

(h) Noise: 13.5 mV

(i) Extinction: 12

Diameter	MV
2.020	41
3.020	60
5.007	132
9.870	309
15.000	475
20.490	641
32.200	1020
40.100	1240
58.500	1720
112.000	3210
165.000	4300
301.000	7500

(18)Press the exit key to go to the calibration function menu.

(19)Press the bin size and enter the following data:

Number of Channels 3

Channel	Threshold (Micrometers)
1	10
2	200
3	400

(20)Press the exit key to return to the calibration function menu.

(21)Press the exit key and return to the main menu.

NOTE

The tester is now ready for use.

9. Volume Resistivity.

a. Introduction. This procedure describes the method for performing volume resistivity of silicate ester based coolant with the JPF-60 test set.

b. Equipment and Materials.

Description	Manufacturer	Part Number	NSN
Methanol			
Isopropyl Alcohol			
Coolanol 25R	Exxon	212342	
Flo-Cool 180	Chevron		9160-00-638-9794
EthyleneGlycol			
Petroleum Ether			
Dielectric Test Set	Hipotronics	Model 0C60D	
Particle Counter	HIAC	Model 8000A	
Tech 1865			
JPF-60 test cell	Rosemond		
Test Fixture	Rosemond	TF-12	
Megohmeter		Modle 1865	
Aaquatest 8	Photovolt		
Generator Solution	Photovolt		
Vessel Solution	Photovolt		
Methanol		O-M-232	
Sodium Hydroxide, 1N QuadTech 1865 Rosemond JPF-60 Test Cell Rosemond (PN JPF-60) Model TF-12 Test Fixture Glass Vials		0S598 1865	

c. Test Information.

(1) The referenced test set provides technicians and the capability to interface a liquid sample of SEBD with the resistivity test set (test fixture) and the megohmeter in order to perform a volume resistivity test. This test measures the dielectric properties of the fluid that may be degraded by particle contamination.

(2) The test set consists of a pronged end, a three terminal guarded electrode end, and a wire bale clasping section used to hold the glass vial, which contains the required sample.

(3) The pronged end is a three pole male connector that will mate with the resistivity test fixture. The test fixture is a rectangular box shaped fixture, which includes a hinged cover provided for safety concerns. When the user opens the cover during testing, the test voltage will be curtailed. The back of the test fixture contains a two input hard wire connection. The back also contains a hard wire phone jack connection that mates with the ohmmeter rear phone jacks to establish a foot remote control feature. In addition, the back of the test fixture contains a single thin (ground) lead that will run

to the ohmmeter's chassis ground terminal. Inside the test fixture cover, a cylindrical receptacle is installed that allows the resistivity test set to be mounted.

(4) A glass vial containing sample fluid will be clamped inside the test set, and at the same time the three terminal electrodes of the test set will become immersed in the vial fluid. The test set containing the sample fluid is put onto the test fixture part of the test set and the test fixture is connected to the megohmeter. When the resistivity test fixture, test cell, and glass vial containing the test sample of SEBD is connected to the megohmeter, a series resistance circuit is formed. The resistance of the sample is connected in series with a known value of resistance (in the megohmeter) selected for the test. These two resistance's (one unknown) form a voltage divider across the regulated power supply. The output of this voltage divider, which is inversely proportional to the value of the unknown resistance (test sample), is applied to an amplifier that drives the megohmeter meter (calibrated in megohms) to display the measured value.

d. Test Procedures.

(1) Preliminary adjustments - Model 1865 Megohmeter

(a) Turn unit on.

(b) Recall setup data. Recall function is found in the utility menu.

(c) Zero the megohmeter at 500 volts after connecting with the test fixture. Zero function is found in the utility menu.

(2) Megohmeter set-up:

(a) Set-Up Menu

1. Voltage: 500 volts

2. Change Time: 10 sec

3. Dwell Time: 1 sec

4. Measure Time: 60 sec

5. Discharge Time: 10 sec

6. Mode: Auto

7. Range: Auto

8. Limit: 1.52 x 10_8 ohms

9. Stop on Pass: 60

10. Average: 60

(b) I/O Menu

1. Display Type: Pass/Fail

2. Result Format: Engineering

NOTE

Remainder of I/O Menu is optional.

(c) Utilities Menu

1. Save Set-Up: Optional

2. Recall Set-Up: Optional

3. Zero: Refer to preliminary adjustment above.

4. Lock Out: Optional

NOTE

Remainder of menu is optional.

(3) Operation

(a) Fill a clean test cell vial to the reference mark with a sample. Insert the cell into the vial and latch the vial in place with the wire holder. Turn the vial (one or two quarter turns) to wet the electrode surfaces and clear any entrained air bubbles.

(b) Insert the test cell with sample into the test fixture receptacle. Close the test fixture lid. Press the green start key. The megohmeter will display a pass or fail message on the instrument screen.

(4) Calculations

P = R/K

(a) In the formula above P = volume resistivity, K = the test cell constant, and R = volume as indicated on the megohmeter. To determine the volume resistivity of the sample, divide the volume resistance (R) measured by the megohmeter by the test cell constant (K). A volume resistivity equal to or greater than 4×10^{10} ohm per centimeter is acceptable. The cell constant (K) for the JPF-60 test cell is .0038/cm.

(b) In the event the test cell changes, a new limit (volume resistance) will have to be calculated based on the new test cell constant (usually expressed as K) and entered in the megohmeter set-up screen. Using the JPF-60 test cell constant as a reference, calculate the new limit as follows:

P = R/K
R = PK = (4×10^{10}) (.0038) = 152,000,000 or
1.52 x 108 ohms

(5) Cleaning cell. For routine cell cleaning, rinse with petroleum ether and wipe with a clean cloth, particularly the area between the tip and the sleeve. Unscrew the outer cylindrical electrode from the cell body. Rinse with petroleum ether and wipe the insulator area with a clean cloth, particularly between the inner electrode and the guard ring.

10. Water Content.

a. Introduction. This procedure describes the method for measuring the water content of silicate ester based coolant with the Karl Fischer Coulometric Titrator (Aquatest 8). The Aquatest 8 uses both the dead stop electrode and the coulometric generation of iodine in a closed vessel system. The coulometric addition of iodine makes the Aquatest an absolute instrument. When a sample is added to the vessel reagent, the voltage rises across the sensing electrode to indicate the wet state. This triggers the coulometer and a constant current flow through the generator producing iodine in the vessel reagent. The iodine reacts with the water from the sample and the vessel solution. When all the water has reacted, the voltage at the sensing electrode drops. This signals the coulometer to stop. The electrical charge produced during the titration is measured coulometrically and is displayed as the total water content. Since the reagent in the vessel is returned to an initial state at the end of each sample addition, sequential analysis can be performed until the vessel reagent is exhausted.

b. Equipment and Materials.

(1) Titrator, Karl Fischer Coulometric (P/N 02-128-10) Solvent

(2) Generator Pyridine Free (50 ml) Solution

(3) Vessel Pyridine Free Isopropyl Alcohol TT-I-735

(4) Methanol O-M-232

(5) Sodium Hydroxide, 1 Normal Solution 0S598

c. Test Information.

(1) The referenced Karl Fischer Coulometric Titrator consists of an Aquatest 8 Titrator and a printer. The Aquatest 8 is a microprocessor-controlled, automated Karl Fischer Coulometric Titrator, which is manufactured by Photovolt, a division of Seradyn, Inc. (FSCM 47125). It is comprised of a base unit, which houses the microprocessor, a titration vessel assembly.

(2) The sample is inserted into the Titractor by means of a sample syringe. The sample will be taken from the sample container and injected into the Titrator's vent hole or its septum opening. At this point, test parameters and other data are input to the Aquatest 8 Titrator via a spill-resistant keypad on the base. The titration is then initiated, via the keypad, and the Aquatest 8 proceeds to automatically perform the titration.

Upon detection of the titration end-point, the results are displayed on the base's sixteen character alphanumeric display. This value can be given in terms of micrograms, percent water, or PPM (parts per million). The printer that is provided with the Aquatest 8 can then be used to obtain hard copies of the test results.

(3) The silicate in the SEBD will react with the reagent to produce water over an extended period of time. The addition of water to the solution will give inaccurate results. In order to remedy the situation, new solution and reagent will be used every 48 hours.

(4) Specifications for the Aquatest 8 are as follows:

(a) Accuracy: 1 microgram or 0.05% whichever is greater.

(b) Capacity: Readouts to 999,999 micrograms of water.

(c) Range: 1 PPM to 100% moisture.

(d) Rate: 2540 micrograms of water per minute.

(e) Electrical: 110 V, 50/60 Hz, 40 Watts

d. Test Procedures.

(1) Instrument Set-Up

(a) Place the Aquatest 8 instrument on the laboratory bench in an area away from direct sunlight and sources of heat such as ovens.

(b) Handle the generator assembly by the Teflon collar.

(c) Holding the vessel cover with the thumbscrews facing away from you, feed the generator plugs and wires through the larger threaded opening. While gently pulling the wires out of the way of the threads, insert the end of the generator that is opened into the cover. Carefully screw the generator into cover.

NOTE

Do not overtighten generator in the vessel cover.

(d) Lightly and evenly grease the ground glass rim of the Pyrex vessel jar with the Photovolt special sealant. Check to see that the three thumbscrew fasteners on the cover are fully unscrewed and extended.

(e) Place a clean and dry magnetic stir bar into the vessel jar.

(f) Carefully join the titration vessel jar and cover with the generator assembly. Twist the cover gently to spread the sealant. Finger tighten the thumbscrew grasps the lip of the vessel jar securely.

(g) Install a membrane septum.

(h) Lightly grease the ground glass collar area of the sensor electrode. Insert the electrode into the small opening of the vessel cover. Carefully and gently seal the collar into the cover. Assure the two circle platinum rings at the end of the electrode are parallel to each other and to the side area of the vessel jar closest to them.

(i) Enter the test parameters into the Aquatest 8 via the keypad.

(2) Pyridine Free Reagent Set-up

(a) In an exhaust hood or well ventilated area, remove the septum holder cap and membrane from the vessel cover, place the funnel supplied into the septum support, and add the entire contents of a bottle of vessel reagent. Remove the funnel and replace the septum and cap.

(b) Remove the generator cap and using a glass syringe, add approximately 3-4 ml of pyridine-free generator solution to the generator. Replace the generator cap.

(c) Place the vessel jar onto the Aquatest 8 inside the plastic retaining ring.

(d) Plug the two banana plugs from the generator into the two banana jacks on back of the Aquatest 8, black-to-black and red-to-red for proper polarity. Plug the sensing electrode plug into the smaller two jacks; the larger sensor plug goes into the small red jack.

(e) Plug the power cable of the Aquatest 8 into a 110-vac grounded receptacle.

NOTE

Assure the Aquatest 8 does not share its power line with devices capable of causing power line disturbances such as motor, compressors, refrigerators and ovens.

(f) Switch on power. The Aquatest 8 will perform internal diagnostics, then display select mode.

NOTE

Once the Aquatest 8 is first turned on, wait 30 minutes before performing a sample assay. This time allow the instrument and vessel assembly to stabilize in its new working environment. Photovolt pyridine-free reagent does not require the use of any neutralizing reagent.

(g) Dipswitch setting should be 1, 2, 4, 8, UP and 3, 5, 6, 7, DOWN.

(h) Turn on the Aquatest 8, and when select mode is displayed press monitor.

(i) Press the first key on the left of the upper 4 keys that correspond to sen.

(j) At this time you will see wet/dry status which will usually show the reagent being at set point or slightly wet; this will be displayed on the Aquatest 8 as follows:

WET….!..^…….DRY.

(k) When the vessel is at set point a caret (^) on the dotted line will appear. The instrument is ready to perform assays.

(3) PPM Moisture Assay.

(a) Press set-up.

(b) Press the fourth white function key under WT.

(c) Press the fourth white function key under NO to enter in a single sample weight.

(d) Press the fourth white function key under NO to allow manual entry of sample weight.

(e) Press clr to remove the weight value stored in memory.

(f) Key the 1800 mg as the weight of the sample and press enter. The Aquatest VIII will beep as it stores the value in memory.

NOTE

In order for the Aquatest 8 microproccessor to compute water content in ppm by weight, it must know the weight of the fluid sample. SEBD has a specific gravity of 0.9, weighing 0.9 grams per ml.

The sample size of 1 ml, therefore, represents a sample weight of 0.9 grams or 900 milligrams (mg). A sample size of 2 ml, therefore, represents a sample weight of 1800 mg.

(g) Again press set-up and this time press the first function key to choose unit.

(h) MCG PCT PPM will be displayed. Press the third function key to choose ppm.

CAUTION

If the test set has not been used for 12 hours or more, initial test results may tend to be inaccurate. Perform two or three analysis, using spare SEBD to allow the test set to stabilize.

NOTE

Since the weight analysis is to be based on the weight transferred, care must be taken to remove all air bubbles from both the syringe and the needle.

Careful wiping of the liquid clinging to the needle is required for precision. Do not draw the tissue all the way over the end of the needle. Wipe to just the edge of the needle tip and then stop. Blot the membrane septum between samples.

(i) Remove the cap from the sample bottle. Using a clean, dry 10 ml glass hypodermic syringe fitted with 4-1/2 inch needle, slowly draw approximately 1 ml of sample fluid from the sample bottle into the syringe. Withdraw the plunger past the 8 ml mark. Coat the interior walls of the syringe with the SEBD. Depress the plunger and expel the 1 ml of SEBD into a waste container. Wipe needle clean.

(j) Using the same 10 ml glass hypodermic syringe fitted with 4-1/2 inch needle, slowly draw approximately 7 ml of sample of fluid from sample bottle into the syringe.

(k) With the needle pointed up, allow the air bubbles to rise to the tip. Place the wiping material halfway over the needlepoint and slowly expel into wiping material any air trapped in the syringe and any fluid in excess of 6 ml. Syringe should now contain exactly 6 ml of sample fluid and no air. Clean the needle with wiping material.

(l) Press set-up. The third option is dly; press the white pad. Next menu will display mcg time. Press the second pad correlating to time. Press the clr key on the keypad and enter 0.3. This is 0.3 minutes or 18 seconds of a delay in the titration. Finally press enter. Now the instrument will delay the start of the titration by 18 seconds after the initial 7-second injection period has elapsed.

(m) Press start. Introduce sample immediately and add sample 7 sec is displayed as follows: Insert needle through membrane septum on sampling port in vessel cover until it is below the level of the vessel solution and discharge precisely 2 ml of fluid directly into the vessel solution. Remove the needle from sampling port. After 7 seconds, the display will show delay for 0.3 minutes and be automatically followed by titration.

(n) At the end of the titration, the weight that is in memory will be displayed as a confirmation test. If it is the correct weight, merely press enter and the results of the assay will be displayed in parts per million water.

NOTE

If the sample weight displayed after titration is incorrect, press clr and enter the correct weight followed by enter. If you are assaying a number of samples of the same weight, you will only need to enter this weight once. Results of water analysis should be reported as an average of at least three runs. Results are considered to have good repeatability if they are within 11 ppm of each other.

(o) Repeat step m above for next injection of the same sample. If a different sample is to be injected, repeat step l above.

(p) Thoroughly clean the syringe, attached needle and plunger with methanol and allow them to air dry. If an explosion-proof oven is available, place the syringe with plunger out of the barrel into the oven at 150-185 degrees F or 65-85 degrees C. After 5 minutes, remove the apparatus from the oven using protection for the hands and insert the plunger into the syringe barrel. Allow it to cool to room temperature (approximately 2 to 3 minutes).

e. Cleaning Generator for Silicate Diester.

(1) The bottom end of the generator assembly consists of a porous Pyrex glass frit. With use, the minute fluid passages in the frit will become clogged, retarding the transfer of generator solution to vessel solution during titration. This condition may be indicated by the error display gen overvoltage and can be corrected by cleaning the frit. (This display does not always occur).

WARNING

Do not get sodium hydroxide (NaOH) solution in eyes, on skin, or on clothing; it causes severe burns. Do not take it internally. Wear gloves and wear goggles (or face shield) when handling. Continuously stir solution while adding compound; add it slowly to surface of solution to avoid violent splattering. Limit the heat rise to 50°F (10°C) per minute. Do not allow temperature of solution to exceed 194°F

(90°C) when mixing. Do not use on aluminum parts; reaction with aluminum forms large volumes of hydrogen gas. Flush area of spillage or leakage with water spray.

(2) The generator frit is cleaned by soaking it in a sodium hydroxide (caustic) solution (5, table 6-3) and applying a vacuum to the top of the generator assembly. The vacuum pulls the caustic solution through the frit, opening up the pore structure. To clean frit, proceed as follows:

(a) Remove power from the Aquatest 8 by switching the power off in back of the instrument.

(b) Disconnect the generator and sensing electrode cables from the jacks.

(c) Loosen the three thumbscrews on the vessel cover and swing pawls away from the titration vessel. Use gentle twisting motion to loosen grease seal and remove cover.

(d) Remove generator cap from generator assembly and pour used generator solution into an approved waste container.

(e) Pour used vessel solution into the same waste container used step 4.b.(4). Be careful not to pour out the magnetic stirring bar. Seal the waste container. Next transfer the magnetic stirrer bar from titration vessel onto a clean wiping cloth. Wipe and dry stirring bar.

CAUTION

Do not separate the sensor and generator assembly from the teflon cover.

(f) Grasp Teflon mounting collar on generator assembly and remove from vessel cover by carefully unscrewing threaded section. Remove sensing electrode and wipe it clean.

(g) Using the empty titration vessel, stand sensor and generator assembly to be cleaned in empty vessel. Pour technical grade one Normal (1N) sodium hydroxide (NaOH) solution into the empty vessel jar until a level of approximately 2 inches is reached.

(h) Pour additional solution into top opening of generator assembly, just enough to cover the frit.

(i) Allow generator assembly to soak 4 hours, or longer, in the sodium hydroxide solution. Periodically observe fluid level inside generator. An increase in level will indicate partial clearing of the frit; the open frit allows fluid to transfer from the vessel into the generator. Upon completion of soaking, discard used NaOH solution into an approved waste container, or dispose by approved methods.

(j) Expedite cleaning of porous frit after soaking procedure by the application of a vacuum (not to exceed 15 inches mercury (Hg)) to the generator assembly. Required vacuum can be obtained using the syringe and valve provided with contamination Analysis Kit, part No. 57L414. Locally fabricate required adapters to connect vacuum source to generator, using modified rubber or cork stopper to connect vacuum line to open end of generator.

(k) Place fresh sodium hydroxide solution in emptied titration vessel, enough to partially cover the generator assembly when it is placed in the titration vessel. Apply vacuum to generator assembly until caustic cleaning solution flows freely from the vessel jar to the inside of the generator. Carefully observe fluid level in generator and assure that fluid is not sucked into vacuum line. A filtering flask may be installed as a trap between the generator and the vacuum pump. If required, pour excess fluid from generator assembly to waste

(l) When frit has been cleaned, remove sensor and generator assembly from vessel jar and discard caustic solution into an approved waste container, or dispose by approved methods. Rinse generator assembly and vessel jar using generous amounts of water, preferably hot.

(m) Return generator assembly to the vessel jar and partially fill vessel with water (tap or deionized). Using vacuum procedure specified in steps (j.) and (k.), flush frit with water to remove residual caustic solution.

(n) Remove generator assembly from vessel jar and discard water.

WARNING

Methanol is flammable - Do not use near open flames, near welding area, or on hot surfaces. Do not smoke when using it, and do not use it where others are smoking. Prolonged or repeated inhalation of vapor can cause eye irritation, drowsiness, and headache. Ingestion may be fatal or may cause eye damage. If vapor contacts eyes, immediately flush eyes with large amounts of water. Immediately remove solvent-saturated clothing. If vapor cause drowsiness, remove affected person from area and expose to fresh air. When handling or applying liquid at air-exhausted workbench, wear approved goggles and gloves. When handling or applying liquid at unexhausted workbench, wear approved respirator, goggles and gloves.

(o) Remove residual water from generator assembly by pulling Methanol through generator with vacuum, as described in steps (j) and (k), and then drying in oven (if available) at 150 to 185°F (65 to 85°C) for a period of 2 hours. If no oven is available, allow to air dry before use. Store generator in desiccator if available, until needed.

(p) In some cases, because of lack of equipment, it may not be possible to clean the frit in shipboard laboratories. In these cases the laboratory should change the generator assembly. The assemblies which need cleaning of the frits should be retained and subsequently taken to a shore based laboratory where cleaning can be accomplished.

f. Calibration.

NOTE

The Aquatest 8 does not require calibration. However, a user calibration procedure is provided so that the user can quickly confirm that the instrument is indeed titrating water accurately. User calibration is generally done every 6 months or as needed (whenever erroneous results are suspected).

(1) Set Aquatest 8 to mcg mode (see paragraph D (g) and (h)).

NOTE

In preparation for the following, fill beaker or other clean container with small amount of tap or deionized water. Set adapter on syringe to 1.0 microliter mark on syringe barrel. Pump syringe several times while needle is submerged in water to remove air. Remove membrane from sample port to enable needle (shorter length) to be below vessel solution.

(2) Press start. Introduce sample immediately after add sample 7 sec is displayed as follows: Insert needle of a gas tight 2 micro liter syringe (15, table 3-1) with built in Chaney adapter directly through the septum on the sampling port in the vessel cover until it extends below the level of the vessel solution and discharge precisely 1.0 micro liter of water into the vessel solution. After a brief moment,

remove syringe and needle from sampling port and replace membrane. After 7 seconds, the display will show delay and be automatically followed by titration. Established that; you obtain 1000 + 50 micrograms of water. Repeat additions until you have 5-10 replicates to determine precision (standard deviation less than or equal to 50 mcg is acceptable). Flush needle several times with water prior to storing to remove chemicals from Aquatest that will cause corrosion.

CONTAMINATION TESTING OF COOLANT

Table of Contents

1. Introduction. This section defines the procedures, requirements, equipment and material needed for sampling and testing Ethylene Glycol/Water (EGW) used in operating systems such as airborne systems, filtering and fluid supply carts, and other ground servicing equipment. The testing shall provide information on the degradation and contamination of EGW for controlling and monitoring their use.

2. General.

   a. The equipment cooling system of the B-2 aircraft incorporates three liquid cooling subsystems and five circulated air subsystems. The liquid cooling subsystems consist of the Ethylene Glycol-Water Subsystem (EGW), DMS/LC Subsystem and the Liquid Cooling Subsystem (LCS).

   b. The EGW subsystem is composed of two independent closed cooling loops which use Ethylene Glycol-Water (EGW) solution as a heat transfer fluid. Each loop circulates coolant from the heat sources and transports the heat to the sink heat exchanger for heat dissipation. The primary heat sources for the EGW loops are the aft bay rack mounted avionics, the forward left avionics, the forward right avionics, the forward left avionics, the forward right avionics, the DMS/LS and the LCS. The Ethylene-Glycol Water subsystem supplies coolant at a flow rate of 85 psig per minute to transport the sink heat from the heat sources to the heat exchangers. The coolant is supplied at a nominal temperature of 47 degrees F with a maximum system pressure of 175 psig.

   c. The Ethylene Glycol-Water solution is a mixture of 62.8 + 1.0 percent ethylene glycol by weight, distilled water and appropriate corrosion inhibitors. The EGW coolant appears as a clear, light straw colored liquid and has a characteristic odor. The EGW fluid is composed of the following:

Table 1 - MATERIALS SPECIFICATION

MATERIALS	OR SOURCE	PART BY WEIGHT
Ethylene Glycol, Technical	ASTM E 1119-92	62.80 + 1.00
Triethanolamine-Phosphate (TEAP)	Commercial Grade	1.60 +/- 0.10
50 Percent (by weight) Sodium Mercaptobenzothia-Zole (NaMBT)	Commercial Grade	0.17 +/- 0.02
Benzotriazole	Commercial Grade	0.50 + 0.5
DI Water	Commercial Grade	35.00 + 1.00

Table 2 - EGW COOLANT TEST REQUIRMENTS

Appearance	Clear and bright, with no evidence of turbidity, haze, cloudiness, gelation, sediment, visible particles or fibers, separation, precipitation, or contamination.
Foaming (Optional) -Increase in volume 5 minutes -Break Time	 -350 milliliters, maximum -30 seconds, maximum
Particulate Contamination per 100 milliliters of Aircraft Fluid, microns: - 5 to 15 microns - 15 to 25 microns - 25 to 50 microns - 50 to 100 microns - over 100 microns - over 200 microns	 - 93,000 particles - 15,400 particles - 3,130 particles - 430 particles - 41 particles - 5 particles
Particulate Contamination per 100 milliliters of GSE Fluid, microns: - 5 to 15 microns - 15 to 25 microns - 25 to 50 microns - 50 to 100 microns - over 100 microns - over 200 microns	 - 27,000 particles - 4,000 particles - 1,300 particles - 180 particles - 17 particles - 2 particles
pH at 60ºF	7.80 to 8.50
Refractive Index at 60ºF	1.3900 to 1.4030
Specific Gravity at 60ºF	1.0850 to 1.0910
Accelerated Stability	No turbidity, cloudiness, precipitation, deposit formation, gelation or phase separation after the coolant is heated to 190 F for 24 hours.
Sodium Mercaptobenzothiazole (NaMBT) Content	0.13 to 0.20% by weight 50% NaMBT

3. Equipment/Materials. Equipment identified to each specific test shall be maintained per manufacture's requirements. Records of maintenance and calibration of the equipment shall be maintained. Testing facilities shall be free of contaminates detrimental to test performance and shall be cleaned at intervals deemed necessary to maintain the cleanliness of the area.

Table 3 – EQUIPMENT / MATERIALS

Description	Manufacturer	Part Number	NSN
Kim Wipes		A-A-1432A	7920-00-721-8884
Paper Towels			7920-00-823-9773
Ethylene Glycol			
pH-4			
pH-7			
Phosphoric Acid			
Glacial Acetic Acid			
Isopropyl Alcohol			
Benzotriazole			
Monobromonaphthalene			
Goggles (or splash guard)		ANSIZ87 1.1989	4240-00-190-6432
Gloves, medium			8415-01-492-0179
Gloves, large			8415-01-492-0178
Gloves, extra large			8415-01-492-0180
Petroleum Ether			
Methanol			
pH Meter	Corning	245	
Particle Counter	HIAC	8000A	
Refractometer			
Thermometer			
Water Bath		Model F3K	4920-01-096-6405
Hydrometers			
DI Water			

4. Test Sequence. To minimize the quantity of fluid needed to perform the EGW tests and to minimize the effects of sample handling, testing should be conducted in the following sequence:

	Paragraph
Appearance	6.a
Dielectric Strength	6.b
Particulate Contamination	6.c
Refractive Index	6.d
Specific Gravity	6.e
Accelerated Stability	6.f
NaMBT Content	6.g

5. Laboratory Safety.

a. Standard lab safety procedures should be followed. All chemicals should be treated as potentially hazardous and handled with care. Petroleum ether and methanol, which will be used to clean the sample containers on the instruments are flammable and should not be exposed to a flame, spark or high heat.. Safety goggles and gloves impervious to organic solvents should be worn at all times. An eye wash station, fire blanket and fire extinguisher should be readily accessible at all times. Material Safety Data Sheets (MSDS) for all chemicals should be accessible to lab personnel while working in the lab. Never work in the lab alone-ensure there is someone else within easy calling distance.

b. Waste chemicals should be disposed of in approved marked waste containers. While the waste organic chemicals used in these procedures may be mixed in a single waste container, it may be more convenient to use one container for EGW waste chemicals and another for EGW wastes. Remove waste chemicals from the lab on a regular basis.

6. Testing.

a. Appearance.

(1). Prior to the sample analysis, the unopened sample bottle shall be visually inspected for proper filling and sealing, as well as evidence of gross contamination. Properly filled bottles will be almost completely filled with fluid extending up to the bottom of the threaded neck section. The purpose of completely filling the bottle is to minimize the quantity of air present, which could contain large amounts of atmospheric moisture, and to assure that adequate fluid is available to perform all of the required tests. Activities submitting EGW fluid samples in improper or inadequately filled bottles shall be advised to resample the equipment.

(2). Prior to sample analysis, fluid in the sample bottle shall be visually inspected for evidence of turbidity or visible particles. This inspection is somewhat limited by translucent plastic bottles but can be remedied by using a clean glass bottle or positioning the plastic bottle in front of a strong light source.

(3). Gross particulate contamination, i.e., particles large enough to be seen with the unaided eye, will also be most visible when the fluid is allowed to stand motionless for a period of time. Particles will generally settle to the bottom of the bottle. Gross particulate contamination is usually indicative of improper sampling technique. If this is suspected, the submitting activity shall be advised and requested to resample the equipment.

(4). Fluid turbidity results in the EGW fluid appearing cloudy as opposed to its normal clear, transparent appearance. Turbidity is most visible when the fluid is agitated and may be indicative of large amounts of air, free water or suspended foreign matter.Turbidity caused by suspended semi-solid matter is of particular concern as it may be indicative of chemical degradation of the EGW fluid. The contamination by-products of such degradation shall be cause for sample rejection.

b. Dielectric Strength.

(1). Introduction. This procedure describes how to measure the pH content of EGW using the type M-245 pH test meter.

(2). Equipment and Materials.

(a) Pyrex Beaker

(b) pH Meter, Corning 245

(c) Glass Electrode

(d) Calomel Electrode, commonly referred to as the reference electrode.

(e) Adapter (if required)

(f) Thermometer - Saybolt Viscosity 14C (Range 19C to 27C, reading to 0.01C)

(g) DI Water

(h) Buffer solution: Buffer solutions can be purchased pre-mixed and certified. (pH 4, pH 7).

(3). Equipment Information and Test Procedures. The referenced pH test meter is an upright box design. On the face of the meter is a keypad operated control panel which programs the calibration, temperature, mode selection, and time interval adjustments.

The pH test meter has the following capabilities:

Range: -2 to 14 pH

Resolution: 0.01 pH

Relative Accuracy: +/- 0.01 pH

Modes: pH

Temperature Span: -5 C to 105 C

Power Requirements: 90 -127 or 198 -264 VAC, 50/60 HZ

NOTE

In use, the pH test meter is first set up with the calomel electrode and pH electrode attached to the electrode holder.

Before beginning the test, standardize instrument with pH and pH7 buffers for maximum accuracy,

Sample should be cooled in a water bath to 60°F or 15.6C before pH testing or calibration begins.

(4). Calibration Procedures.

(a) Calibrate the pH meter, Corning Model 245, as follows:

1. Remove protective caps from electrodes.

2. Remove filler cap from reference electrode.

3. Set the instrument to pH mode.

4. Press cal button.

5. Press right arrow key to select 2 point calibration.

NOTE

Lower display will read "cal 1" and upper display will read "7.00". If the upper display reads "0", press 7.00 on the keypad. Lower display will read "read".

6. Place the electrodes in the pH 7 buffer solution and press the read button. Instrument will automatically adjust to pH 7 and a beep will be heard. Remove electrodes from buffer solution and clean.

7. Lower display will read cal 2 and upper display will read 4.00. If the upper display reads 0 press 4.00 on the keypad. Lower display will read "read".

8. Place electrodes in pH 4 buffer solution and press read button. Instrument will automatically adjust to pH 4 and a beep will be heard. Remove electrodes from the buffer solution and clean. Press exit button. Ensure unit is in pH mode.

9. Verify calibration by measuring pH 4 and pH 7 buffer solutions as if they were a fluid sample.

(5). Test Procedures.

(a) Before beginning the test, measure samples of both pH 4 and pH 7 buffers for maximum accuracy using preceding instructions. If samples do not measure correctly, calibrate instrument..

1. Transfer sufficient volume of EGW fluid into a marked Pyrex beaker to allow the electrode tips to be fully immersed without touching the glass container.

2. Remove electrodes from the storage solution and rinse with DI water. Gently blot the electrodes with clean, soft cloth.

3. Using a twisting motion, remove the plastic caps from the electrodes.

4. Pull black plug out of the electrode fill hole.

5. Measure sample temperature with thermometer.

6. Place pH electrodes in sample. The tips are fully immersed when 1/2 inch into a sample; they may be immersed further, but, never up to the fill holes.

7. Ensure unit is in pH mode.

8. Press read. Instrument will automatically display pH measurement and a beep will be heard.

(6). Care of pH Meter. Remove electrodes from EGW fluid and rinse with DI water. Replace tip protectors and insert black plug into fill hole. The electrodes are stored immersed in pH 7 buffer solution, or distilled water, which is changed after every test setup or weekly at a minimum. Electrodes should be cleaned with DI water and blotted with a clean, soft cloth after each measurement.

CAUTION

Special care should be exercised in handling the electrodes, which are composed of a very fragile glass and may be easily broken.

c. Particulate Contamination.

(1). Introduction. This procedure describes how to perform the counting of particles suspended in EGW using the Hiac/Royco Model 8000A Particle Counter.

(2). Equipment and Materials.

(a) Model 8000A Hiac/Royco Particles Counter with printer

(b) Automatic Bottle Sampler Unit (ABS)

(c) Methanol or Isopropanol (filter the solution through a 0.45 micron filter)

(d) Petroleum Ether (Reagent grade)

(3). Equipment Information.

(a) The referenced particle counting system is comprised of several individual components: A counter, an automatic bottle sampler, and a sensor. Descriptions of each of the components are given below.

1. The counter is equipped with a keypad, a 40 column 16 line liquid crystal display (LCD), and an internal 40 character per line graphics printer. Although wide ranges of contamination standards are resident in the unit, the operator has the option of storing a different standard, which better describes his application. Any of the standards can then be selected with a single keyboard entry. The Model 8000A is capable of acquiring count data for eight particle size ranges. The calibration graph for the sensor being utilized shows the actual values that must be input to the counter to set the size range limits for the test. Whenever a different size range is desired or when a different sensor is utilized, the corresponding calibration graph must be entered into the counter. The calibration graph is supplied by the manufacturer, and the counter is recalibrated every 6 months. Before a test can be run, the operator must input the number of sample runs to be performed. The counter automatically gives results for each sample data run as well as the average of the selected number of runs. The operator must also input the limit for the counter's audible alarm. After the test has been performed, the results can be displayed in either tabular or histogram format, and a hardcopy can be obtained from the printer.

2. The automatic bottle sampler is a Hiac/Royco model ABS sampler (P/N BS-313). The sampler is comprised of three components: A sampler holder, a volume measuring tube, and a control box. The sample to be analyzed is placed in a container inside the sampler holder.

This sample holder has a pressure rating of 60 PSI and is equipped with a magnetic stirrer, which keeps the sample particles in a uniform suspension. Positive pressure is then used to transfer the sample, at a constant flow rate, from the sample holder through the sensor (which will be discussed later) to the volume measuring tube. The pressure required for this transfer can be provided by either a facility air supply or by a separate pump. The sampler is equipped with a locking regulator to regulate the supply pressure down to the desired 5 to 60 psi. Once the sample has passed through the sensor, it goes into the volume measuring tube. This tube is equipped with two moveable light sensors, which generate the "start count" and "stop count" signals to the counter. The volume of sample to be analyzed is determined by the positioning of these two light blocks. Upon completion of a test, the volume measuring tube is drained by means of an automatic valve and drain line. A Hiac/Royco model HRLD-400 sensor (P/N 040 X 300-01) is provided with the particles in the sample by means of the light obscuration method, has the following specifications:

a. Measurement Range: 2 - 400 microns

b. Recommended Concentration Limit: 8,000 particles/ml

c. Flow Rate: 10 - 200 ml/Min

d. Pressure Limit: 1000 psi

e. Temperature Limit: 150 degrees Fahrenheit

f. Frequency Response: To 250 kHz

g. Precision: Coefficients of variation less than 1% for mean counts greater than 1000 particles per ml

h. Accuracy: Traceable to NIST Standard Reference Materials

(4). Test Procedures.

(a). Turn on the particle counter and the automatic bottle sampler.

(b). Press any key on the keypad to access the main function menu.

(c). Place a container of the sample to be analyzed into the sample holder. Put a clean stirring rod into the container and turn the sample holder's magnetic stirrer on.

NOTE

Be extremely careful that the stir bar is "just" moving to eliminate the counting of bubbles as particles.If a vortex appears in the center of the liquid, it is being stirred rapidly. Adjust stir speed until vortex is no longer visible.

(d). Position the volume measuring tube light blocks. The volume of sample that is analyzed is determined by the positioning of these two blocks. Volume should be set for a 20 ml sample size.

(e). Set the locking regulator on the sample holder to the desired pressure. Desire pressure will provide a flow rate of 20 ml in 20 seconds, ≈ 14 -20 psi.

(f). Press start key.

(g). Once the test is complete obtain results from the display and/or printer.

(h). First flush the system with a total of 100 ml of Methanol or IPA, followed by a flush with 120 ml of Petroleum Ether.

(i). Turn off the particle counter and automatic bottle sampler.

NOTE

If initial set-up data is lost, reenter data using the following calibration procedures.

(5). Calibration Procedures.

(a). Turn unit on and press any key.

(b). Press the more key on the main function menu.

(c). Press the user std key.

(d). Press the alter std key.

(e). Enter the following data:

1. Standard Name: Latex
2. Number of Classes: 16
3. Coml/Diff: Cumulative
4. Class Limit Units: Counts
5. Sample Volume: 20.00 ml
6. Classify: Runs only
7. Number of Runs: 3
8. Number of Channels: 3
9. Class 1 thru 16: N/A
10. Channel 1: 10
11. Channel 2: 200
12. Channel 3: 400

(f) Press exit key.

(g) Save standard in storage slot #1.

(h) Using exit key, return to main menu.

(i) From the main menu, press set-up.

(j) Press the global set-up key and enter the following data:

1. Operator ID: Operator's Initials
2. Number of Runs: 3
3. Delete Time: 00H, 00M, 10S
4. Delay Time: 00H, 00M, 00S
5. Transducer Units: English
6. Quick Adjust Rate: 02H, 30M

(k) Press the exit key to return to the parameter set-up function menu.

(l) Press the control set-up key and enter the following data:

1. Sample ID: 000
2. Background: OFF
3. Dilution Factor: 1.00
4. Standard: Latex in Water

5. Mode: volume
6. Sample Volume: 20.00 ml

(m) Press the exit key and return to the parameter set-up function menu.

(n) Press the exit key to return to the main menu.

(o) From the main menu press the cal key.

(p) Press the set cal key.

(q) Press the alter cal key and enter the following data:

1. Sensor Model: HR-LD400
2. Serial Number: 9306-003
3, Calibration Date: dd/mm/yr
4. Material: Latex in Water
5. Flow Rate: 60 ml/Min
6. Sensor Type: Extinction
7. Algorithm: Interpolation
8. Noise: 13.5 mV
9. Extinction: 12
10. Diameter mV

2.020	41
3.020	60
5.007	132
9.870	309
15.000	475
20.490	641
32.200	1020
40.100	1240
58.500	1720
112.000	3210
165.000	4300
301.000	7500

(r) Press the exit key to go to the calibration function menu.

(s) Press the bin size and enter the following data:

Number of Channels 3

Channel	Threshold (micrometers)
1	10
2	200
3	400

(t) Press the exit key to return to the calibration function menu.

(u) Press the exit key and return to the main menu.

NOTE

The tester is now ready for use.

d. Refractive Index

(1). Introduction. This procedure describes the method for measuring the refractive index of EGW coolant fluid using a refractometer and water bath.

(2). Equipment and Materials.

(a) Refractometer

(b) Thermometer - Saybolt Viscosity 17C (range 19C to 27C, reading to 0.01C)

(c) Water Bath, Model F3K

(d) Distilled Water

(e) Glass Standard

(f) Lens Tissue Paper

(g) Methanol

(h) Monobromonaphthalene ***Usually supplied with refractometer for calibration. Calibration procedures are found in the manufacturers manual.

(2). Equipment Information.

(a) The refractometer is a precision optical instrument, with a focusable eyepiece and dispersion corrective prism, equipped for connection to a water bath for uncompensated measurements. It also has an adjustable built-in illumination system.

(b) The refractometer has the following specifications:

1. Display: Direct reading LED

2. Range, Dissolved solids: 0 to 85 degrees Brix, and % solids. Refractive index 1.3210 to 1.7001 ND.

3. Accuracy: +/-0.1 Birx, +/-0.0001 ND, +/-0.1% Solids

4. Temperature Compensation Accuracy: +/- 0.2 degrees Centigrade

5. Sample Types: Transparent or translucent liquids or solids.

6. Sample Temperature Control: Refractive index and uncompensated Brix or % solids.

(c) The circulating heated electric water bath, part number F3-K, NSN 4920-01-096-6405, is used in conjunction with the refractometer. The circulating water bath is necessary to maintain prism temperature so sample is at the desired temperature (60°F).

Calibrate the refract meter with standards such as monobromonaphthalene and a glass standard.

1. The water bath has the following specifications:

2. Mounting type: stand

3. Inside dimensions of the reservoir: 295 x 190 x 150 mm

4. Operating temperature range: 10 to 150 degrees Fahrenheit (-23 to 65 C)

5. Heating element current type: single

6. Heating element wattage in watts: 1000

(d). Test Procedures.

1. Instructions for performing Refractive Index (RI) are as follows:

a Turn on circulating water bath and adjust controls to allow refractometer prism to reach 60°F +/-0.5°F or 15.6°C +/- 0.2°C.

b Place sample container in water bath and allow to come to 60°F +/- 0.5°F or 15.6°C +/- 0.2°C.

c Turn the mode selector to measurement mode N.

NOTE

Prism face is easily scratched which will cause inaccurate measurements. Use only lens tissue designed for instrument cleaning on prism surface.

d Verify prism temperature is 60 degrees F by pressing temp button.

e Open prism assembly and remove lens tissue from prism face (used to protect prism when instrument is not in use). When adding sample be careful not to touch the eyedropper to the prism face. Never "wipe" sample onto prism. Sample should be added dropwise and when prism is closed it will spread.

f Place sample on prism using an eyedropper (the entire surface of the lower prism should be covered). Do not touch prism face with eyedropper.

g Position the illuminator arm and lens for maximum contrast.

NOTE

While viewing through eyepiece, turn the adjustment control knob (located on right hand side of instrument) until the shadow line appears in the reticle field. The adjustment should be counterclockwise when the field appears dark and clockwise when bright.

h Press temperature button on front panel for readout of sample temperature. Sample should be tested at 15.2 - 15.6C.

i When sample reaches correct temperature range, focus on the shadow line. Turn the knob to precisely intersect the shadow line with the cross hair.

j Depress the read button for measurement. Unit will count then display the measurement.

NOTE

If test fails, check accuracy of tester using distilled water. If tester is proven to be accurate, the EGW sample is out of the specification requirement. If test failed, recalibrate the instrument using the calibration procedures.

(e). Calibration Procedures.

1. Calibrate refractometer as follows:

a Turn mode selector to refractive index.

b Open the prism assembly and insure that the surfaces are clean.

c Apply a minute drop of 1-bromonaphthalene to the illuminator end of the refracting prism surface.

d Place the test glass standard on the contact liquid with the polished side down (refractive index alue face up), polished end toward the illuminator end of the refracting prism. Do not use an excessive amount of 1-bromonaphthalene, and avoid build-up along the polished front end of the standard.

e Gently press down on the test glass to insure there are no bubbles between the test glass and the refracting prism.

f Align the illuminator arm and lens so that the front edge face of the test glass is fully illuminated.

NOTE

To achieve the best possible contrast of the liquid field for this measurement, place a sheet of white tissue between the lamp and prism assembly. Diffused lighting will eliminate the black-white fringes (horizontal lines).

g Follow the steps in the general operating instructions for focusing the eyepiece, aligning the shadow line with the cross hair and obtaining a measurement.

NOTE

The alignment of the lamp and color compensation must be accurate. Lamp mis-positioning can create a secondary shadow line. The recognition of the proper contrast line can be easily achieved. Move the illuminator slightly up and down; the primary shadow line will not move. The accuracy of the instrument depends on how well the shadow line is set on the cross half.

h Depress the read button; 1.3330 will be instantaneously displayed, followed by counting. When the counting stops, the ND value of the test glass is displayed. Note the value shown. The accuracy of calibration should be within 0.0001 ND of the value stamped on the test glass.

i If calibration is necessary, rotate the adjustment control knob and depress the read button, Repeat until the correct value, as indicated on the test glass, is obtained. Insert the allen wrench provided through the access hole in the dispersion control. Turn the adjusting screw carefully to move the reticle up and down until the shadow line is aligned with the center of the crosshair. Remove the test glass; clean and close the prism assembly.

CAUTION

Care should be taken to avoid any contact between the edges or sharp corners of the solid sample and the prism. If the flat surface of the sample is smaller than the refracting prism, place the sample on the far half of the prism surface, toward the illuminator. This will improve the contrast line visibility.

(f). Care of Refractometer. - Prism should be cleaned after each sample is removed with a soft cloth or cotton swab dampened with DI water. The prism may be wiped with lens cleaning tissues but it should NOT be wiped with a hard, dry cloth.

e. Specific Gravity.

(1). Introduction. This procedure describes the method of measuring the specific gravity of EGW using the hydrometer.

(2). Equipment and Materials.

(a) Glass Stirrer or Glass Rod (to use with cylinder)

(b) Thermometer - Gravity 12 C, (range -20 to +120 C) or 12 F (range -5 to +215 F)

(c) Water Bath

(d) Hydrometers, Numbers 111H to 117H, specific gravity range 1.000 to 1.350, precision 0.050 each hydrometer.

(e) Hydrometer Cylinder

(3). Test Procedures.

NOTE

Assure that the sample temperature is 60 ºF + 0.5 F, by immersing a thermometer into sample.

(a) Carefully pour the sample into the hydrometer cylinder without splashing. Remove the bubbles formed after they have collected on the surface of the sample by touching with a clean, dry glass rod. Fill cylinder about 2/3 - 3/4 full.

(b) Place sample in water bath and allow sample to reach 15ºC (60ºF).

(c) Lower the hydrometer gently into the sample. Avoid wetting the stem above the level to which it will be immersed. Stir the sample with glass rod, and record the temperature when a steady temperature has been reached. Remove the thermometer after recording temperature.

(c) Depress the hydrometer about two scale divisions into the sample and then release it, imparting a slight spin.

(e) When the hydrometer has come to rest away from the cylinder walls and with no air bubbles present, read the density/specific gravity, by placing the eye slightly below the level of the liquid and slowly raising it until the surface of the sample becomes a straight line cutting the hydrometer scale.

(f) Again determine the sample temperature. If this differs from the initial value, repeat the hydrometer test and then thermometer observations until no more than 1 ºF difference is obtained.

(g) Report the specific gravity/relative density to the nearest 0.001, and temperature measurement to the nearest 1ºF.

f. Accelerated Stability.

(1). Fill a 100-ml centrifuge tube to the 100 +0, –2 ml mark with coolant or add coolant to an acceptable level in a 100 ml to 500 ml three-neck flask so that a thermometer will have its bulb in the fluid. Cap with a properly sized one-hole rubber or cork stopper.

NOTE

Cork stopper particles will float. Rubber particles will not.

(2). Insert a 12-inch long glass condenser tube through the stopper. Insert a dry Nichrome or stainless wire into the condenser past the bottom of the condenser but not into the coolant as shown in ASTM D5828 Figure 1. The purpose of the wire is to provide a means of directing condensate back to the centrifuge tube. It is also permissible to have the fluid in a 100 ml to 500 ml three-neck flask and to utilize a 600 mm Vigreux distillation column in the center neck with an appropriate thermometer in one of the side necks and a solid rubber, cork, ground glass or Teflon stopper in the other side neck.

(3). Expose the fluid to a target temperature of 200 F for 24 to 30 hours. It is permissible for the fluid temperature to fluctuate between 185 F and 210 F during the test. At the end of the test period, remove the fluid from the heat source and allow to cool to room temperature for at least one hour.

(4). Remove the air condenser and stopper and replace with a solid rubber or cork stopper. Balance the centrifuge tube, stopper and fluid sample against another centrifuge tube (with stopper) containing another coolant sample that was not heated 190 F. If a three-neck flask was used, decant 100 ml +0, –2 ml of cooled fluid into a 100 ml centrifuge tube, then balance with another centrifuge tube filled with coolant to 100 ml +0, –2 ml.

g. NaMBT Content.

(1). Adjust reagent grade deionized water (resistivity > 3,000,000 ohm-cm) to a pH of 5.2 using a pH meter, a small Pasteur pipette and glacial acetic acid that is diluted to 1% acetic acid by volume. Stir the water constantly with a magnetic stirrer while adding the diluted acetic acid. Use a Ross combination electrode or other suitable sensing electrode. Adjust at least 500 ml of deionized water that has been freshly boiled and allowed to cool to room temperature while covered.

NOTE

UV-visible measurement of NaMBT in EGW is not feasible because the 310-nm peak for this compound is strongly interfered by other ingredients that absorb at a lower but close frequency. If NaMBT is converted to MBT by adjusting the pH to near 5.2, the analytical peak changes to 322nm where the interference is slight.

(2). Adjust a 100 ml sample of the coolant to a pH of 5.2 using reagent grade or better glacial acetic acid, a small Pasteur pipette, a magnetic stirrer, and a pH meter with Ross or other suitable electrode. Stir the sample constantly while adding the acid drop wise.

(3). If available, use reagent grade ethylene glycol, benzotriazole, deionized water, triethanolamine, and phosphoric acid to formulate EGW fluid in accordance with MS-139, omitting the 50% NaMBT. Standards cannot be made using water alone, since the NaMBT is converted to the MBT form at pH 5.2, and is insoluble in water. Adjust the pH of the fluid to 5.2 as per step 2, then add known amounts of 50% NaMBT (R.T. Vanderbilt "NACAP") to the fluid (weighing to the nearest 0.1 mg) to provide the desired standard (suggested approximate values of weight % of 50% NaMBT added to the fluid are 0.05, 0.10, 0.15, 0.20, and 0.25). Store the standards in a dark place in carefully sealed bottles (amber glass preferred).

(4). Use pH 5.2 water or pH 5.2 EGW with no NaMBT to fill both cells and perform a baseline analysis. Perform a zero analysis as well, operating the instrument in accordance with the manufacturer's instructions. After completion of the baseline analysis, remove the cell from the sample beam, and leave the cell in the reference beam.

(5). Dilute a 1 ml aliquot of each standard with pH 5.2 water to 1% standard by volume for a 1 cm cell or 10% standard by volume for a 1 mm cell. Use a Class A glass pipette or a Gilmont Micrometer Buret to obtain the 1 ml sample for the Cary 400 spectrophotometer. Other spectrophotometers may require different dilutions. Rinse the cell down with the diluted sample, then fill, and place in the sample beam. Scan the sample from 500 nm to 200 nm or other desired wavelengths, as long as there is sufficient distance on either side of the 322 nm peak. Multiple scans may be performed if the instrument does not demonstrate sufficient repeatability (the Cary 400 typically will not vary more than 0.001 absorbance unit from run to run, and does not normally required more than one analysis). Print the results, making note of the absorbance at 322 nm, and determine the absorbance of the valley just to the left of the 322 nm peak, and of the baseline to the right. Add the two absorbances on either side of the 322 nm peak, divide by two, and subtract from the 322 nm absorbance. Repeat for all of the standards, so as to have a reference range for all analyses. Use only Class A glass volumetric flasks for all dilutions.

(6). Use a Class A glass pipette or a Gilmont micrometer buret to obtain a 1 ml aliquot of the sample, and dilute as specified in step 5. Perform the analysis per step 5, and determine the 50% NaMBT content by computing the ratio of the net absorbance of the sample (calculated as in step 5) to the standard closest in net absorbance to the sample, and multiplying by the amount of NaMBT in the standard. Alternatively, the absorption coefficient may be determined using Beer's law (A = axbxc; b= pathlength of the cell, c is the concentration in whatever desired units, and a is the absorption coefficient) and at least two of the known concentration standards. The method of known additions may be used when NACAP and only used MS-139 are available. Add a known amount of NACAP to the EGW fluid after analysis, dilute as in step 5, and analyze.Use the 2 net absorbances to determine your absorption coefficient via subtraction and division into the remaining net absorption. The weight % of 50% NaMBT = net absorbance divided by response factor.

NOTES

Do not calculate concentration based on just the maximum peak values of the samples and the standard or use nonscanning UV-visible spectrometers that measure fixed wavelengths. Do not determine concentration based on the area of the 322 nm peak rather than the peak height. Samples with lower concentrations of NaMBT give slightly higher values when analyzed by UV-visible spectroscopy because the interference is relatively greater for these samples.

FLUID CONTAMINATION

Table of Contents

1. **Introduction** - This section discusses the contamination of lubricating and hydraulic fluids, how it occurs, how it is identified, what its impacts are, and what to do when contamination is suspected.

2. **Types of contamination** - Essentially, anything that is not supposed to be in the oil sump is a contaminant, regardless of its source. Contaminants may enter the system as a result of environmental exposure, normal operation, normal or abnormal wear, or human error (wrong fluid type).

    a. **Environmental.** Environmental contamination occurs when materials normally present in the environment enter the oil. Environmental contamination can occur when fluid is transferred or when any reservoir (cart, pre-oiler, can, drum) is open to the environment. Environmental contaminants include (1) finely divided, airborne and windborne soil, dust, sand, or clay, (2) large particles of debris from contaminated surfaces, such as corroded cans, and (3) water from rain, snow, or other sources. Environmental contamination is largely a function of the environmental conditions under which fluids are stored and transferred and the care taken by personnel to ensure cleanliness and to protect transfer. Environmental contamination occurs when (1) bottles, cans, pre-oilers, or oil carts are left open or in unprotected conditions for extended periods, (2) closures malfunction or seals/gaskets have degraded, (3) drum or can surfaces are allowed to corrode and debris enters the oil as the container is opened, (4) dirty can openers, church keys, pour spouts, funnels, or nozzles are used, or (5) contaminants enter through the component air intake (or other exposure) as a result of normal operation. Improvements in personnel training and material handling equipment have reduced much of the environmental contamination.

    b. **Wrong fluid type.** This results from human error (such as putting the wrong fluid in a pre-oiler) or sloppy handling (such as reusing a pre-oiler for a different type of fluid without proper cleaning). Contamination with the wrong fluid type most commonly occurs when an oil cart or pre-oiler (for example, PON-6) is filled with the wrong material at the maintenance site. However, it is also possible for mix-ups to happen in the supply system. Any time fluid is transferred between containers or to a vehicle's oil sump, there is an opportunity for contamination. There are three general types of fluids used in aircraft: hydraulic fluids (MIL-PRF-83282 and MIL-PRF-5606), mineral lubricants [SAE J1899 (formerly MIL-L-22851D) and SAE J1966 (formerly MIL-L-6802E)], and synthetic lubricants (MIL-PRF-7808 and MIL-PRF-23699). However, there are many types of vehicles and components (engines, transmissions, gearboxes) enrolled in the JOAP. There are also many types of fluids used in servicing mechanical equipment (antifreezes or coolants, fuels, additives, lubricants, and hydraulic fluids). Any of these types of fluid may be inadvertently added to the oil sump or to an intermediate container (i.e., between the manufacturer's container and the sump.

    c. **Wear debris.** Friction from moving parts and abrasion from environmental debris causes small fragments of metal to slough off into the oil. Excessive wear debris indicates poor engine health. For aeronautical equipment, nearly the entire oil analysis program is directed towards wear debris and engine health.

    d. **Operational byproducts.** Chemical reactions that take place during combustion yield products that reduce oil quality and effectiveness. Soot is formed from the incomplete combustion of hydrocarbon fuels. Water formed by combustion and fuel vaporized during combustion may enter the oil. Sulfur and phosphorus compounds may occur as impurities in diesel fuel and will burn to produce acids that attack metallic parts. Heat and mechanical stress break down the long hydrocarbon chains of the compounds that make up the oil itself.

3. **Identifying and measuring contamination.** Much of the JOAP Manual is dedicated to detecting and quantitating wear debris contamination and/or operational byproduct contamination.

    a. **Water.** Although water is an environmental contaminant, it is also an operational byproduct that forms as a result of combustion of hydrocarbon fuels; therefore, it is already addressed when it represents a significant threat to a component or to oil performance. Water is measured via the crackle test, Karl Fischer titrimetry, and infrared spectrometry. These topics are covered in Volume II Section V of the JOAP Manual and are a part of routine analysis for many samples.

b. **Particulate debris.** This includes environmental particulate debris and soot. Dust, sand, grit, clay, and soil can be encountered as environmental particulate debris. Silicon is present in sand (silicon dioxide). When silicon is found with aluminum, that suggests the presence of aluminosilicates found in soils and clays. High levels of iron, inconsistent with engine composition, may be from rust on a can, can opener, pour spout, or church key. Many aircraft engine oils contain low concentrations of silicon in the form of silicone pour point depressants that allow the oil to be dispensed easily in cold weather. Therefore, it is normal to see silicon concentrations around 3-4 ppm and occasionally as high as 5-6 ppm. Silicon, aluminum, and iron are all quantitated via rotrode atomic emission spectroscopy, which is covered heavily in Volume II WP 001 00, and to which the wear limit tables in Volumes III and IV are dedicated. In addition, particle counting is used for hydraulic fluids and covered in Volume II Section V.

c. **Wrong fluid type.** Wrong fluid type is normally found by identifying additives that would be absent in the correct fluid.

(1). **Zinc.** High levels of zinc are consistent with MIL-PRF-2104 or other automotive lubricants. As of 2005, zinc dialkyldithiophosphate (ZDDP) compounds are still added as antiwear agents to engine oils. These compounds form protective zinc phosphate glasses on engine parts. ZDDP compounds are not used in turbojet oils.

(2). **Molybdenum.** Although not routinely found in MIL-PRF-2104, many commercial automotive (e.g., 5W30, 10W40) and truck (e.g., 15W40, 20W50) oil formulations incorporate suspensions of molybdenum disulfide. Molybdenum disulfide is a solid lubricant, and it is found in both engine oils and anti-seizing compounds. Unfortunately, molybdenum is also used in many aircraft engine bearings (such as 4.0-4.5% in M50 steel). The presence of molybdenum alone is not diagnostic for wrong fluid type. When detected in the oil of a component that does not contain molybdenum, this finding does point to contamination with automotive/truck engine oil.

(3). **Boron.** Historically, the presence of boron has suggested the presence of coolant in the oil since borates are used as buffers to control pH in cooling systems. Nevertheless, boron additives, such as boron nitride, are found as solid lubricants, especially in heavy weight (e.g., 20W50) commercial oils. As of 2005, boron compounds were not used in any qualified product under MIL-PRF-2104 in the Defense supply system, and the presence of boron should initially suggest contamination with antifreeze coolant.

(4). **Magnesium**. Historically, the presence of magnesium has suggested the presence of coolant in the oil since magnesium compounds are used as detergents in cooling systems. However, it has become increasingly common for the same detergents to be used in automotive/truck engine oils. When detected in the oil of a component that does not contain magnesium, this finding points to contamination with either automotive/truck engine oil or antifreeze coolant.

(5). **Glycol**. Most antifreeze coolant formulas are based on ethylene glycol, but environmentally friendly formulations contain propylene glycol. The alcohol functional groups are observed by infrared spectroscopy. Contamination with antifreeze coolant occurs mostly in ground equipment and rarely in aircraft. Glycol contamination usually occurs simultaneously with water contamination.

(6). **Analytical techniques**. Zinc, molybdenum, and boron are determined via rotrode atomic emission spectrometry. Glycol and some other additives can be determined by infrared spectrometry. Some services and some laboratories may not have all techniques available.

d. **Operational byproducts**. In addition to water, various acidic species may be formed by the partial combustion of hydrocarbon fuels or impurities in them; these are measured collectively as the total acid number. Though not a byproduct, vaporized fuel may enter the oil during operation, and so it is included here. Fuel contamination can be determined by decrease in the flash point or fuel sniffer (Volume II Section V) as well as a decrease in viscosity when severe. Decreases in viscosity are also associated with the degradation of the oil itself resulting from exposure to heat and mechanical shearing action.

e. **Wear debris**. Like environmental particulate debris, wear debris is determined primarily by rotrode atomic emission spectrometry. Most wear debris is too large to remain suspended in the oil so that it cannot be estimated by the oil's opaqueness to infrared light (unlike soot). Volume II Section III is devoted to rotrode atomic emission spectrometry.

4. **Consequences of contamination**

a. **Water**. Small amounts of water are dispersed by the surfactants in the oil; however, large amounts of water lead to the formation of sludge, which clogs the filter and increases the viscosity. As sludge forms, the oil becomes less effective at lubricating surfaces and less effective at conducting heat energy. This makes the engine work harder and wear out faster. Water also speeds corrosion.

b. **Environmental particulate debris and soot**. Depending on the particle size, these contaminants either interfere with the proper function of the dispersants and surfactants in the oil (leading to sludge formation) or they abrade the moving parts of the engine. In most aircraft, large debris is removed by the oil filter so that the presence of individually visible particles (i.e., turnings, chunks, flakes, needles) suggests improper filter function. Even in ground equipment, individually visible particles suggest substantial engine wear and/or poor air/oil filtration.

c. **Wrong fluid type.** For aircraft, wrong fluid type can be an extremely serious problem. Aircraft consume oil at a rate such that any noncombustible or involatile compounds are rapidly concentrated and can clog filters or deprive the system of needed lubrication and heat transference. Furthermore, aircraft components are not designed for exposure to some of the additives present in automotive/truck engine oils. Because aircraft lubricants are relatively free of additives, it is difficult to identify contamination of automotive/truck oil with aircraft oil, but it is also less serious.

d. **Operational byproducts.** Acidic compounds produced from the burning of sulfur or phosphorus impurities in fuel, incomplete combustion of hydrocarbon fuels, or nitrogen oxides formed from air at operating temperatures all attack metallic engine parts, corroding them. They also react with seals and gaskets, reducing their lifetimes.

e. **Fuel.** Excessive levels of fuel (about 5% by weight or higher) pose a safety risk by making the oil combustible or even flammable. Fuel incursion lowers viscosity, which, in turn, reduces lubricity. It also decreases thermal conductivity. Fuel incursion is primarily a concern for ground equipment and diesel engines.

f. **Wear debris**. Depending on the level of debris and the component, the debris may be normal or abnormal. In precision gas turbine engines, even small amounts of wear debris can signal an impending engine failure. The wear debris limits for aeronautical equipment are given in JOAP Manual Volume III. The wear debris limits for ground equipment are given in JOAP Manual Volume IV. Safety of flight dictates that special attention is given to aircraft. As a rule, limits for aircraft are much lower than limits for ground equipment or diesel engines on ships. Wear debris results should ideally be diagnostic (identifying what part is failing) and prognostic (how long that part will last). When coupled with knowledge of the engine composition and design, wear debris analysis is an important aspect to a condition-based maintenance program.

5. **Mandatory actions for addressing contamination**

a. **Environmental debris and water.** Recommend resampling and retesting when dust, dirt, sand, soil, clay, or water is suspected. Confirm proper instrument function with appropriate check standards. Recommend continual flushing, sampling, and testing until contamination is undetectable (< 8.0 ppm Si if no limit given) or nearly so. Consult program manager if further information is needed. Compare results with reported limits in JOAP Manual Volumes III and IV limit tables.

b. **Visible particulate debris.** When visible debris is present, regardless of the nature of the debris (wear or environmental), the sample fails automatically. Confer with mechanic or maintenance chief if appropriate to ensure sample was not contaminated during/after collection. Recommend resampling or draining/flushing if evidence indicates. Test to identify and quantitate wear debris in original sample and any additional samples.

c. **Wrong fluid type**. Report results suggesting wrong fluid type as soon as practical; recommend resampling and retesting. Confirm proper instrument function with appropriate check standards. When wrong fluid type has been verified, notify local chain of command, oil analysis program manager, maintenance chief, cognizant engineering authority (Army and Navy only), and other personnel as required by local written procedures. When contamination has been identified in sealed materials procured through the Defense supply system, initiate action through the Defense supply deficiency reporting system. Recommend continual flushing, sampling, and testing until contamination is undetectable (< 8.0 ppm Zn and B) or nearly so. Consult program manager if further information is needed.

d. **Operational byproducts.** Report results as required for individual components or equipment. Report recommendations for additional sampling and testing or maintenance as required. Further detail is provided elsewhere in the manual.

e. **Wear debris.** When metallic debris consistent with component wear is confirmed by rotrode atomic emission spectrometry (RAES), take action consistent with the wear limit tables in JOAP Manual Volumes III and IV.

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SVM 3000 VISCOMETER LABORATORY OPERATING PROCEDURE

NOTE

This is a complete revision of this work package therefore changes are not marked with a line in the right margin.

1. Scope. This procedure can be used to determine the dynamic viscosity, kinematic viscosity, and density of liquid petroleum products and crude oils with a typical working range 10 to 600 cSt (kinematic viscosity). This test method is derived from references a. and b. The result obtained from this test method is dependent on the behavior of the sample and is intended for application to liquids for which the shear stress and shear rate are proportional (Newtonian flow behavior).

2. Summary of Method. The typical sample does not require any preparation (if no large particulates are present). The test specimen is introduced into the measuring cells which are held at a closely controlled and known temperature. The measuring cells consist of a pair or rotating concentric cylinders and an oscillating U-tube. The dynamic viscosity is determined from the equilibrium rotational speed of the inner cylinder under the influence of the shear stress of the test specimen and an eddy current brake in conjunction with adjustment data. The density is determined by the oscillation frequency of the U-tube in conjunction with adjustment data. The kinematic viscosity is calculated by dividing the measured dynamic viscosity by the density of the fluid. All values are displayed concurrently on the instrument.

3. References.

   a. ASTM D445, Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

   b. ASTM D2270, Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 ºC and 100 ºC

   c. ASTM D4052, Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

   d. ASTM D7042, Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

   e. Instruction Manual. SVM 3000 / G2 Stabinger Viscometer

4. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Viscometer	Anton Paar	SVM3000	6630-01-564-6096
Maintenance Kit	Anton Paar	16864	
Syringe, 5mL Luer or similar	Anton Paar	6772	
Screen, 75 um apperture			
Kim Wipes	GSA		7920-00-721-8884
Paper Towels	GSA		7920-00-823-9773

Table 2. Chemicals / Reagents

Description	Manufacturer	Part Number	NSN
Biotek HI-solv (cleaning solvent)	Bio-Tek	134 HI-Solv	6850-01-277-0595
Heptane (cleaning solvent)	Fisher Scientific		6810-01-448-7151
Petroleum Ether REA (drying solvent), technical grade or better			6810-01-962-2018
Cannon Certified Viscosity Standard (S60)	Fisher Scientific	22-288-552	
N35 Certified Viscosity Reference Standard	Cannon Instrument Company		
N75 Certified Viscosity Reference Standard	Cannon Instrument Company		
N140 Certified Viscosity Reference Standard	Cannon Instrument Company		

NOTE

Manufacturers' names are provided as examples. Equivalent products obtained from another source are acceptable.

NOTE

For HAZMAT items See Volume II WP HMWS for handling information.

Table 3. Protective Equipment

Description	Manufacturer	Part Number	NSN
Goggles, chemical splash	GSA	ANSIZ87.1989	4240-00-190-6432
Gloves, nitrile, medium	GSA		8415-01-492-0179
Gloves, nitrile, large	GSA		8415-01-492-0178
Gloves, nitrile, extra large	GSA		8415-01-492-0180
Lab Coat			

5. <u>Testing Evironment</u>. Avoid severe vibrations, direct sunlight and explosion hazards. Ambient air temperature range should be 5°C to 35°C (41°F to 95°F). Ambient relative humidity should be below 80% non-condensing. If these environmental conditions cannot be met, testing should be stopped and the facilities department contacted to have the lab environmental conditions restored within specifications.

6. <u>Procedure</u>.

NOTE

Verify accuracy of the instrument at the beginning of each day using the Certified Viscosity Standard(s). It is recommended that, if available, standards with viscosity close to that of oils that will be tested are used for the verification check. For example, use N35 for ISO 32 oil; N75 for ISO 68 oil, including 2190 TEP and 2190 S; N140 for diesel engine oils. Measure the viscosity of the standard by following steps 6.d. through 6.i. If the reading is within 1.0% of the standard value, accuracy check is considered satisfactory.

a. Turn on the instrument (rocker switch is located at the rear of the instrument).

b. Set the internal temperature control to the desired measuring temperature by clicking on the “SET” key twice, and then press “START”. Enter the temperature for the test and press “START”. Press the “ESC” key to return to the measuring window. Wait for the unit to reach the set temperature.

NOTE

Naval machinery fluids require viscosity values measured at 40.0°C or 100.0°C, as specified in the relevant documentation. Contact NSWCPD C/331 (NSWCPD_Lubricants@navy.mil) if measurement of viscosity at a different temperature is requested.

c. Ensure the measuring cells are clean and dry as described in section 7. As an option, wet the cells with the samples to be analyzed.

d. Load a minimum of 5 ml of the sample fluid into the syringe.

NOTE

Ensure that no visible particles are loaded into the syringe.

e. Attach filter to the syringe luer and to the inlet port of the viscometer.

f. Inject 3 ml of the test specimen. Leave the syringe in the inlet opening and start the measurement by pressing “START”. Wait for the instrument to indicate that the determination is valid and record the value.

g. Inject a further 2 ml of sample without taking off the syringe and repeat measurement.

h. If the deviation between two consecutive measurements exceeds 1.0%, repeat steps 5.d through 6.f. until the deviation is within these limits. Disregard all previously determined values. Record the average of the last two measurements as the result in LARA.

i. If the syringe is emptied before obtaining a valid result, repeat the procedure starting at step 6.d.

j. Other samples of the same fluid type can be measured by repeating steps 6.d. through 6.i. (without cleaning the instrument).

k. After the last sample of a given fluid type is tested, perform a cleaning as described in section 7.

l. To measure a sample viscosity at a different temperature, follow step 6.b.

NOTE

It is recommended to test all samples that require measurement at 40°C, then switch to 100°C for the remaining samples, if necessary.

m. Turn off instrument when all analysis is complete.

NOTE

Prior to turning off the instrument, ensure that the instrument has been cleaned according to Section 7.

7. Cleaning the instrument.

NOTE

Cleaning is required when switching between fluid types; or four repetitions of a sample did not yield results within 1.0% ; of after running the last sample of the day on the instrument

a. Push out the sample from the cells using the empty syringe.

b. Inject 5ml cleaning solvent into the instrument and press “START.” Allow the motor to run at measuring speed for approximately 10 seconds; press “START” again to stop the motor. Repeat this step 2 times.

c. Inject 5ml drying solvent into the instrument and press “START.” Allow the motor to run at measuring speed for approximately 10 seconds; press “START” again to stop the motor. This improves the cleaning action. Repeat this step 2 times.

d. If shop air is available, dry the cells using air. Attach an air hose to the connector on the filling adapter and press the “PUMP” key to start airflow. After 30 seconds, turn off the air by pressing the “PUMP” key again.

e. Cleanliness can be checked by pressing “START”. The density value shall read less than 0.0020g/ml. If the value exceeds this limit, repeat the cleaning procedure

8. Calibration.

a. The SVM3000 is calibrated by NAVY METCAL or by the equipment vendor on an annual basis.

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TYPE EQUIPMENT CODES

Table of Contents

Table #	Title	Page

NOTE

JOAP Type Equipment Codes (TEC's) are provided for use by Lab operators to assist in their identification of the appropriate Work Packages in Vol 3 or 4 to consult for oil analysis limits applicable to a specific component or lubricant. JOAP TEC's are unique to the JOAP and do not match Service unique maintenance TEC's.

Table 1 – Aeronautical Type Equipment Codes - Sorted by End Item

END ITEM	COMPONENT	JOAP TEC
5220	Hyd-PU	DXBA
05-7014-1200	Hyd-PU	DXBB
05-7008	Hyd-PU	DXBC
A/M32A-95	GTCP 85-180	DJBC
A-10	GTCP36-50	DCBA
A-10	TF34-GE-100	KDAA
A-37	J85-GE-17	ERFA
A-4	CSD	DSAA
A-4	J52-P-408	EECA
A-4	J52-P-6C	EEDA
A-4	J52-P-8B	EEBA
A-6	CSD	DSBA
A-6	J52-P-408 Gbx	EECB
A-6	J52-P-408 Tank	EECC
A-6	J52-P-8B	EEBB
AH-1E	42/Int Gbx	GAIE
AH-1E	Main Xmsn	GAME
AH-1E	90/Tail Gbx	GATE
AH-1G	42/Int Gbx	GAIG
AH-1G	90/Tail Gbx	GATC
AH-1G	Hyd Sys 1	HA1G
AH-1G	Hyd Sys 2	HA2G
AH-1G	Hyd Sys 3	HA31
AH-1G	Main Xmsn	GAMG
AH-1G	T53-L-13B	SBEA
AH-1S	42/Int Gbx	GAIS
AH-6C	90/Tail Gbx	GHTC
AH-6C	Hyd Sys	HHA1
AH-6C	Main Xmsn	GHMC

END ITEM	COMPONENT	JOAP TEC
AH-6C	T63-A720	SFCB
AH-6J	90/Tail Gbx	GHTJ
AH-6J	Hyd Sys	HHA2
AH-6J	Main Xmsn	GHMJ
AH-6N	90/Tail Gbx	GHTN
AH-6N	Hyd Sys	HHA3
AH-6N	Main Xmsn	GHMN
AH-64A	T700-GE-701	SHCB
AH-64A	Int Gbx	GMIA
AH-64A	Tail Gbx	GMTA
AH-64A	#1 Nose Gbx	GM1A
AH-64A	#2 Nose Gbx	GM2A
AH-64A	APU	DQAA
AH-64A	Hyd Sys 1	HM11
AH-64A	Hyd Sys 2	HM21
AH-64A	Main Xmsn	GMMA
AH-64A	PTO Clutch	GMPA
AH-64D	Hyd Sys	HMAD
AH-64D	Hyd Sys 2	HM22
AH-64D	PTO Clutch	GMPD
AH-64D	T700-GE-701	SHCA
AH-64D	APU	DQAD
Aircraft	Hydraulic Oil	HHYD
Aircraft	Synthetic Oil	ASYN
AV-8	F402-RR-402	FMAA
AV-8	F402-RR-404	FMCA
AV-8	ING DR GEN	DPAA
AV-8B	F402-RR-406	FMEA
AV-8B	F402-RR-408	FMFA
B-1	F101-GE-102	FBAA
B-111	TF30-P-107	KAEA
B-111	TF30-P-7	KABA
B-1B	GTCP165-9	DLBA
B-2	F118-GE-100	FKAA
B-52	J57-P-19	EFGA

END ITEM	COMPONENT	JOAP TEC
B-52	J57-P-43	KFCA
B-52	TF33-P-103	KCGA
B-52	TF33-P-3	KCAA
BE-65	IO-720-A1B	RHBA
BIO-RAD	FT-IR	AIRA
C-10	FI 03-G E- 101	FDBA
C-12	PT5A-41	SPHA
C-12	PT6A-27	SPCC
C-12	PT6A-34	SPFA
C-12	PT6A-38	SPGA
C-12	PT6A-42	SPJA
C-12C	PT6A-41	SPHB
C-12D	PT6A-41	SPHC
C-12J	PT6A-65B	SPPA
C-12U	PT6A-42	SPJC
C-130	GTCP85-180	DJBA
C-130	GTC85-71	DGEA
C-130	Nose Gear	GTNK
C-130	T56-A-15	SDFA
C-130	T56-A-15 Gbx	GTMF
C-130	T56-A7	SDAA
C-130	T56-A-9	SDCA
C-130	T56-A-9 Gbx	GTMC
C-135	F108-CF-100	FFAA
C-135	GTC70-15	DFAA
C-135	J57-P-43	EFCB
C-135	J57-P-59	EFDA
C-135	T41 M-9	DAAA
C-135	TF33-P-5	KCBA
C-135	TF33-P-9	KCDA
C-135	TF33-PW-102	KCFA
C-135	TF33-PW-102/JT3D–3B	KCFC
C-137	GTCP 85-97	DJDA
C-137	GTCP85-98	DJEA
C-137	JT-3D-3	KJAA

END ITEM	COMPONENT	JOAP TEC
C-137	TF33-PW-102/JT3D-3B	KGBA
C-140	J60-P-5	EHCA
C-141	GTCP85-106	DJAA
C-141	TF33-P-7	KCCA
C-17	F117-PW-100	FLAA
C-18	TF33-PW-102	KCFB
C-2	GTCP36-201C	DCAA
C-20	F113-RR-100	FJAA
C-20	GTCP36-100	DCCA
C-21	TFE731-2	KMAA
C-22	JT-8D-7	KKAA
C-23	PT6A-45	SPKA
C-23C	PT6A-65AR	SPRA
C-27	CTCP36-16A	DCGA
C-27	T64-P4D	SPLA
C-5	GTCP165-1	DLAA
C-5	TF39-GE-1	KGAA
C-6	PT6A-20	SPAA
C-9	JT-8D-9	KKBA
C-9	JT-8D-9	KKBB
CH-47A	Hdy Sys 3	HE3A
CH-47A	Hyd Sys 1	HE1A
CH-47A	Hyd Sys 2	HE2A
CH-47A	T55-L-7C	SCBA
CH-47A	Fwd Xmsn	GEFA
CH-47A	Aft Xmsn	GEAA
CH-47A	Eng Comb Xmsn	GEEA
CH-47A	1eng Mec Zmsn	GEGA
CH-47A	2eng Mec Xmsn	GEHA
CH-47B	Hdy Sys 3	HE3B
CH-47B	Hyd Sys 1	HE1B
CH-47B	Hyd Sys 2	HE2B
CH-47C	Hyd Sys 1	HE1C
CH-47C	Hyd Sys 2	HE2C
CH-47C	Hyd Sys 3	HE3C

END ITEM	COMPONENT	JOAP TEC
CH-47C	T55-L-712	SCDA
CH-47D	1 EngMecXmsn	GEGD
CH-47D	APU	DQAF
CH-47D	2 EngMecXmsn	GEHD
CH-47D	Aft Xmsn	GEAD
CH-47D	Engcombxmsn	GEED
CH-47D	Fwdxmsn	GEFD
CH-47D	Hyd Sys 1	HE1D
CH-47D	Hyd Sys 2	HE2D
CH-47D	Hyd Sys 3	HE3D
CH-47D	T55-GA-714A	SCFA
CH-47D	T55-L-712	SCDB
CH-47D	T55-L-714	SCED
CH-47F	Aft Xmsn	GEAF
CH-47F	Fwd Xmsn	GEFF
CH-47F	APU	DQAG
CH-47F	1 Eng Mec Xmsn	GEGF
CH-47F	2 Eng Mec Xmsn	GEHF
CH-47F	Eng Comb Xmsn	GEEF
CH-47F	Hyd Sys 1	HE1F
CH-47F	Hyd Sys 2	HE2F
CH-47F	Hyd Sys 3	HE3F
CH-47F	T55-L-712	SCDD
CH-47F	T55-L-714	SCEE
CH-47FS	Hyd Pump	HEAD
CH-54	T73-P-1	SSAA
CH-54A	Hyd Sys 1	HG1A
CH-54A	Hyd Sys 2	HG2A
CH-54A	Hyd Sys 3	HG3A
CH-54B	Hyd Sys 1	HG1B
CH-54B	Hyd Sys 2	HG2B
CH-54B	Hyd Sys 3	HG3B
Cruise Missile	F107-WR-402	KEAA
Cruise Missile	F112-WR-100	KEBA

END ITEM	COMPONENT	JOAP TEC
CMV-22	Emer Lube Res	DVAS
CMV-22	Mid-Wing Gbx	GVBS
CMV-22	Prop Rotor Gbx	GVDS
CMV-22	Tilt Axis Gbx	GVJS
CMV-22	AE1107C Engine	T1BC
CV-22	Emer Lube Res	DVAC
CV-22	Mid-Wing Gbx	GVBC
CV-22	Prop Rotor Gbx	GVDC
CV-22	T406-AD-400	SWAA
CV-22	Tilt Axis Gbx	GVJC
CV-22	AE1107C Engine	T1BB
E-3	GTCP165-1	DLAB
E-3	TF33-PW-100	KCEA
E-4	CSD	DSFA
E-4	JT-9D-7	KNAA
E-4B	GTCP660-4	DMAA
E-6A	CFM56-2A-2	FFAB
E-6A	GTCP165-1	DLAC
E-8	TF33-PW-102/JT3D-3B	KCFD
EA-6B	CSD	DSBB
EH-60A	APU	DXAC
EH-60A	42/INT GBX	GLID
EH-60A	90/Tail Gbx	GLTD
EH-60A	Main Xmsn	GLMM
EH-60A	Main Xmsn (3u)	GLMC
EH-60A	T62T-40-1	DBEB
EH-60A	T700-GE-701	SHCJ
EH-60L	APU	DQAB
EH-60L	Main Xmsn	GLML
EH-60L	T700-GE-701	SHCK
EH-60L	Int Gbx	GLIJ
EH-60L	Tgb	GLTJ
EMU-30	T62T-32	DBDA
EMU-36	T62T-32	DBDB
EO-5B	PT6A-50	SPNB

END ITEM	COMPONENT	JOAP TEC
F-111	CSD	DSGA
F-111	TF30-P-100	KAJA
F-111	TF30-P-103	KADA
F-111	TF30-P-109	KAFA
F-111	TF30-P-3	KAAA
F-111	TF30-P-9	KACA
F-14	CSD	DSEA
F-14	F110-GE-400	FHBA
F-14A	TF30-P-414A	KAHA
F-15	F100-PW-100	FAAA
F-15	F100-PW-220	FACA
F-15	F100-PW-229	FADA
F-15	F110-GE-129	FAAM
F-16	F100-B	FAEA
F-16	F100-PW-200	FABA
F-16	F100-PW-220	FACB
F-16	F100-PW-229	FADB
F-16	F110-GE-100	FHAA
F-16	F110-GE-100B	FHDA
F-16	F110-GE-129	FHCA
F-16	T62T40-8	DBFA
F-16N	F110-GE-100	FHAB
F-18	F404-GE-400	PPAA
F-18	GTCP36-200	DCDA
F-21	J79-JIE	EPFA
F-22	F119-PW-100A	FRAA
F-22	F119-PW-614C	FRCA
F-22	F119-PW-611C	FRBA
F-35	F135-PW-100	FSAA
F-35	F235-PW-600	FSAB
F-35	F135-PW-400	FSAC
F-35	RR-Lift System	FSAD
F-4	J79-GE-10	EPCA
F-4	J79-GE-15	EPDA
F-4	J79-GE-17	EPEA

END ITEM	COMPONENT	JOAP TEC
F-4	J79-GE-8	EPAA
F-5	J85-GE-13	EREA
F-5	J85-GE-21	ERGA
G-159	MK-529-8X	SQAA
GSE	GTC 85-16	DGBA
GSE	GTC 85-116	DGJA
GSE	GTC 85-180L	DGHA
GSE	GTC 85-56	DGCA
GSE	GTC 85-72	DGFA
GSE	GTC 85-76	DGGA
H-1	42/Int Gbx	GAIA
H-1	90/Tail Gbx	GATA
H-1	Main Xmsn	GAMA
H-1	T400-CP-400	SRAA
H-1	T400-WV-402	SRCA
H-1	T53-L-11-D	SBCD
H-1	T53-L-13	SBDA
H-1	T58-GE-3	SEAA
H-2	42/Int Gbx	GBIA
H-2	90/Tail Gbx	GBTA
H-2	Main Xmsn	GBMA
H-2	T58-GE-8F	SEDA
H-3	42/Int Gbx	GCIA
H-3	90/Tail Gbx	GCTA
H-3	Main Xmsn	GCMA
H-3	T58-GE-10	SEEA
H-3	T58-GE-402	SEJA
H-3	T58-GE-5	SEBA
H-3	T58-GE-8F	SEDB
H-3	T62T-16	DBBB
H-46	T58-GE-402	SEJB
H-46	Aft Xmsn	GDAA
H-46	Fwd Xmsn	GDFA
H-46	T58-GE-10	SEEB
H-46	T58-GE-16	SEFA

END ITEM	COMPONENT	JOAP TEC
H-46	T62T-I 1	DBAA
H-52	42/Int Gbx	GRIA
H-52	90/Tail Gbx	GRTA
H-52	Main Xmsn	GRMA
H-52	T58-GE-8	SECA
H-53	#1 Nose Gbx	GF1A
H-53	#2 Nose Gbx	GF2A
H-53	42/Int Gbx	GFIA
H-53	90/Tail Gbx	GFTA
H-53	Acesory Gbx	GFCA
H-53	Main Xmsn	GFMA
H-53	T62T-27	DBCA
H-53	T64-GE-100	SGGA
H-53	T64-GE-413	SGFA
H-53	T64-GE-6B	SGBA
H-53	T64-GE-7	SGCA
H-53D	T64-GE-415	SGDA
H-53E	T64-GE-416	SGEA
H-53E	#1 Nose Gbx	GF1E
H-53E	#2 Nose Gbx	GF2E
H-53E	Acessory Gbx	GFCE
H-53E	Main Xmsn	GFME
H-53E	90/TAIL GBX	GFTE
H-60	T400-GE-401	SRBB
H-60	T700-GE-700	SHBA
HH-1H	42/Int Gbx	GAID
HH-1H	90/Tail Gbx	GATID
HH-1H	Main Xmsn	GAMD
HH-60A	T700-GE-701	SHCI
HH-60A	APU	DXAD
HH-60A	T62T-40-1	DBEH
HH-60A	Int Gbx	GLIL
HH-60A	Main Xmsn	GLMP
HH-60A	MAIN XMSN-3u	GLMS
HH-60A	Tail Gbx	GLTL

END ITEM	COMPONENT	JOAP TEC
HH-60A	Hyd Sys 1	HL1E
HH-60A	Hyd Sys 2	HL2E
HH-60A	Hyd Sys 3	HL3E
HH-60J	Int Gbx	GLIK
HH-60J	Tail Gbx	GLTK
HH-60L	GRCP36-15BH	DCHB
HH-60L	Hyd Sys 1	HL1D
HH-60L	Hyd Sys 2	HL2D
HH-60L	Int Gbx	GLII
HH-60L	Main Xmsn	GLMI
HH-60L	T62T-40-1	DBEG
HH-60L	Tail Gbx	GLTI
HH-60L	T700-GE-701	SHCL
HH-65	90/Tail Gbx	GPTA
HH-65	LTS-101-750	STAA
HH-65	Main Xrnsn	GPMA
HM-60L	Main Xmsn	GLMJ
HU-25	CSD	DSJA
HU-25	Hyd Sys 1	HT1A
HU-25	Hyd Sys 2	HT2A
KC-135	T62T-40LC	DBGA
M32A-60	GTCP 85-180	DJBB
M32A-60	GTCP 85-397	DJCA
MA-1	GTC 85-70	DGDA
MH-47D	1eng Mec Xmsn	GEGG
MH-47D	2eng Mec Xmsn	GEHG
MH-47D	Aft SP	GESG
MH-47D	Eng Comb Xmsn	GEEG
MH-47D	Fwdsp	GERG
MH-47D	Hyd Sys 1	HE1G
MH-47D	Hyd Sys 2	HE2G
MH-47D	Hyd Sys 3	HE3G
MH-47D	T55-L-712	SCDE
MH-47D	Aft Xmsn	GEAG
MH-47D	Fwd Xmsn	GEFG

END ITEM	COMPONENT	JOAP TEC
MH-47D	T55-L-714	SCEG
MH-47E	1EngMecXmsn	GEGE
MH-47E	2EngMecXmsn	GEHE3
MH-47E	Aft Xmsn	GEAF
MH-47E	Eng CombXmsn	GEEE
MH-47E	Fwd Xmsn	GEFE
MH-47E	Hyd Sys 1	HE1E
MH-47E	Hyd Sys 2	HE2E
MH-47E	Hyd Sys 3	HE3E
MH-47E	T55-GA-714A	SCFB
MH-47E	T55-L-714	SCDC
MH-47E	Aft Xmsn	GEAE
MH-47E	Fwd Swplte Brg	GERA
MH-47E	Aft Swplte Brg	GESA
MH-47E	APU	DXAF
MH-47G	Fwd Swplte Brg	GERH
MH-47G	Aft Swplte Brg	GESH
MH-47G	APU	DXAG
MH-47G	Aft Xmsn	GEAH
MH-47G	Fwd Xmsn	GEFH
MH-47G	Comb Xmsn	GEEH
MH-47G	Eng Mec Xmsn 1	GEGH
MH-47G	Eng Mec Xmsn 2	GEHH
MH-47G	Hyd Sys 1	HE1H
MH-47G	Hyd Sys 2	HE2H
MH-47G	Hyd Sys 3	HE3H
MH-47G	T55-L-714	SCEH
MH-53E	T64-GE-419	SGHA
MH-6C	90/Tail Gbx	GHTD
MH-6C	Hyd Sys	HHAD
MH-6C	Main Xmsn	GHMD
MH-6C	T63-A-720	SFCH
MH-6H	90/Tail Gbx	GHTH
MH-6H	HYD SYS	HHA4
MH-6H	Main Xmsn	GHMH

END ITEM	COMPONENT	JOAP TEC
MH-6J	90/TailGbx	GHTK
MH-6J	Hyd Sys	HHA5
MH-6J	Main Xmsn	GHMK
MH-6M	250-C-30-R3	SVBA
MH-6M	Main Xmsn	GHMM
MH-6M	90/Tail Gbx	GHTM
MH-6M	Hyd Sys	HHA8
MH-6N	90/TailGbx	GHTP
MH-6N	Hyd Sys	HHA6
MH-6N	Main Xmsn	GHMP
MH-60K	Hyd Sys 1	HL1F
MH-60K	Hyd Sys 2	HL2F
MH-60K	Hyd Sys 3	HL3F
MH-60K	T700-GE-701	SHCF
MH-60L	T700-GE-701	SHCG
MH-60L	GTCP36-150H	DCHA
MH-60L	Hyd Sys 1	HL1B
MH-60L	Hyd Sys 2	HL2B
MH-60L	Hyd Sys 3	HL3B
MH-60L	Int Gbx	GLIG
MH-60L	Main Xmsn	GLMG
MH-60L	T62T-40-1	DBED
MH-60L	Tail Gbx	GLTG
MH-60L	APU	DXAE
MH-60M	APU	DQAE
MH-60M	Int Gbx	GLIR
MH-60M	Main Xmsn	GLMR
MH-60M	Tail Gbx	GLTR
MH-60M	T700-GE-701	SHCH
MH-60R	Int Gbx	GLIF
MH-60R	Main Xmsn	GLMF
MH-60R	Tail Gbx	GLTF
MH-60S	Int Gbx	GLIE
MH-60S	Main Xmsn	GLME
MH-60S	Tail Gbx	GLTE

END ITEM	COMPONENT	JOAP TEC
MQ-5B	Heavy Fuel Engine	RPAA
MQ-5B	Heavy Fuel Engine	RPAB
MQ-8B	RR250-C20W	RQAA
MQ-8B	Gearbox	RQAB
Multiple	GTCP36-50H	DCJX
MV-22	Emer Lube Res	DVAM
MV-22	Mid-Wing Gbx	GVBM
MV-22	Prop Rotor Gbx	GVDM
MV-22	Tilt Axis Gbx	GVJM
MV-22	AE1107C Engine	T1BA
O-2	IO-360	RBAA
O-5A	PT6A-50	SPNA
OH-58A	90/Tail Gbx	GKTA
OH-58A	Hyd Sys	HKAA
OH-58A	Main Xrnsn	GKMA
OH-58A	T63-A 700	SFBA
OH-58A	T63-A-720	SFCG
OH-58C	Main Xmsn	GKMC
OH-58C	T63-A-720	SFCF
OH-58C	90/TAIL GBX	GKTC
OH-58C	Hyd Sys	HKAC
OH-58D	Main Xmsn	GKMD
OH-58D	Tail Gbx	GKTD
OH-58D	T63-A-730	SFDA
OH-6A	Hyd Sys	HHA7
OH-6A	T63-A-700	SFBB
OH-6A	Main Xmsn	GHMA
OH-6A	90/TAIL GBX	GHTA
Oil Cart	PON-6	DRAA
Oil-Lube	MIL-H-5606	A007
Oil-Lube	MIL-H-83282	A006
Oil-Lube	MIL-L-23699	A001
Oil-Lube	MIL-L-7808	A003
Oil-Lube	MIL-L-85734	A005
Oil-Lube	MIL-PRF23699	A002

END ITEM	COMPONENT	JOAP TEC
Oil-Lube	MIL-PRF85734	A004
OV-10	T76-G-10	SMAA
OV-10	T76-G-12	SMBA
OV-10	T76-G-418	SMCA
OV-10	T76-G-419	SMDA
OV-10	T76-G-420	SMEA
OV-10	T76-G-421	SMFA
P-3	GTCP 95-2	DKAA
Predator	TPE331-10	SJAA
QF-86F	J47-GE-27	ECAA
RC-12D	PT6A-41	SPHD
RC-12G	PT6A-41	SPHE
RC-12K	PT6A-67	SPMA
RC-12P	PT6A-41	SPHG
RC-12Q	PT6A-41	SPHH
RQ-5A	Main Gbx	GNMA
RQ-5A	V-75	RNAA
RU-9D	O-480-B1A6	RDEA
S-3	GTCP36-201A	DCAB
S-3	TF34-GE-400B	KDBA
SH-2G	#1 Nose Gbx	GB1G
SH-2G	#2 Nose Gbx	GB2G
SH-2G	42/Int Gbx	GBIG
SH-2G	90/Tail Gbx	GBTG
SH-2G	Acesory Gbx	GBCG
SH-2G	Main Xmsn	GBMG
SH-60B	42/Int Gbx	GLIB
SH-60B	90/Tail Gbx	GLTB
SH-60B	Main Xmsn	GLMB
SH-60F	Main GBX	GQMB
SH-60F	Tail GBX	GQTB
SH-60F	Int GBX	GQIB
T-1A	JT15D-5B	KPAA
T-2	J85-GE-4	ERBA
T-2C	J85-GE-4A	ERCA

END ITEM	COMPONENT	JOAP TEC
T-34	PT6A-42	SPJB
T-34B	O-470	RCAA
T-34C	Brake Sys	HNBC
T-34C	PT6A-25	SPBA
T-37	J69-T-25	EKAA
T-38	J85-GE-5	ERDA
T-39	J60-P-3	EHAA
T-39	J60-P-3A	EHBA
T-39	JT-12A-8	KLAA
T-41	IO-360	RBAB
T-41	O-300D	RLAA
T-41B	IO-360-D	RBCA
T-41C	IO-360-C	RBBA
T-41C	IO-360-D	RBCB
T-41D	IO-360-D	RBCC
T-43	JT-8D-9	KKBC
T-44A	PT6A-34B	SPFB
T-45A	F405-RR-400	FQAA
T-46	F109-GA-100	FGAA
T-6A	PT6A-68	SPQA
Test Cell	GTCP 95-3	DKBA
Test Cell	T56-A-10	SDDX
Test Cell	T56-A-14	SDEX
Test Cell	T56-A-16	SDGX
Test Cell	T56-A-425	SDHX
Test Cell	T56-A-426	SDJX
Test Cell	T56-A-7B	SDBX
Test Cell	T62T-16	DBBA
Test Cell	T700-GE-401	SHAX
TG-7	O-235	RAAA
TH-1G	Hyd Sys 3	HA32
TH-57B	90/Tail Gbx	GSTB
TH-57B	Main Xmsn	GSMB
TH-57B	T63-A-720	SFCA
TH-67	250-C-30	SVAA

END ITEM	COMPONENT	JOAP TEC
TH-67	90/TAIL GBX	GUTA
TH-67	Hyd Sys	HUAA
TH-67	Main Xmsn	GUMA
U-10	GO-480-G1D6	RDHA
U-2	J57-P-31	EFBA
U-2	J75-P-17	EMAB
U-21F	PT6A-28	SPDA
U-21G	T74-CP-700	SUAF
U-2S	F118-GE-101	EMAC
UH-1B	42/Int Gbx	GAIB
UH-1B	90/Tail Gbx	GATB
UH-1B	Hyd Sys	HAAB
UH-1B	Main Xmsn	GAMB
UH-1B	T53-L-11	SBCA
UH-1C	42/Int Gbx	GAIC
UH-1C	90/Tail Gbx	GATC
UH-1C	Hyd Sys	HAAC
UH-1C	Main Xmsn	GAMC
UH-1C	T53-L-11	SBCB
UH-1FS	Hyd Pump	HAA1
UH-1H	42/Int Gbx	GAIH
UH-1H	90/Tail Gbx	GATH
UH-1H	Hyd Sys	HAAH
UH-1H	Main Xmsn	GAMH
UH-1H	T53-L-13B	SBEE
UH-1M	42/Int Gbx	GAIM
UH-1M	90/Tail Gbx	GATM
UH-1M	Hyd Sys 1	HA1M
UH-1M	Hyd Sys 2	HA2M
UH-1M	Main Xmsn	GAMM
UH-1M	T53-L-13B	SBEF
UH-1N	42/Int Gbx	GAIN
UH-1N	90/Tail Gbx	GATN
UH-1N	Eng Comb Gbx	GAEN
UH-1N	Hyd Sys	HAA4

END ITEM	COMPONENT	JOAP TEC
UH-1N	Main Xmsn	GAMN
UH-1N	T400-CP-400	SRAB
UH-1V	42/Int Gbx	GAIV
UH-1V	90/Tail Gbx	GATN
UH-1V	Hyd Sys	HAAV
UH-1V	Main Xmsn	GAMV
UH-1V	T53-L-11	SBCC
UH-1V	T53-L-13B	SBEG
UH-1X	42/Int Gbx	GAIX
UH-1X	90/Tail Gbx	GATX
UH-1X	Hyd Sys	HAAX
UH-1X	Main Xmsn	GAMX
UH-60	Hyd-Pump	HLPA
UH-60A	T700-GE-701	SHCC
UH-60A	90/Tail Gbx	GLTI
UH-60A	Main Xmsn	GLMK
UH-60A	Main Xmsn (3u)	GLMA
UH-60A	T62T-40-1	DBEA
UH-60A	Int Gbx	GLIA
UH-60A	90/Tail Gbx	GLTA
UH-60A	APU	DXAA
UH-60FS	Hyd Pump	HLAA
UH-60L	T700-GE-701	SHCD
UH-60L	GTC36-150	DCEA
UH-60L	42/Int Gbx	GLIC
UH-60L	Hyd Sys 1	HL12
UH-60L	T62T-40-1	DBEC
UH-60L	T700-GE-701C	SHDA
UH-60L	Main Xmsn	GLMD
UH-60L	Main Gbx	GLMD
UH-60L	90/Tail Gbx	GLTC
UH-60L	APU	DXAB
UH-60L	Hyd Sys	GLTC
UH-60M	APU	DQAC
UH-60M	Int Gbx	GLIM

END ITEM	COMPONENT	JOAP TEC
UH-60M	Main Xmsn	GLMQ
UH-60M	Tail Gbx	GLTM
UH-60M	T700-GE-701	SHCE
UH-60Q	Hyd Sys 1	HL1C
UH-60Q	Hyd Sys 2	HL2C
UH-60Q	Hyd Sys 3	HL3C
UH-60Q	Main Xmsn (3u)	GLMH
UH-60Q	Tail Gbx	GLTH
UV-18	PT6A-27	SPCA
UV-18A	PT6A-27	SPCB
VC-140	GTCP 30-92	DNAA

END ITEM	COMPONENT	JOAP TEC
VH-3D	42/Int Gbx	GCID
VH-3D	90/Tail Gbx	GCTD
VH-3D	Hyd Sys	HCA1
VH-3D	Main Xmsn	GCMD
VH-3D	T58-GE-400	SEGA
VH-3D	T58-GE-400B	SEHA
VH-60N	Main Xmsn	GLMT
VH-60N	Int Gbx	GLTT
VH-60N	Tail Gbx	GLIT

Table 2 – Aeronautical Type Equipment Codes - Sorted by TEC

END ITEM	COMPONENT	JOAP TEC
Oil-Lube	MIL-L-23699	A001
Oil-Lube	MIL-PRF23699	A002
Oil-Lube	MIL-L-7808	A003
Oil-Lube	MIL-PRF85734	A004
Oil-Lube	MIL-L-85734	A005
Oil-Lube	MIL-H-83282	A006
Oil-Lube	MIL-H-5606	A007
BIO-RAD	FT-IR	AIRA
Aircraft	Synthetic Oil	ASYN
C-135	T41 M-9	DAAA
H-46	T62T-l 1	DBAA
Test Cell	T62T-16	DBBA
H-3	T62T-16	DBBB
H-53	T62T-27	DBCA
EMU-30	T62T-32	DBDA
EMU-36	T62T-32	DBDB
UH-60A	T62T-40-1	DBEA
EH-60A	T62T-40-1	DBEB
UH-60L	T62T-40-1	DBEC
MH-60L	T62T-40-1	DBED
HH-60L	T62T-40-1	DBEG
HH-60A	T62T-40-1	DBEH
F-16	T62T40-8	DBFA
KC-135	T62T-40LC	DBGA
C-2	GTCP36-201C	DCAA
S-3	GTCP36-201A	DCAB
A-10	GTCP36-50	DCBA
C-20	GTCP36-100	DCCA
F-18	GTCP36-200	DCDA
UH-60L	GTC36-150	DCEA
C-27	CTCP36-16A	DCGA
MH-60L	GTCP36-150H	DCHA
HH-60L	GRCP36-15BH	DCHB
Multiple	GTCP36-50H	DCJX
C-135	GTC70-15	DFAA
GSE	GTC 85-16	DGBA
GSE	GTC 85-56	DGCA
MA-1	GTC 85-70	DGDA
C-130	GTC85-71	DGEA
GSE	GTC 85-72	DGFA
GSE	GTC 85-76	DGGA
GSE	GTC 85-180L	DGHA
GSE	GTC 85-116	DGJA
C-141	GTCP85-106	DJAA
C-130	GTCP85-180	DJBA
M32A-60	GTCP 85-180	DJBB
A/M32A-95	GTCP 85-180	DJBC
M32A-60	GTCP 85-397	DJCA
C-137	GTCP 85-97	DJDA
C-137	GTCP85-98	DJEA
P-3	GTCP 95-2	DKAA
Test Cell	GTCP 95-3	DKBA
C-5	GTCP165-1	DLAA
E-3	GTCP165-1	DLAB
E-6A	GTCP165-1	DLAC
B-1B	GTCP165-9	DLBA
E-4B	GTCP660-4	DMAA
VC-140	GTCP 30-92	DNAA
AV-8	ING DR GEN	DPAA
AH-64A	APU	DQAA
EH-60L	APU	DQAB
UH-60M	APU	DQAC
AH-64D	APU	DQAD
MH-60M	APU	DQAE
CH-47D	APU	DQAF
CH-47F	APU	DQAG

END ITEM	COMPONENT	JOAP TEC
Oil Cart	PON-6	DRAA
A-4	CSD	DSAA
A-6	CSD	DSBA
EA-6B	CSD	DSBB
F-14	CSD	DSEA
E-4	CSD	DSFA
F-111	CSD	DSGA
HU-25	CSD	DSJA
CV-22	Emer Lube Res	DVAC
CMV-22	Emer Lube Res	DVAS
MV-22	Emer Lube Res	DVAM
UH-60A	APU	DXAA
UH-60L	APU	DXAB
EH-60A	APU	DXAC
HH-60A	APU	DXAD
MH-60L	APU	DXAE
MH-47E	APU	DXAF
MH-47G	APU	DXAG
5220	Hyd-PU	DXBA
05-7014-1200	Hyd-PU	DXBB
05-7008	Hyd-PU	DXBC
QF-86F	J47-GE-27	ECAA
A-4	J52-P-8B	EEBA
A-6	J52-P-8B	EEBB
A-4	J52-P-408	EECA
A-6	J52-P-408 Gbx	EECB
A-6	J52-P-408 Tank	EECC
A-4	J52-P-6C	EEDA
U-2	J57-P-31	EFBA
C-135	J57-P-43	EFCB
C-135	J57-P-59	EFDA
B-52	J57-P-19	EFGA
T-39	J60-P-3	EHAA
T-39	J60-P-3A	EHBA

END ITEM	COMPONENT	JOAP TEC
C-140	J60-P-5	EHCA
T-37	J69-T-25	EKAA
U-2	J75-P-17	EMAB
U-2S	F118-GE-101	EMAC
F-4	J79-GE-8	EPAA
F-4	J79-GE-10	EPCA
F-4	J79-GE-15	EPDA
F-4	J79-GE-17	EPEA
F-21	J79-JIE	EPFA
T-2	J85-GE-4	ERBA
T-2C	J85-GE-4A	ERCA
T-38	J85-GE-5	ERDA
F-5	J85-GE-13	EREA
A-37	J85-GE-17	ERFA
F-5	J85-GE-21	ERGA
F-15	F100-PW-100	FAAA
F-15	F110-GE-129	FAAM
F-16	F100-PW-200	FABA
F-15	F100-PW-220	FACA
F-16	F100-PW-220	FACB
F-15	F100-PW-229	FADA
F-16	F100-PW-229	FADB
F-16	F100-B	FAEA
B-1	F101-GE-102	FBAA
C-10	FI 03-G E- 101	FDBA
C-135	F108-CF-100	FFAA
E-6A	CFM56-2A-2	FFAB
T-46	F109-GA-100	FGAA
F-16	F110-GE-100	FHAA
F-16N	F110-GE-100	FHAB
F-14	F110-GE-400	FHBA
F-16	F110-GE-129	FHCA
F-16	F110-GE-100B	FHDA
C-20	F113-RR-100	FJAA
B-2	F118-GE-100	FKAA

END ITEM	COMPONENT	JOAP TEC
C-17	F117-PW-100	FLAA
AV-8	F402-RR-402	FMAA
AV-8	F402-RR-404	FMCA
AV-8B	F402-RR-406	FMEA
AV-8B	F402-RR-408	FMFA
T-45A	F405-RR-400	FQAA
F-22	F119-PW-100A	FRAA
F-22	F119-PW-611C	FRBA
F-22	F119-PW-614C	FRCA
F-35	F135-PW-100	FSAA
F-35	F235-PW-600	FSAB
F-35	F135-PW-400	FSAC
F-35	RR Lift System	FSAD
UH-1N	Eng Comb Gbx	GAEN
H-1	42/Int Gbx	GAIA
UH-1B	42/Int Gbx	GAIB
UH-1C	42/Int Gbx	GAIC
HH-1H	42/Int Gbx	GAID
AH-1E	42/Int Gbx	GAIE
AH-1G	42/Int Gbx	GAIG
UH-1H	42/Int Gbx	GAIH
UH-1M	42/Int Gbx	GAIM
UH-1N	42/Int Gbx	GAIN
AH-1S	42/Int Gbx	GAIS
UH-1V	42/Int Gbx	GAIV
UH-1X	42/Int Gbx	GAIX
H-1	Main Xmsn	GAMA
UH-1B	Main Xmsn	GAMB
UH-1C	Main Xmsn	GAMC
HH-1H	Main Xmsn	GAMD
AH-1E	Main Xmsn	GAME
AH-1G	Main Xmsn	GAMG
UH-1H	Main Xmsn	GAMH
UH-1M	Main Xmsn	GAMM
UH-1N	Main Xmsn	GAMN

END ITEM	COMPONENT	JOAP TEC
UH-1V	Main Xmsn	GAMV
UH-1X	Main Xmsn	GAMX
H-1	90/Tail Gbx	GATA
UH-1B	90/Tail Gbx	GATB
AH-1G	90/Tail Gbx	GATC
UH-1C	90/Tail Gbx	GATC
AH-1E	90/Tail Gbx	GATE
UH-1H	90/Tail Gbx	GATH
HH-1H	90/Tail Gbx	GATID
UH-1M	90/Tail Gbx	GATM
UH-1N	90/Tail Gbx	GATN
UH-1V	90/Tail Gbx	GATN
UH-1X	90/Tail Gbx	GATX
SH-2G	#1 Nose Gbx	GB1G
SH-2G	#2 Nose Gbx	GB2G
SH-2G	Acesory Gbx	GBCG
H-2	42/Int Gbx	GBIA
SH-2G	42/Int Gbx	GBIG
H-2	Main Xmsn	GBMA
SH-2G	Main Xmsn	GBMG
H-2	90/Tail Gbx	GBTA
SH-2G	90/Tail Gbx	GBTG
H-3	42/Int Gbx	GCIA
VH-3D	42/Int Gbx	GCID
H-3	Main Xmsn	GCMA
VH-3D	Main Xmsn	GCMD
H-3	90/Tail Gbx	GCTA
VH-3D	90/Tail Gbx	GCTD
H-46	Aft Xmsn	GDAA
H-46	Fwd Xmsn	GDFA
CH-47A	Aft Xmsn	GEAA
CH-47D	Aft Xmsn	GEAD
MH-47E	Aft Xmsn	GEAE
CH-47F	Aft Xmsn	GEAF
MH-47E	Aft Xmsn	GEAF

END ITEM	COMPONENT	JOAP TEC
MH-47D	Aft Xmsn	GEAG
MH-47G	Aft Xmsn	GEAH
CH-47A	Eng Comb Xmsn	GEEA
CH-47D	Engcombxmsn	GEED
MH-47E	Eng CombXmsn	GEEE
CH-47F	Eng Comb Xmsn	GEEF
MH-47D	Eng Comb Xmsn	GEEG
MH-47G	Comb Xmsn	GEEH
CH-47A	Fwd Xmsn	GEFA
CH-47D	Fwdxmsn	GEFD
MH-47E	Fwd Xmsn	GEFE
CH-47F	Fwd Xmsn	GEFF
MH-47D	Fwd Xmsn	GEFG
MH-47G	Fwd Xmsn	GEFH
CH-47A	1eng Mec Zmsn	GEGA
CH-47D	1 EngMecXmsn	GEGD
MH-47E	1EngMecXmsn	GEGE
CH-47F	1 Eng Mec Xmsn	GEGF
MH-47D	1eng Mec Xmsn	GEGG
MH-47G	Eng Mec Xmsn 1	GEGH
CH-47A	2eng Mec Xmsn	GEHA
CH-47D	2 EngMecXmsn	GEHD
MH-47E	2EngMecXmsn	GEHE3
CH-47F	2 Eng Mec Xmsn	GEHF
MH-47D	2eng Mec Xmsn	GEHG
MH-47G	Eng Mec Xmsn 2	GEHH
MH-47E	Fwd Swplte Brg	GERA
MH-47D	Fwdsp	GERG
MH-47G	Fwd Swplte Brg	GERH
MH-47E	Aft Swplte Brg	GESA
MH-47D	Aft SP	GESG
MH-47G	Aft Swplte Brg	GESH
H-53	#1 Nose Gbx	GF1A
H-53E	#1 Nose Gbx	GF1E
H-53	#2 Nose Gbx	GF2A

END ITEM	COMPONENT	JOAP TEC
H-53E	#2 Nose Gbx	GF2E
H-53	Acesory Gbx	GFCA
H-53E	Acessory Gbx	GFCE
H-53	42/Int Gbx	GFIA
H-53	Main Xmsn	GFMA
H-53E	Main Xmsn	GFME
H-53	90/Tail Gbx	GFTA
H-53E	90/TAIL GBX	GFTE
OH-6A	Main Xmsn	GHMA
AH-6C	Main Xmsn	GHMC
MH-6C	Main Xmsn	GHMD
MH-6H	Main Xmsn	GHMH
AH-6J	Main Xmsn	GHMJ
MH-6J	Main Xmsn	GHMK
MH-6M	Main Xmsn	GHMM
AH-6N	Main Xmsn	GHMN
MH-6N	Main Xmsn	GHMP
OH-6A	90/TAIL GBX	GHTA
AH-6C	90/Tail Gbx	GHTC
MH-6C	90/Tail Gbx	GHTD
MH-6H	90/Tail Gbx	GHTH
AH-6J	90/Tail Gbx	GHTJ
MH-6J	90/TailGbx	GHTK
MH-6M	90/Tail Gbx	GHTM
AH-6N	90/Tail Gbx	GHTN
MH-6N	90/TailGbx	GHTP
OH-58A	Main Xrnsn	GKMA
OH-58C	Main Xmsn	GKMC
OH-58D	Main Xmsn	GKMD
OH-58A	90/Tail Gbx	GKTA
OH-58C	90/TAIL GBX	GKTC
OH-58D	Tail Gbx	GKTD
UH-60A	Int Gbx	GLIA
SH-60B	42/Int Gbx	GLIB
UH-60L	42/Int Gbx	GLIC

END ITEM	COMPONENT	JOAP TEC
EH-60A	42/INT GBX	GLID
MH-60S	Int Gbx	GLIE
MH-60R	Int Gbx	GLIF
MH-60L	Int Gbx	GLIG
HH-60L	Int Gbx	GLII
EH-60L	Int Gbx	GLIJ
HH-60J	Int Gbx	GLIK
HH-60A	Int Gbx	GLIL
UH-60M	Int Gbx	GLIM
MH-60M	Int Gbx	GLIR
VH-60N	Tail Gbx	GLIT
UH-60A	Main Xmsn (3u)	GLMA
SH-60B	Main Xmsn	GLMB
EH-60A	Main Xmsn (3u)	GLMC
UH-60L	Main Xmsn	GLMD
UH-60L	Main Gbx	GLMD
MH-60S	Main Xmsn	GLME
MH-60R	Main Xmsn	GLMF
MH-60L	Main Xmsn	GLMG
UH-60Q	Main Xmsn (3u)	GLMH
HH-60L	Main Xmsn	GLMI
HM-60L	Main Xmsn	GLMJ
UH-60A	Main Xmsn	GLMK
EH-60L	Main Xmsn	GLML
EH-60A	Main Xmsn	GLMM
HH-60A	Main Xmsn	GLMP
UH-60M	Main Xmsn	GLMQ
MH-60M	Main Xmsn	GLMR
HH-60A	MAIN XMSN-3u	GLMS
VH-60N	Main Xmsn	GLMT
UH-60A	90/Tail Gbx	GLTA
SH-60B	90/Tail Gbx	GLTB
UH-60L	90/Tail Gbx	GLTC
UH-60L	Hyd Sys	GLTC
EH-60A	90/Tail Gbx	GLTD

END ITEM	COMPONENT	JOAP TEC
MH-60S	Tail Gbx	GLTE
MH-60R	Tail Gbx	GLTF
MH-60L	Tail Gbx	GLTG
UH-60Q	Tail Gbx	GLTH
HH-60L	Tail Gbx	GLTI
UH-60A	90/Tail Gbx	GLTI
EH-60L	Tgb	GLTJ
HH-60J	Tail Gbx	GLTK
HH-60A	Tail Gbx	GLTL
UH-60M	Tail Gbx	GLTM
MH-60M	Tail Gbx	GLTR
VH-60N	Int Gbx	GLTT
AH-64A	#1 Nose Gbx	GM1A
AH-64A	#2 Nose Gbx	GM2A
AH-64A	Int Gbx	GMIA
AH-64A	Main Xmsn	GMMA
AH-64A	PTO Clutch	GMPA
AH-64D	PTO Clutch	GMPD
AH-64A	Tail Gbx	GMTA
RQ-5A	Main Gbx	GNMA
HH-65	Main Xrnsn	GPMA
HH-65	90/Tail Gbx	GPTA
SH-60F	Int GBX	GQIB
SH-60F	Main GBX	GQMB
SH-60F	Tail GBX	GQTB
H-52	42/Int Gbx	GRIA
H-52	Main Xmsn	GRMA
H-52	90/Tail Gbx	GRTA
TH-57B	Main Xmsn	GSMB
TH-57B	90/Tail Gbx	GSTB
C-130	T56-A-9 Gbx	GTMC
C-130	T56-A-15 Gbx	GTMF
C-130	Nose Gear	GTNK
TH-67	Main Xmsn	GUMA
TH-67	90/TAIL GBX	GUTA

END ITEM	COMPONENT	JOAP TEC
CV-22	Mid-Wing Gbx	GVBC
CMV-22	Mid-Wing Gbx	GVBS
MV-22	Mid-Wing Gbx	GVBM
CV-22	Prop Rotor Gbx	GVDC
CMV-22	Prop Rotor Gbx	GVDS
MV-22	Prop Rotor Gbx	GVDM
CV-22	Tilt Axis Gbx	GVJC
CMV-22	Tilt Axis Gbx	GVJS
MV-22	Tilt Axis Gbx	GVJM
AH-1G	Hyd Sys 1	HA1G
UH-1M	Hyd Sys 1	HA1M
AH-1G	Hyd Sys 2	HA2G
UH-1M	Hyd Sys 2	HA2M
AH-1G	Hyd Sys 3	HA31
TH-1G	Hyd Sys 3	HA32
UH-1FS	Hyd Pump	HAA1
UH-1N	Hyd Sys	HAA4
UH-1B	Hyd Sys	HAAB
UH-1C	Hyd Sys	HAAC
UH-1H	Hyd Sys	HAAH
UH-1V	Hyd Sys	HAAV
UH-1X	Hyd Sys	HAAX
VH-3D	Hyd Sys	HCA1
CH-47A	Hyd Sys 1	HE1A
CH-47B	Hyd Sys 1	HE1B
CH-47C	Hyd Sys 1	HE1C
CH-47D	Hyd Sys 1	HE1D
MH-47E	Hyd Sys 1	HE1E
CH-47F	Hyd Sys 1	HE1F
MH-47D	Hyd Sys 1	HE1G
MH-47G	Hyd Sys 1	HE1H
CH-47A	Hyd Sys 2	HE2A
CH-47B	Hyd Sys 2	HE2B
CH-47C	Hyd Sys 2	HE2C
CH-47D	Hyd Sys 2	HE2D

END ITEM	COMPONENT	JOAP TEC
MH-47E	Hyd Sys 2	HE2E
CH-47F	Hyd Sys 2	HE2F
MH-47D	Hyd Sys 2	HE2G
MH-47G	Hyd Sys 2	HE2H
CH-47A	Hdy Sys 3	HE3A
CH-47B	Hdy Sys 3	HE3B
CH-47C	Hyd Sys 3	HE3C
CH-47D	Hyd Sys 3	HE3D
MH-47E	Hyd Sys 3	HE3E
CH-47F	Hyd Sys 3	HE3F
MH-47D	Hyd Sys 3	HE3G
MH-47G	Hyd Sys 3	HE3H
CH-47FS	Hyd Pump	HEAD
CH-54A	Hyd Sys 1	HG1A
CH-54B	Hyd Sys 1	HG1B
CH-54A	Hyd Sys 2	HG2A
CH-54B	Hyd Sys 2	HG2B
CH-54A	Hyd Sys 3	HG3A
CH-54B	Hyd Sys 3	HG3B
AH-6C	Hyd Sys	HHA1
AH-6J	Hyd Sys	HHA2
AH-6N	Hyd Sys	HHA3
MH-6H	HYD SYS	HHA4
MH-6J	Hyd Sys	HHA5
MH-6N	Hyd Sys	HHA6
OH-6A	Hyd Sys	HHA7
MH-6M	Hyd Sys	HHA8
MH-6C	Hyd Sys	HHAD
Aircraft	Hydraulic Oil	HHYD
OH-58A	Hyd Sys	HKAA
OH-58C	Hyd Sys	HKAC
UH-60L	Hyd Sys 1	HL12
MH-60L	Hyd Sys 1	HL1B
UH-60Q	Hyd Sys 1	HL1C
HH-60L	Hyd Sys 1	HL1D

END ITEM	COMPONENT	JOAP TEC
HH-60A	Hyd Sys 1	HL1E
MH-60K	Hyd Sys 1	HL1F
MH-60L	Hyd Sys 2	HL2B
UH-60Q	Hyd Sys 2	HL2C
HH-60L	Hyd Sys 2	HL2D
HH-60A	Hyd Sys 2	HL2E
MH-60K	Hyd Sys 2	HL2F
MH-60L	Hyd Sys 3	HL3B
UH-60Q	Hyd Sys 3	HL3C
HH-60A	Hyd Sys 3	HL3E
MH-60K	Hyd Sys 3	HL3F
UH-60FS	Hyd Pump	HLAA
UH-60	Hyd-Pump	HLPA
AH-64A	Hyd Sys 1	HM11
AH-64A	Hyd Sys 2	HM21
AH-64D	Hyd Sys 2	HM22
AH-64D	Hyd Sys	HMAD
T-34C	Brake Sys	HNBC
HU-25	Hyd Sys 1	HT1A
HU-25	Hyd Sys 2	HT2A
TH-67	Hyd Sys	HUAA
F-111	TF30-P-3	KAAA
B-111	TF30-P-7	KABA
F-111	TF30-P-9	KACA
F-111	TF30-P-103	KADA
B-111	TF30-P-107	KAEA
F-111	TF30-P-109	KAFA
F-14A	TF30-P-414A	KAHA
F-111	TF30-P-100	KAJA
B-52	TF33-P-3	KCAA
C-135	TF33-P-5	KCBA
C-141	TF33-P-7	KCCA
C-135	TF33-P-9	KCDA
E-3	TF33-PW-100	KCEA
C-135	TF33-PW-102	KCFA

END ITEM	COMPONENT	JOAP TEC
C-18	TF33-PW-102	KCFB
C-135	TF33-PW-102/JT3D–3B	KCFC
E-8	TF33-PW-102/JT3D-3B	KCFD
B-52	TF33-P-103	KCGA
A-10	TF34-GE-100	KDAA
S-3	TF34-GE-400B	KDBA
Cruise Missile	F107-WR-402	KEAA
Cruise Missile	F112-WR-100	KEBA
B-52	J57-P-43	KFCA
C-5	TF39-GE-1	KGAA
C-137	TF33-PW-102/JT3D-3B	KGBA
C-137	JT-3D-3	KJAA
C-22	JT-8D-7	KKAA
C-9	JT-8D-9	KKBA
C-9	JT-8D-9	KKBB
T-43	JT-8D-9	KKBC
T-39	JT-12A-8	KLAA
C-21	TFE731-2	KMAA
E-4	JT-9D-7	KNAA
T-1A	JT15D-5B	KPAA
F-18	F404-GE-400	PPAA
TG-7	O-235	RAAA
O-2	IO-360	RBAA
T-41	IO-360	RBAB
T-41C	IO-360-C	RBBA
T-41B	IO-360-D	RBCA
T-41C	IO-360-D	RBCB
T-41D	IO-360-D	RBCC
T-34B	O-470	RCAA
RU-9D	O-480-B1A6	RDEA
U-10	GO-480-G1D6	RDHA
BE-65	IO-720-A1B	RHBA
T-41	O-300D	RLAA
RQ-5A	V-75	RNAA

END ITEM	COMPONENT	JOAP TEC
MQ-5B	Heavy Fuel Engine	RPAA
MQ-5B	Heavy Fuel Engine	RPAB
MQ-8B	RR250-C20W	RQAA
MQ-8B	Gearbox	RQAB
UH-1B	T53-L-11	SBCA
UH-1C	T53-L-11	SBCB
UH-1V	T53-L-11	SBCC
H-1	T53-L-11-D	SBCD
H-1	T53-L-13	SBDA
AH-1G	T53-L-13B	SBEA
UH-1H	T53-L-13B	SBEE
UH-1M	T53-L-13B	SBEF
UH-1V	T53-L-13B	SBEG
CH-47A	T55-L-7C	SCBA
CH-47C	T55-L-712	SCDA
CH-47D	T55-L-712	SCDB
MH-47E	T55-L-714	SCDC
CH-47F	T55-L-712	SCDD
MH-47D	T55-L-712	SCDE
CH-47D	T55-L-714	SCED
CH-47F	T55-L-714	SCEE
MH-47D	T55-L-714	SCEG
MH-47G	T55-L-714	SCEH
CH-47D	T55-GA-714A	SCFA
MH-47E	T55-GA-714A	SCFB
C-130	T56-A7	SDAA
Test Cell	T56-A-7B	SDBX
C-130	T56-A-9	SDCA
Test Cell	T56-A-10	SDDX
Test Cell	T56-A-14	SDEX
C-130	T56-A-15	SDFA
Test Cell	T56-A-16	SDGX
Test Cell	T56-A-425	SDHX
Test Cell	T56-A-426	SDJX
H-1	T58-GE-3	SEAA

END ITEM	COMPONENT	JOAP TEC
H-3	T58-GE-5	SEBA
H-52	T58-GE-8	SECA
H-2	T58-GE-8F	SEDA
H-3	T58-GE-8F	SEDB
H-3	T58-GE-10	SEEA
H-46	T58-GE-10	SEEB
H-46	T58-GE-16	SEFA
VH-3D	T58-GE-400	SEGA
VH-3D	T58-GE-400B	SEHA
H-3	T58-GE-402	SEJA
H-46	T58-GE-402	SEJB
OH-58A	T63-A 700	SFBA
OH-6A	T63-A-700	SFBB
TH-57B	T63-A-720	SFCA
AH-6C	T63-A720	SFCB
OH-58C	T63-A-720	SFCF
OH-58A	T63-A-720	SFCG
MH-6C	T63-A-720	SFCH
OH-58D	T63-A-730	SFDA
H-53	T64-GE-6B	SGBA
H-53	T64-GE-7	SGCA
H-53D	T64-GE-415	SGDA
H-53E	T64-GE-416	SGEA
H-53	T64-GE-413	SGFA
H-53	T64-GE-100	SGGA
MH-53E	T64-GE-419	SGHA
Test Cell	T700-GE-401	SHAX
H-60	T700-GE-700	SHBA
AH-64D	T700-GE-701	SHCA
AH-64A	T700-GE-701	SHCB
UH-60A	T700-GE-701	SHCC
UH-60L	T700-GE-701	SHCD
UH-60M	T700-GE-701	SHCE
MH-60K	T700-GE-701	SHCF
MH-60L	T700-GE-701	SHCG

END ITEM	COMPONENT	JOAP TEC
MH-60M	T700-GE-701	SHCH
HH-60A	T700-GE-701	SHCI
EH-60A	T700-GE-701	SHCJ
EH-60L	T700-GE-701	SHCK
HH-60L	T700-GE-701	SHCL
UH-60L	T700-GE-701C	SHDA
Reaper	TPE331-10	SJAA
OV-10	T76-G-10	SMAA
OV-10	T76-G-12	SMBA
OV-10	T76-G-418	SMCA
OV-10	T76-G-419	SMDA
OV-10	T76-G-420	SMEA
OV-10	T76-G-421	SMFA
C-6	PT6A-20	SPAA
T-34C	PT6A-25	SPBA
UV-18	PT6A-27	SPCA
UV-18A	PT6A-27	SPCB
C-12	PT6A-27	SPCC
U-21F	PT6A-28	SPDA
C-12	PT6A-34	SPFA
T-44A	PT6A-34B	SPFB
C-12	PT6A-38	SPGA
C-12	PT5A-41	SPHA
C-12C	PT6A-41	SPHB
C-12D	PT6A-41	SPHC
RC-12D	PT6A-41	SPHD
RC-12G	PT6A-41	SPHE
RC-12P	PT6A-41	SPHG

END ITEM	COMPONENT	JOAP TEC
RC-12Q	PT6A-41	SPHH
C-12	PT6A-42	SPJA
T-34	PT6A-42	SPJB
C-12U	PT6A-42	SPJC
C-23	PT6A-45	SPKA
C-27	T64-P4D	SPLA
RC-12K	PT6A-67	SPMA
O-5A	PT6A-50	SPNA
EO-5B	PT6A-50	SPNB
C-12J	PT6A-65B	SPPA
T-6A	PT6A-68	SPQA
C-23C	PT6A-65AR	SPRA
G-159	MK-529-8X	SQAA
H-1	T400-CP-400	SRAA
UH-1N	T400-CP-400	SRAB
H-60	T400-GE-401	SRBB
H-1	T400-WV-402	SRCA
CH-54	T73-P-1	SSAA
HH-65	LTS-101-750	STAA
U-21G	T74-CP-700	SUAF
TH-67	250-C-30	SVAA
MH-6M	250-C-30-R3	SVBA
CV-22	T406-AD-400	SWAA
MV-22	AE1107C Engine	T1BA
CV-22	AE1107C Engine	T1BB
CMV-22	AE1107C Engine	T1BC

Table 3 – Non-Aeronautical Type Equipment Codes U.S. Marine Corps Components

Non-Aeronautical USMC JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
1150-MC	A38714	MEDH
1150-MC	DD453	MEGC
1150-MC	HYD SYS	MEDN
4000K-MC	18314-2	MJBG
4000K-MC	4BT3.9	MJBA
4000-MC	DD353	MEBC
4000-MC	HYD SYS	MEBN
4000-MC	TTB2221-1	MEBJ
420-C-MC	DD353	MECB
420-C-MC	HMD2315CB	MECH
48MC-MC	DD453	MEBB
48MC-MC	HR18325	MEBH
580-MC	A38714	MEFH
580-MC	CASE-G188D	MEFB
6000K-MC	6359T	MKZA
6000K-MC	FUNK-1724	MKZG
6000RTL-MC	A3331-1	MDBJ
6000RLT-MC	A38714	MDAG
6000RLT-MC	DD453	MDBB
6000RLT-MC	HYD SYS	MDBN
6000RLT-MC	MHR18325	MDAH
UH-60L	HYD SYS 3	HL32
600GPM-MC	DD353	MEDC
621B-MC	3406	MECA
621B-MC	7G2780	MECG
621B-MC	HYD SYS	MECN
72-31-MC	CRT 3333-1	MEEH
72-31-MC	DD471	MEEC
72-31-MC	HYD SYS	MEEN
AAVC7A1-MC	HS400-3A1	MWAG
AAVC7A1-MC	VT-400	MWAA
AAVP7A1-MC	HS400-3A1	MWBG
AAVP7A1-MC	VT-400	MWBA
AAVR7A1-MC	HS400-3A1	MWCG
AAVR7A1-MC	HYD SYS	NWCN
AAVR7A1-MC	VT-400	MWCA
AIRCOMP-MC	DEUTZ-F4L912	META
AVLB-MC	1790-2DA	MAGB
AVLB-MC	CD850-6A	MAGH

Non-Aeronautical USMC JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
AVLB-MC	HYD SYS	MAJN
BRIDGE-MC	SABRE 212	MXJA
CAT-130G-MC	5R6172	MEMH
CAT-130G-MC	CAT-3304	MEMC
CAT-130G-MC	HYD SYS	MEMN
CAT-D7G-MC	9R5382	MENG
CAT-D7G-MC	CAT-3306	MENA
CAT-D7G-MC	HYD SYS	MENN
CAUSEWAY-MC	CMD-2A-221	MWFN
CAUSEWAY-MC	DD8V71T	MWDC
CAUSEWAY-MC	F301HY1PCNTB	MWQN
CAUSEWAY-MC	MH30L	MWDH
CAUSEWAY-MC	PAVC38RA	MWEN
CAUSEWAY-MC	RSA 04K	MWDN
COMPACTO-MC	DD4534	MVPA
COMPACTO-MC	HMD2315CB	MVPG
CONMIXER-MC	TRI-02	MEMB
CRANE-MC	4133.9	MEKA
CRANE-MC	CAT-3208T	MXBA
CRANE-MC	CLARK-28000	MXBG
CRANE-MC	FUNK-17243E	MEKG
DECONAPP-MC	4A084-3	MBQA
DRCH2500-MC	DD6V53	MEAB
DRCH2500-MC	R28621-12	MEAH
EXCAVATO-MC	5043-7000	MEJA
EXCAVATO-MC	FUNK-17243E	MEJG
GRADER-MC	CAT-3304	MEGA
GRADER-MC	POWESHIFT	MEGG
HOSEREEL-MC	AT5CC	MDCN
HOSEREEL-MC	DD371	MDCB
LAV-25-MC	DD6V53T	MWGA
LAV-25-MC	MT653	MWGG
LAV-AT-MC	DD6V53T	MWHA
LAV-AT-MC	MT653DR	MWHG
LAV-C2-MC	DD6V53T	MWJA
LAV-C2-MC	MT653DR	MWJG
LAV-L-MC	DD6V53T	MWKA
LAV-L-MC	MT653DR	MWKG
LAV-M-MC	DD6V53T	MWLA

Non-Aeronautical USMC JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
LAV-M-MC	MT653DR	MWLG
LAV-R-MC	DD6V53T	MWMA
LAV-R-MC	MT653DR	MWMG
M109A3-MC	DD8V71T	MAAA
M109A3-MC	XTG-411-2A	MAAG
M110A2-MC	DD8V71T	MABA
M110A2-MC	XTG-411-2A	MABG
M123A1C-MC	V8-300	MBCC
M123E2-MC	V8-300	MBDC
M1A1-MC	AGT-1500	MACA
M1A1-MC	HYD SYS	MAVN
M1A1-MC	X1100-3B	MACG
M35A2C-MC	LD-465-1	MBAC
M45A2-MC	LD-465-1	MBFC
M49A2C-MC	LD-465-1	MBEC
M50A2-MC	LD-465-1	MBGC
M543A2-MC	LD-465-1	MBLC
M578-MC	DD8V71T	MADA
M578-MC	XTG-411-2A	MADG
M60A1-MC	1790-2CA	MAEA
M60A1-MC	CD850-6A	MAEG
M813A1-MC	NHC-250	MBAA
M814-MC	NHC-250	MBBA
M816-MC	HYD SYS	MBCN
M816-MC	NHC-250	MBCA
M817-MC	HYD SYS	MBDN
M817-MC	NHC-250	MBDA
M818-MC	NHC-250	MBEA
M88A1-MC	1790-2DR	MAFA
M88A1-MC	XT-1410-4	MAFG
M893-MC	LD-465-1	MBDB
M923A1-MC	NHC-250	MCFA
M923-MC	NHC-250	MBFA
M925A1-MC	HYD SYS	MCGN
M925A1-MC	NHC-250	MCGA
M925-MC	HYD SYS	MBGN
M925-MC	NHC-250	MBGA
M927A1-MC	NHC-250	MCHA
M927-MC	NHC-250	MBHA
M928A1-MC	HYD SYS	MCJN

Non-Aeronautical USMC JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
M928A1-MC	NHC-250	MCJA
M928-MC	HYD SYS	MBJN
M928-MC	NHC-250	MBJA
M929A1-MC	HYD SYS	MCKN
M929A1-MC	NHC-250	MCKA
M929-MC	HYD SYS	MBKN
M929-MC	NHC-250	MBKA
M930A1-MC	NHC-250	MCLA
M930-MC	NHC-250	MBLA
M931A1-MC	NHC-250	MCMA
M931-MC	NHC-250	MBMA
M934	HYD SYS	BTBM
M934A1-MC	NHC-250	MCMB
M935	HYD SYS	BTCM
M936A1-MC	HYD SYS	MCMN
M936A1-MC	NHC-250	MCNA
M936-MC	HYD SYS	MBMN
M936-MC	NHC-250	MBNA
M970-MC	ONAN	MBNC
M9-MC	CLARK-1345	MHPH
M9-MC	CUMMINSV903C	MHPB
MEP-003-MC	ONAN/DJC	MVCB
MEP-005A-MC	D298ERX37	MVMC
MEP-006A-MC	AC3500	MVDC
MEP-007A-MC	CAT-D333CT	MVEC
MEP-021A-MC	42032	MVBA
MEP-112A-MC	ONAN/DJC	MVDB
MEP-113A-MC	D198ERX51	MVLC
MEP-114A-MC	D298ERX37	MVMC
MEP-115A-MC	AC3500	MVHC
MEP-16A-MC	42032	MVAB
MEP-208A-MC	KTA-2300G	MVNC
MEP-208A-MC	ONAN	MVPC
MK-23	ENGINE	MBPB
MK-23	XMSN	MBPH
MK-23	HYD SYST	MBPP
MK-25	ENGINE	MBPC
MK-25	XMSN	MBPJ
MK-25	HYD SYST	MBPQ
MK-27	ENGINE	PBCA

Non-Aeronautical USMC JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
MK-27	XMSN	PBCG
MK-27	HYD SYST	PBCN
MK-28	ENGINE	PBDA
MK-28	XMSN	PBDG
MK-28	HYD SYST	PBDN
MK48 4X4-MC	DD8V92TA	MBPA
MK48 4X4-MC	HT740D	MBPG
MK48 4X4-MC	HYD SYS	MBPN
P19A-MC	ALLIS750DRD	MBRH
P19A-MC	NHC-250	MBRB
P250WDN-MC	F2L511	MEMA
RTCH-MC	3P9094	MDAW
RTCH-MC	CAT-3408T	MDAC
RTCH-MC	CAT-5R3855	MDAJ
RTCH-MC	HYD SYS	MDAN
SCRAPER-MC	3406	MEHA
SCRAPER-MC	POWERSHIFT	MEHG
SLWT-4-MC	70823300	MAEB
SLWT-4-MC	CMD-2A-221	MAGN
SLWT-4-MC	DD8V71T	MAEC
SLWT-4-MC	F301HY1PCNTB	MAHN
SLWT-4-MC	MH30L	MAEH
SLWT-4-MC	PAVC38RA	MAFN
SLWT-4-MC	RSA 04K	MAEN
SWEEPER-MC	4239D	MSEA
SWEEPER-MC	ALLISON-540	MSEG
TRACTOR-MC	4WG-200	MJCG
TRACTOR-MC	6076ADW02	MJCA
TRACTOR-MC	BENZ-320	MEDA
TRACTOR-MC	BENZ-MECH	MEDG
TRACTOR-MC	CASE-6T590	MHPA
TRACTOR-MC	CASE-G107561	MHPG
TRK FIRE-MC	NTC-400	MTCA
CSTRS	WNCH GEARBOX	DLCA
WINCH-MC	1489	MDDN
WINCH-MC	50438301	MDDB
WINCH-MC	DD453	MDDC
WLDTLMTD-MC	PERKINS4236	MEFC

Table 4 – Non-Aeronautical Type Equipment Codes Army Components

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
10000M	6BT5.9	DJFA
10000M	FUNK-1723M	DJFG
10000M	HYD SYS	DJFN
1200	CSG649	NC4A
1200	C-6	NC4G
1500M	DD6V53	TVAA
140H	CAT-3306	EHAB
140H	CAT-1442234	EHAG
140H	HYD SYS	EHAM
175B	CLK4000	EFBG
175B	DD8V71N	EFBF
175B	HYD SYS	EFBN
175B	NT-855-C	EFBB
1854	9.0L180F	NB2A
1854	CM-5552D	NB2G
1854	HYD SYS	NB2N
2500L	DD6V92	TCWA
2500L	HT750DRD	TCWG
250DCMS1	JD403	DWSA
250RPV	DD453	DWLA
270-9	DD353	EU5A
3000 KW-N	CB LSV16T	PVDA
3000M	2067761	DJ8G
3000M	C-180	DJ8A
35KVA	GPT 30-150E	TVYA
4200	3TNE78A	NB5A
4200	4200HST	NB5G
4200	HYD SYS	NB5M
444C	6329	NA5A
444C	NOII	NA5G
444C	HYD SYS	NA5M
450D	4219	NA7A
450D	NOII	NA7G
450D	HYD SYS	NA7M
450E	TO4276	NC3A
450E	JD4SPD	NC3G
450E	HYD SYS	NC3M
4700	T444E	NA4A

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
4700	AT545	NA4G
4700	HYD SYS	NA4M
4800	DT466	NB9A
4800	MT643	NB9G
4800	HYD SYS	NB9M
5060	DD23010052	EMKG
5060	DD471T	EMKA
515	D-359N	NC2A
515	S710	NC2G
515	HYD SYS	NC2M
530B	LDS-465-1	TEDA
530BAM	LDS-465-1	TEEA
544E	HYD SYS	TDBN
544E	JD6059TDW04	TDBA
544E	WG-120	TDBG
609-C	F6L912B	ZTCA
6000M	6BT5.9	TDHA
6000M	FUNK-1723	TDHG
6000M	HYD SYS	TDHN
600TV75	T-1010 S-39	TVFA
613BSNS	8S3543	EHZG
613BSNS	CAT-3208	EHZA
613BSNS	HYD SYS	EHZN
613BSNSI	8S3543	EJLG
613BSNSI	CAT-3208	EJLA
613BSNSI	HYD SYS	EJLN
613BSS	8S3543	EH2G
613BSS	CAT-3208	EH2A
613BSS	HYD SYS	EH2N
613BSSI	8S3543	EJKG
613BSSI	CAT-3208	EJKA
613BSSI	HYD SYS	EJKN
613BWDNS	8S3543	EVGG
613BWDNS	CAT-3208	EVGA
613BWDNS	HYD SYS	EVGN
613BWDS	8S3543	EVFG
613BWDS	CAT-3208	EVFA
613BWDS	HYD SYS	EVFN

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
621B	3406	EH3A
621B	7G2780	EH3G
621B	HYD SYS	EH3N
645M	AC3500	EFLA
645M	HYD SYS	EFLN
645M	TT2420-1	EFLG
6M125	D2000X16	TVGA
750PQ	DD6V71N	TVJA
75TPH EAGLE	N855-P235	TFAA
780T	T4.236	E47A
950BNS	7G4851	EFWG
950BNS	CAT-3304	EGEA
950BNS	HYD SYS	EFWN
950BNSCE	7G4851	EGEG
950BNSCE	CAT-3304	EGEA
950BMSCE	HYD SYS	EGEN
950BS	7G4851	EFVG
950BS	CAT-3304	EFVA
950BS	HYD SYS	EFVN
950BSCE	7G4851	EGFG
950BSCE	CAT-3304	EGFA
950BSCE	HYD SYS	EGFN
AMTC	HYD SYS	TMTN
AN/MJQ-10A	D298ERX37	VCOA
AN/MJQ-11A	CAT-D343TA	VENA
AN/MJQ-12A	AC3500	VELA
AN/MJQ-15	D198ERX51	VLOA
AN/MJQ-18	D198ERX51	VLAA
AN/MJQ-18	100-1345	VLAB
AN/MJQ-21	T62T32A	VIHA
AN/MJQ-24	A04043B02	VICA
AN/MJQ-35	DN2M	VICD
AN/MJQ-35A	DN2M	VICE
AN/MJQ-36	DN2M	VICF
AN/MJQ-37	DN4M-1	VIDA
AN/MJQ-38	DN4M-1	VIDB
AN/MJQ-39	ISUZU-C240	VICJ
AN/MJQ-40	JD4039T	VICB
AN/MJQ-41	JD6059T	VICC
AP308	4B3.96	DXLA

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
AP308	FORD C-6	DXLG
APP-1	GTCP85-127	VAFC
ARTFT6	ALS 3331-1	DJCG
ARTFT6	DD453N	DJCF
ARTFT6	HYD SYS	DJCN
AT422T	13.9LFHR	ELTG
AT422T	6BTA5.9	ELTA
AT422T	HYD SYS	ELTM
B413	RTG3600C-S1	TVPB
B8	4-53T	NA9A
B8	13.3HR28420	NA9G
B8	HYD SYS	NA9M
BBBUESCSBMK1	10-18-002	XJGG
BBBUESCSBMK1	SABRE 212	XJGA
BBBUESCSBMK2	10-18-002	TWVG
BBBUESCSBMK2	SAVE 212	TWVA
BD 264B	CO-5EN668	WACE
BD 264B	CO-6EN68	WACB
BD 264B	CO-DSM-6	WACC
BD 264B	CO-GAB4	WACA
BD 264B	FM-316A6	WACD
BD-6802	NTA-855-63	WB1A
BD-6802	KTA38-G2	WB1B
BD-6802	HYD SYS	WB1M
BD-6802	HYD SYS ANC1	WB1N
BD-6802	HYD SYS ANC2	WB2N
BD-6802	HYD SYS ANC3	WB3N
BIO-RAD	FT-IR	GRDA
BP	4002	WAHA
BP	4003	WAFA
BRIDGE-MA	DD8V71	TWDA
BRIDGE-MA	HT70	TWDG
BSF-400	DD353	EXEA
BSF-400	HYD SYS	EXEN
C350B	DD353	TEHA
C350B	HYD SYS	TEHN
C350B-D	DD353	TEWA
C3508-D	HYD SYS	TEWN
C530A	393303	EURG
C530A	DD353	EURA

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
CAT-12	CAT-D333	EHKA
CAT-120ROPS	3R9859	EHKG
CAT-130G	5R6192	EHFG
CAT-130G	CAT-330DIT	EHFA
CAT-130G	HYD SYS	EHFN
CAT-130GNS	CAT-3304	EHNA
CAT-130GNS	5R6192	EHNG
CAT-130GNS	HYD SYS	EHNN
CAT-130GNSC	5R6192	EJJG
CAT-130GNSC	CAT-3304DIT	EJJA
CAT-130GNSC	HYD SYS	EJJN
CAT-130GNSE	5R6192	TAAG
CAT-130GNSE	CAT-3304	TAAA
CAT-130GNSE	HYD SYS	TAAN
CAT-130GS	5R6192	EHPG
CAT-130GS	CAT-3304	EHPA
CAT-130GS	HYD SYS	EHPN
CAT-130GSCE	5R6192	TABG
CAT-130GSCE	CAT-3304	TABA
CAT-130GSCE	HYD SYS	TABN
CAT-814F	1223774	E5DG
CAT-814F	CAT-3306B	E5DA
CAT-814F	HYD SYS	E5DM
CAT-815F	1223774	E5EG
CAT-815F	CAT-3306B	E5EA
CAT-815F	HYD SYS	E5EM
CAT-816F	1223774	E5FG
CAT-816F	CAT-3306B	E5FA
CAT-816F	HYD SYS	E5FM
CAT-D5	3S7094	EAPG
CAT-D5	CAT-3306	E5FA
CAT-D5	HYD SYS	E5FM
CAT-D5A	3S7094	EAPG
CAT-D5A	CAT-3306	EAPA
CAT-D5A	HYD SYS	EANN
CAT-D5B	3S7094	TEKG
CAT-D5B	9P4905	TEKH
CAT-D5B	CAT-2WA1/UP	TEKI
CAT-D5B	CAT-3306	TEKA
CAT-D5B	D5/3T3394	TEKJ

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
CAT-D5B	HYD SYS	TEKN
CAT-D7E	CAT-D333	EA3G
CAT-D7F	5R82	EA2G
CAT-D7F	CAT-3306	EA2A
CAT-D7F	CAT-6CYL638C	EA2B
CAT-D7F	HYD SYS	EA2N
CAT-D7G	9P5382	TELG
CAT-D7G	CAT-3306	TELA
CAT-D7G	HYD SYS	TELN
CAT-D7H	9P5382	TELH
CAT-D7H	CAT-3306	TELB
CAT-D7H	HYD SYS	TELM
CAT-D7R	CAT-3306	TEMA
CAT-D7R	CAT-9TXI-UP	TEMG
CAT-D7R	HYD SYS	TEMN
CAT-D8K	3N1869	EADG
CAT-D8K	CAT-D342	EADA
CAT-D8K	HYD SYS	EADN
CB-534B	CAT-3054	E5BA
CB-534B	HYD SYS	E5BN
CS433C	HYD SYS	E5HM
CS433C	CAT-3054	E5KA
CS563D	CAT-3114	E5JA
CS563D	CAT-3116	E5JB
CS563D	CAT-3126	E5JC
CS563D	HYD SYS	E5JM
D424A	A0403B02	TVPA
D5	HYD SYS	EAPM
D5 ENG TS	HYD SYS	TB3N
D5BNS	CAT-2WA1/UP	EBAH
D5BNS	CAT-3306	EBAA
D5BNS	D5/3T3394	EBAG
D5BS	CAT-2WA1/UP	EBBH
D5BS	CAT-3306	EBBA
D5BS	D5/3T3394	EBBG
D5BS	HYD SYS	EBBN
D5BS1	CAT-2WA1/UP	TFBA
D5BS1	CAT-3306	TFBG
D5BS1	D5/3394	TFBH
D5BS1	HYD SYS	TFBN

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
D6	HYD SYS	TCMM
DV43	CAT-2408T	DJNA
DV43	CAT-3408	DJNB
DV43	CAT-3P9094	DJNH
DV43	CAT-5R3855	DJNG
DV43	HYD SYS	DJNN
DV-100	HYD SYS	EBCM
DV-100	POWER SHIFT	JCCG
DV-100	CAT-3126	JCCA
DYNAMOMETER	V250	DABA
DYNAMOMETER	V35	DABB
EMD12567	16-567-C	TVQA
EPPIII	BF8L513	VCAA
F5070	HT750CRD	EZYH
F5070	HYD SYS	EZYN
F5070	NTC-290	EZYA
FLU419	BENZ-OM352	TEYA
FLU419	HYD SYS 1	TEYN
FLU419	HYD SYS 2	TEYM
FT750	LDT-465-1	ZMAA
GTGE709-2	GPT 70-52	VLVA
H100C	HYD SYS	EFRN
H100C	IHDT817C	EFRA
H100C	P-2004	EFRG
H100C GPB	HYD SYS	EFSN
H100C GPB	IHDT817C	EFSA
H100C GPB	P-2004	EFSG
H40XL-MIL	360311	TDEG
H40XL-MIL	HYD SYS	TDEN
H40XL-MIL	ISUZU-C240	TDEA
H446	DD353	EKTA
H60XL-MIL	360311	TDFG
H60XL-MIL	HYD SYS	TDFN
H60XL-MIL	ISUZU-C240	TDFA
HC-238A	DD671N	DSFA
HC-283A	DD6V92TC	DSFB
HC-238A	HYD SYS	EFJN
HMMH	BENZ-OM352	TEXA
HMMH	HYD SYS 1	TEXN
HMMH	HYD SYS 2	TEXM

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
HSPB	400MERLIN	WCRA
JD230LC-RD	JD6068	AKXA
JD230LC-RD	JD4045	AKXB
JD230LC-RD	HYD SYS	AKXM
JD230LCR	JD6068	AKXC
JD230LCR	HYD SYS	AKXN
JD330LCR	JD6081	AKYD
JD330LCR	HYD SYS	AKYM
JD410	4-2-19DT-03	EDHA
JD410	DP23981	EDHG
JD410	HYD SYS	EDHN
JD550	4276TT01	TEQA
JD550	AT49678	TEQG
JD550	HYD SYS	TEQN
JD644G	6081HDW04	TERG
JD644G	609T	TERA
JD644G	HYD SYS	TERM
JD770C	6081HDW03	TEQB
JD770C	DF1888E00WA	TEQH
JD770C	HYD SYS	TEQM
JD862B	6101AT012	TERB
JD862B	AT59822	TERH
JD862B	HYD SYS	TERN
JEEP77	JAM4.0T5ND1	NA2A
JEEP77	AX5	NA2G
JHTWX1096	GTCP85-127	TVUA
K300	CAT-3208	EXBA
K300	CLK28000	EXBG
K300	HYD SYS	EXBN
KTA50GS	KTA50GS	NB7A
LARC-LX	6080RA	WANB
LARC-LX	6081RC	WANA
LARC-XV	300	WARA
LCM8	671LB63A	WASA
LCM8	671LD63A	WAEA
LCM8	671RB63A	WAZA
LCM8	671RD63A	WAYA
LCM8	DD12V71T	WAEB
LCM8MOD1	DD12V71T	WASB
LCM8MOD1SL	DD12V71T	WASC

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
LCM8-SLEP	7000	WGDA
LCMB-SLEP	7122	WGCA
LCM8-SLEP	7000	WGDA
LCM8-SLEP	7122	WGCA
LCU1646	1033-7005	WAAD
LCU1646	GM1043-7000	WAAB
LCU1646	GM7122-7000	WAAC
LCU1646	MG514	WAAG
LCU2000	4B3.9	WBSC
LCU2000	KTA-50M	WBSA
LCU2000	NT-855-M	WBSD
LCU2000	NTA-855	WBSB
LCU2000	WAV850PT	WBSG
LCU2000	WAV850SB	WBSH
LOCO100T	AMER 539	XCUA
LOCO100T	EMD8-567B	XCIA
LOCO10T	DD3080	TXAA
LOCO115T	AMER 539S	XCAA
LOCO120T	38D-81/8	TXDA
LOCO120T	AMER 244F	XCPA
LOCO120T	BALDWING 606A	TXBA
LOCO120T	EMD16-567B	XCKA
LOCO120T	EMD16-645E	XCQA
LOCO120T	FM-H12-44	XCCA
LOCO25T	HBI-600	XCWA
LOCO44T	CAT-D17000	XCLB
LOCO45T	HBI-600	XDFA
LOCO60T	CAT-3508	XCTA
LOCO60T	CAT-D397	XCSA
LOCO80T	LI-600	XCVA
LOCO80T	NTA-855L4	XC3A
LOCO80T-470	NHBIS-600	XCMA
LOCO80T-550	NHBIS-600	XCNA
LPU-71	GTCP85-127	VAFB
LPU-71W	GTCP85-127	VAAA
LRT-110	17243E	EKZG
LRT-110	4B3.9	EKZA
LRT-110	HYD SYS	EKZN
LSV	3304-B	WAXC
LSV	3306-B	WAXD

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
LSV	3406-B	WAXB
LSV	EMD16-645E6	WAXA
LSV	MG509	WAXG
LSV	WAV630-2240	WAXH
LT	3408DITAJW	WGEB
LT	CAT-3304NA	WGEC
LT	CAT-3306TA	WGED
LT	EMD12645F7B	WGEA
LT	HS400-3	WAMG
LT	LS6DRT	WAMA
LT9500	CAT-C10	NB3A
LT9500	RM0131454	NB3G
LT9500	HYD SYS	NB3M
LT9513	CAT-C10	NC6A
LT9513	RTLO12713A	NC6G
LT9513	HYD SYS	NC6M
LVTC-7	DD8V53T	TWNA
LVTC-7	HS400-3	TWNG
LVTC-7A1	HS400-3	TWPG
LVTC-7A1	VT-400	TWPA
LVTP-7	DD8V53T	TWRA
LVTP-7	HS-400-3	TWRG
LVTP-7A1	HS400-3	TWSG
LVTP-7A1	VT-400	TWSA
LVTR-7	DD8V53T	TWTA
LVTR-7	HS400-3	TWTG
LVTR-7A1	HS400-3	TWUG
LVTR-7A1	V903	TWUB
LVTR-7A1	VT-400	TWUA
M1	AGT-1500	AAAA
M1	HYD SYS	AAAN
M1	X1100-3B	AACG
M1 IP	AGT-1500	AACA
M1 IP	HYD SYS	AACN
M1 IP	X1100-3B	AAAG
M1000	HYD SYS	CXUN
M1025	6.2 L DIESEL	BBFA
M1025	6.5 L DIESEL	BBFC
M1025	THM-3L80	BBFG
M1025A1	6.2 L DIESEL	BBFD

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
M1025A1	6.5 L DIESEL	BBFB
M1025A1	THM-3L80	BBFH
M1025A2	6.5 L DIESEL	BCLB
M1025A2	THM-4L80E	BCFG
M1026	6.2 L DIESEL	BBGA
M1026	6.5 L DIESEL	BBGC
M1026	THM-3L80	BBGG
M1026A1	6.2 L DIESEL	BBGB
M1026A1	6.5 L DIESEL	BBGD
M1026A1	THM-3L80	BBGH
M1035	6.2 L DIESEL	BBLA
M1035	6.5 L DIESEL	BBLC
M1035	THM-3L80	BBLG
M1035A2	6.5 L DIESEL	BCLB
M1035A2	THM-4L80E	BCLG
M1036	6.2 L DIESEL	BBHA
M1036	6.5 L DIESEL	BBHC
M1036	THM-3L80	BBHG
M1037	6.2 L DIESEL	BBKA
M1037	6.5 L DIESEL	BBKC
M1037	THM-3L80	BBKG
M1038	6.2 L DIESEL	BBEA
M1038	6.5 L DIESEL	BBEC
M1038	THM-3L80	BBEG
M1038A1	6.2 L DIESEL	BBEB
M1038A1	6.5 L DIESEL	BBED
M1038A1	THM-3L80	BBEH
M1042	6.2 L DIESEL	TCTA
M1042	6.5 L DIESEL	TCTC
M1042	THM-3L80	TCTG
M1043	6.2 L DIESEL	BBJA
M1043	6.5 L DIESEL	BBJC
M1043	THM-3L80	BBJG
M1043A2	6.5 L DIESEL	BCJB
M1043A2	THM-4L80E	BCJG
M1044	6.2 L DIESEL	BBNA
M1044	6.5 L DIESEL	BBNC
M1044	THM-3L80	BBNG
M1046	6.2 L DIESEL	TCSA
M1046	6.5 L DIESEL	TCSC

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
M1046	THM-3L80	TCSG
M1059	DD6V53	AESA
M1059	TX-100-1	AESG
M1059A3	DD6V53T	AFAA
M1059A3	X200-4	AFAG
M1064	DD6V53	AE4A
M1064	TX-100-1	AE4G
M1064A3	DD6V53T	AE8A
M1064A3	X200-4	AE8G
M1065	OM603.950	TCPA
M1065	W4A040	TCPG
M1066	OM603.950	TCPA
M1066	W4A040	TCQG
M1067	OM603.950	TCRA
M1067	W4A040	TCRG
M1068	DD6V53	AE5A
M1068	TX-100	AE5G
M1068A3	DD6V53T	AFCA
M1068A3	X200-4	AFCG
M1069	6.2 L DIESEL	AKZA
M1069	6.5 L DIESEL	AKZB
M1069	THM-3L80	AKZG
M106A1	DD6V53	AEFA
M106A1	TX-100-1	AEFG
M106A2	DD6V53	AERA
M106A2	TX-100-1	AERG
M1070	CLT-754	B5CG
M1070	DD8V92TA	B5CA
M1070	HYD SYS	B5CM
M1074	CLT-755	B4GG
M1074	DD8V92TA	B4GA
M1074	HYD SYS	B4GM
M1075	CLT-755	B4HG
M1075	DD8V92TA	B4HA
M1075	HYD SYS	B4HM
M1078	CAT-3116-225	BHDA
M1078	HYD SYS	BHHM
M1078	MD3070PT	BHDG
M1078A1	CAT-3126	BHRA
M1078A1	MD3070PT	BHRG

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
M1078A1	HYD SYS	BHRM
M1079	CAT-3116-225	BHEA
M1079	MD3070PT	BHEG
M1079A1	CAT-3126	BHSA
M1079A1	MD3070PT	BHSG
M1079A1	HYD SYS	BHSM
M1080	CAT-3116-290	BHCA
M1080	MD3070PT	BHCG
M1081	CAT-3116-225	BHFA
M1081	MD3070PT	BHFG
M1080A1	CAT-3126	BHTB
M1080A1	MD3070PT	BHTH
M1081A1	CAT-3126	BHUA
M1081A1	MD3070PT	BHUG
M1081A1	HYD SYS	BHUM
M1083	CAT-3116-290	BR2A
M1083	MD3070PT	BR2G
M1083A1	CAT-3126	BT9A
M1083A1	MD3070PT	BT9G
M1083A1	HYD SYS	BT9M
M1084	CAT-3116-290	BR3A
M1084	HYD SYS	BR3N
M1084	MD3070PT	BR3G
M1084A1	CAT-3126	BUBA
M1084A1	MD3070PT	BUBG
M1084A1	HYD SYS	BUBM
M1085	CAT-3116-290	BR7A
M1085	MD3070PT	BR7G
M1085A1	CAT-3126	BUGA
M1085A1	MD3070PT	BUGG
M1085A1	HYD SYS	BUGM
M1086	CAT-3116-290	BR8A
M1086	HYD SYS	BR8N
M1086	MD3070PT	BR8G
M1086A1	CAT-3126	BUHA
M1086A1	MD3070PT	BUHG
M1086A1	HYD SYS	BUHM
M1087	CAT-3116-290	BT3A
M1087	MD3070PT	BT3G
M1087A1	CAT-3126	BUTA

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
M1087A1	MD3070PT	BUTG
M1088	CAT-3116-290	BTJA
M1088	MD3070PT	BTJG
M1088A1	CAT-3126	BUCA
M1088A1	MD3070PT	BUCG
M1088A1	HYD SYS	BUCM
M1089	CAT-3116-290	BR4A
M1089	HYD SYS	BR4N
M1089	MD3070PT	BR4G
M1089A1	CAT-3126	BUDA
M1089A1	MD3070PT	BUDG
M1089A1	HYD SYS	BUDM
M1090	CAT-3116-290	BR5A
M1090	HYD SYS	BR5N
M1090	MD3070PT	BR5G
M1090A1	CAT-3126	BUEA
M1090A1	MD3070PT	BUEG
M1090A1	HYD SYS	BUEM
M1091	CAT-3116-290	BT2A
M1091	MD3070PT	BT2G
M1091A1	CAT-3126	BUSA
M1091A1	MD3070PT	BUSG
M1092	CAT-3116-290	BRZA
M1092	MD3070PT	BRZG
M1092A1	CAT-3126	BT8A
M1092A1	MD3070PT	BT8G
M1093	CAT-3116-290	BR9A
M1093	MD3070PT	BR9G
M1093A1	CAT-3126	BUAA
M1093A1	MD3070PT	BUAG
M1093A1	HYD SYS	BUAM
M1094	CAT-3116-290	BTKA
M1094	HYD SYS	BTKN
M1094	MD3070PT	BTKG
M1094A1	CAT-3126	BUFA
M1094A1	MD3070PT	BUFG
M1094A1	HYD SYS	BUFM
M1096	CAT-3116-290	BR6A
M1096	HYD SYS	BR6N
M1096	MD3070PT	BR6G

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
M1097	6.2 L DIESEL	BBMA
M1097	THM-3L80	BBMG
M1097	6.5 L DIESEL	BBMC
M1097A1	6.2 L DIESEL	BBUA
M1097A1	THM-3L80	BBUG
M1097A2	6.5 L DIESEL	BCMB
M1097A2	THM-4L80E	BCMG
M109A3	LDT-465-1C	BMJC
M10A	HYD SYS	DJUN
M10A	IHCDT-466B	DJUA
M10A	IHCS-700	DJUG
M1109	6.2 L DIESEL	B6AA
M1109	THM-3L80	B6AG
M1109	6.5 L DIESEL	B6AC
M1113	6.5 L DIESEL	B6BA
M1113	THM-4L80E	B6BG
M1114	6.5 L DIESEL	B6CA
M1114	THM-4L80E	B6CG
M1123	6.5 L DIESEL	B6GA
M1123	THM-4L80E	B6GG
M113A2	DD6V53	AENA
M113A2	TX-100-1	AENG
M113A3	DD6V53	AEYB
M113A3	DD6V53T	AEYA
M113A3	TX-100-1	AEYH
M113A3	X200-4	AEYG
M113A3BMP-2	DD6V53T	AEZA
M113A3BMP-2	X200-4	AEZG
M150 CSWP	4BT3.9C	TBCF
M150 CSWP	6CT8.3G	TBCB
M150 CSWP	6CTA8.3-C#1	TBCD
M150 CSWP	6CTA8.3-C#2	TBCE
M150 CSWP	M11-C	TBCC
M1977	DD8V92TA	DV4A
M1977	HT740D	DV4G
M1977	HYD SYS	DV4M
M1A1	AGT-1500	AABA
M1A1	HYD SYS	AABN
M1A1	X1100-3B	AABG
M1A2	AGT-1500	TAUA

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
M1A2	HYD SYS	TAUM
M1A2	X1100-3B	TAUG
M2A3	VTA-903T	APGA
M2A3	HMPT-500	APGH
M2	HMPT-500	APAG
M2	HMPT-500-3	APAH
M2	HMPT-500-3E	APAJ
M2	HMPT-500-B	APAK
M2	VTA903T	APAA
M270	HMPT-500-3EC	QBDG
M270	HYD SYS	QBDM
M270	VTA-903T	QBDA
M291A1	ENDT-673	BRPA
M291A1	LD-465-1C	BRPD
M291A1	LDS-427-2	BRPC
M291A1	LDS-465-1	BRPB
M291A1	LDT-465-1C	BRPF
M291A1	LDT-465-1D	BRPE
M291A2	LDS-465-1	TBCA
M292A1	LD-465-1C	BGMB
M292A1	LDS-427-2	BGMA
M292A1	LDT-465-1C	BGMD
M292A1	LDT-465-1D	BGMC
M292A2	LD-465-1	BGLA
M292A2	LD-465-1C	BGLB
M292A2	LDS-427-2	BGLE
M292A2	LDT-465-1C	BGLD
M292A2	LDT-465-1D	BGLC
M292A4	LD-465-1C	TBDB
M292A4	LDS-427-2	TBDA
M292A4	LDT-465-1C	TBDD
M292A4	LDT-465-1D	TBDC
M292A5	LD-465-1	BGNA
M292A5	LD-465-1C	BGNB
M292A5	LDS-427-2	BGNE
M292A5	LDT-465-1C	BGND
M292A5	LDT-465-1D	BGNC
M2A1	HMPT-500	ALEG
M2A1	HMPT-500-3	ALEH
M2A1	HMPT-500-3E	ALEJ

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
M2A1	HMPT-500-B	ALEK
M2A1	VTA-903T	ALEA
M2A2	HMPT-500	TARG
M2A2	HMPT-500-3	TARH
M2A2	HMPT-500-3E	TARJ
M2A2	HMPT-500-3TE	TARK
M2A2	VTA-903T	TARA
M3	HMPT-500	APBG
M3	HMPT-500-3	APBH
M3	HMPT-500-3E	APBJ
M3	HMPT-500-B	APBK
M3	VTA-903T	APBA
M34A2	LD-465-1	TBEA
M34A2	LD-465-1C	TBEB
M34A2	LDS-427-2	TBEE
M34A2	LDT-465-1C	TBED
M34A2	LDT-465-1D	TBEC
M35A2	LD-465-1	BMAA
M35A2	LD-465-1C	BMAB
M35A2	LDS-427-2	BMAE
M35A2	LDT-465-1C	BMAD
M35A2	LDT-465-1D	BMAC
M35A2C	LD-465-1	BMRA
M35A2C	LD-465-1C	BMRB
M35A2	LDS-427-2	BMRE
M35A2	LDT-465-1C	BMRD
M35A2	LDT-465-1D	BMRC
M35A2C	LD-465-1	BMRA
M35A3	3116ATAAC	BM6A
M35A3	AT1545	BM6G
M35A3C	AT1545	BHQG
M35A3C	CAT-3116	BHQA
M36A2	LD-465-1	BMCA
M36A2	LD-465-1C	BMCB
M36A2	LDS-427-2	BMCE
M36A2	LDT-465-1C	BMCD
M36A2	LDT-465-1D	BMCC
M36A3	AT1545	BHNG
M36A3	CAT-3116	BHNA
M3A1	HMPT-500	ALFG

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
M3A1	HMPT-500-3	ALFH
M3A1	HMPT-500-3E	ALFJ
M3A1	HMPT-500-B	ALFK
M3A1	VTA-903T	ALFA
M3A2	HMPT-500	TASG
M3A2	HMPT-500-3	TASH
M3A2	HMPT-500-3E	TASJ
M3A2	HMPT-500-3TE	TASK
M3A2	VTA-903T	TASA
M3A3	VTA-903T	APHA
M3A3	HMPT-500	APHG
M4	6BT5.9	APCA
M4	VTA-903T	APCB
M4	HMPT-500-3E	APCG
M44A1	LDT-465-1C	TCFB
M487	A413	DXJG
M487	TMD27	DXJA
M48A5	1790-2A	ABCB
M48A5	1790-2DA	ABCD
M48A5	HYD SYS	ABCM
M48A5AVLB	1790-2DA	AREA
M48A5AVLB	CD850-6A	AREG
M48A5AVLB	CD850-6A1	AREH
M48A5AVLB	HYD SYS	AREN
M49A1C	LD-465-1C	BMXB
M49A1C	LDS-427-2	BMXA
M49A1C	LDT-465-1C	BMXD
M49A1C	LDT-465-1D	BMXC
M49A2C	LD-465-1	BMEA
M49A2C	LD-465-1C	BMEB
M49A2C	LDS-427-2	BMEE
M49A2C	LDT-465-1C	BMED
M49A2C	LDT-465-1D	BMEC
M4K	CASE-207D	DJVA
M4K	CLK18340	DJVG
M4K	HYD SYS	DJVN
M51A2	HYD SYS	BQEN
M5142	LDS-465-1	BQEA
M548	DD6V53	AEGA
M548	TX-100-1	AEGG

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
M548A1	DD6V53	AEUA
M548A1	TX-100-1	AEUG
M548A3	DD6V53T	AEUB
M548A3	X200-4	AEUH
M551A1	DD6V53	ALBB
M551A1	DD6V53T	ALBA
M551A1	G250-1A	ALBG
M551OPFOR	DD6V453T	ALDA
M551OPFOR	G250-1A	ALDG
M577A2	DD6V53	AEQA
M577A2	TX-100-1	AEQG
M577A3	DD6V53T	AEQB
M577A3	X200-4	AEQH
M58	DD6V53T	AE8B
M58	X200-4A	AE8H
M6	VTA-903T600	AP6A
M6	HMPT-500-3EC	AP6G
M60A1	CD850-6A1	ABHG
M60A1AVLB	1790-2DA	ARCA
M60A1AVLB	CD850-6A	ARCG
M60A1AVLB	CD850-6A1	ARCH
M60A1AVLB	HYD SYS	ARCN
M60A3	1790-2C	ABBA
M60A3	CD850-6A	ABBG
M60A3	CD850-6A1	ABBH
M60A3	HYD SYS	ABBN
M7	VTA-903T	AP7A
M7	HMPT-500-3EC	AP7G
M764	LD-465-1	BMVA
M792	DD353	BFAA
M809	NHC-250	TBNA
M809A1	NHC-250	TBPA
M810	NHC-250	TBQA
M811	NHC-250	BRNA
M811A1	NHC-250	TBRA
M811A2	NHC-250	TBSA
M812	NHC-250	TBTA
M812A1	NHC-250	TBUA
M813	NHC-250	BSBA
M813A1	NHC-250	BSDA

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
M814	NHC-250	BSKA
M815	NHC-250	BSEA
M816	HYD SYS	BSQN
M816	NHC-250	BSQA
M817	HYD SYS	BSRN
M817	NHC-250	BSRA
M818	NHC-250	BSHA
M819	HYD SYS	BSLN
M819	NHC-250	BSLA
M820	NHC-250	BSMA
M820A1	NHC-250	TBVA
M820A2	NHC-250	BSNA
M821	NHC-250	BSPA
M876	HYD SYS	BHAN
M876	IHD190	BHAA
M876	MT650	BHAG
M877	CAT-11614457	B3GH
M877	CAT-D333	B3GB
M878	DD6V53	BTAA
M877	PS4R219	B3GG
M878	MT653	BTAG
M878A1	DD6V53T	BTLA
M878A1	MT653	BTLG
M88A1	1790-2DR	AQAA
M88A1	HYD SYS	AQAN
M88A2	1790-8CR	AQAB
M88A2	HYD SYS	AQAM
M88A2	XT-1410-5A	AQAH
M9	HYD SYS	ASAN
M9	13.5HR3610-2	ASAG
M9	V903	ASAA
M901	DD6V53	AEMA
M901A1	DD6V53	AEVA
M901A1	TX-100-1	AEVG
M911	CLBT750	B5BG
M911	DD8V92T	B5BA
M911	DD8V92TA	B5BB
M911	HYD SYS	B5BN
M915	CAT-D7155	B4AG

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
M915	NTC-400	B4AA
M915A1	HT754CRD	B4BG
M915A1	NTC-400	B4BA
M915A2	DD12.7L	B4EA
M915A2	DDHT740	B4EG
M915A3	DDEC IV	B4LA
M915A3	HD4560P	B4LG
M915A4	BIG CAM I	B4MA
M915A4	HD4560P	B4MG
M916	CAT-D7155	B4CG
M916	HYD SYS	B4CN
M916	NTC400	B4CA
M916A1	DD12.7L	B4FA
M916A1	DDHT740	B4FG
M916A1	HYD SYS	B4FN
M916A2	DDEC III	B4JA
M916A2	HT740	B4JG
M916A2	HYD SYS	B4JN
M917	CAT-D7155	EZZG
M917	HYD SYS	EZZN
M917	NTC-400	EZZA
M917A1	DDC III	E5CA
M917A1	HT740	E5CG
M917A1	HYD SYS	E5CN
M917A1MCS	DDEC III	E5CB
M917A1MCS	HD456P	E5CH
M918	CAT-D7155	EXCG
M918	HYD SYS	EXCN
M918	NTC-400	EXCA
M919	CAT-D7155	EXDG
M919	HYD SYS	B4DN
M919	NTC-400	EXDA
M920	CAT-D7155	B4DG
M920	HYD SYS	B4DN
M920	NTC-400	B4DA
M923	MT654	BRYG
M923	NHC-250	BRYA
M923A1	MT654	BSSG
M923A1	NHC-250	BSSA
M923A2	6CTA0-8.3	BS7A

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
M923A2	MT654	BS7G
M924	MT654	BRXG
M924	NHC-250	BRXA
M924A1	MT654	BSUG
M924A1	NHC-250	BSUA
M925	HYD SYS	BRTN
M925	MT654	BRTG
M925	NHC-250	BRTA
M925A1	HYD SYS	BSTN
M925A1	MT654	BSTG
M925A1	NHC-250	BSTA
M925A2	6CTA-8.3	BS8A
M925A2	MT654	BS8G
M926	HYD SYS	BRWN
M926	MT654	BRWG
M926	NHC-250	BRWA
M926A1	HYD SYS	BSVN
M926A1	MT654	BSVG
M926A1	NHC-250	BSVA
M927	MT654	BRVG
M927	NHC-250	BRVA
M927A1	MT654	BSWG
M927A1	NHC-250	BSWA
M927A2	6CTA-8.3	BS9A
M927A2	MT654	BS9G
M928	HYD SYS	BRUN
M928	MT654	BRUG
M928	NHC-250	BSUA
M928A1	HYD SYS	TCHN
M928A1	MT654	TCHG
M928A1	NHC-250	TCHA
M928A2	6CTA-8.3	BTMA
M928A2	HYD SYS	BTMN
M928A2	MT654	BTMG
M929	HYD SYS	BTHN
M929	MT654	BTHG
M929	NHC-250	BTHA
M929A1	HYD SYS	BSYN
M929A1	MT654	BSYG
M929A1	NHC-250	BSYA

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
M926A1	HYD SYS	BSVN
M929A2	6CTA-8.3	BTNA
M929A2	HYD SYS	BTGN
M929A2	MT654	BTNG
M930	HYD SYS	BTGN
M930	MT654	BTGG
M930	NHC-250	BTGA
M930A1	HYD SYS	BSZN
M930A1	MT6654	BSZG
M930A1	NHC-250	BSZA
M93A1FOX	OM402A	559B
M93A1FOX	HP500 TYPE 6	559H
M93A1FOX	HYD SYS	559M
M930A2	6CTA-8.3	BTOA
M930A2	HYD SYS	BTON
M930A2	MT654	BTOG
M931	MT654	BTEG
M931	NHC-250	BTEA
M931A1	MT654	BS2G
M931A1	NHC-250	BS2A
M931A2	6CTA-8.3	BTPA
M931A2	MT654	BTPG
M932	HYD SYS	BTDN
M932	MT654	BTPG
M932	NHC-250	BTDG
M932A1	HYD SYS	BS3N
M932A1	MT654	BS3G
M932A1	NHC-250	BS3A
M932A2	6CTA-8.3	BTQA
M932A2	HYD SYS	BTQN
M932A2	MT654	BTQG
M934	MT654	BTBG
M934	NHC-250	BTBA
M934A1	MT654	BS4G
M934A1	NHC-250	BS4A
M931A2	6CTA-8.3	BTRA
M931A2	MT654	BTRG
M935	MT654	BTCG
M935	NHC-250	BTCA
M935A1	HYD SYS	BS5M

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
M935A1	MT654	BS5G
M935A1	NHC-250	BS5A
M935A2	6CTA-8.3	BTSA
M935A2	MT654	BTSG
M936	HYD SYS	BTFN
M936	MT654	BTFG
M936	NHC-250	BTFA
M936A1	HYD SYS	BS6N
M936A1	MT654	BS6G
M936A1	NHC-250	BS6A
M936A2	6CTA-8.3	BTTA
M936A2	HYD SYS	BTTN
M936A2	MT654	BTTG
M939	MT654	BRSG
M939	NHC-250	BRSA
M939A2	6CTA8.3	BRSB
M939A2	MT654	BRSH
M940	MT654	TBXG
M940	NHC-250	TBXA
M941	MT654	TBYG
M941	NHC-250	TBYA
M942	MT654	TBZG
M942	NHC-250	TBZA
M943	MT654	TCAG
M943	NHC-250	TCAA
M944	MT654	TCBG
M944	NHC-250	TCBA
M945	MT654	TCCG
M945	NHC-250	TCCA
M966	6.2 L DIESEL	BBCA
M966	THM-3L80	BBCG
M966	6.5 L DIESEL	BBCC
M966A1	6.2 L DIESEL	BBCB
M966A1	THM-3L80	BBCH
M966A1	6.5 L DIESEL	BBCD
M973	OM617952	BXAA
M973	W4A018	BXAG
M973A1	OM603.950	BXBA
M973A1	W4A040	BXBG
M977	DD8V92TA	B2GA

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
M977	DDA-HT740D	B2GG
M977	HYD SYS	B2GN
M978	DD8V92TA	B2HA
M978	DDA-HT740D	B2HG
M978	HYD SYS	B2HN
M981	DD6V53	AETA
M981	TX-100-1	AETG
M981A1	DD6V53T	TAQA
M981A1	TX-100-1	TAQG
M981A3	DD6V53T	TAQB
M981A3	X200-4	TAQH
M983	DD8V92TA	B2AA
M983	DDA-HT740D	B2AG
M983	HYD SYS	B2AN
M984	DD8V92TA	B2BA
M984	DDA-HT740D	B2BG
M984	HYD SYS	B2BN
M984A1	DD8V92TA	TCDA
M984A1	DDA-HT740D	TCDG
M984A1	HYD SYS	TCDN
M985	DD8V92TA	B2JA
M985	DDA-HT740D	B2JG
M985	HYD SYS	B2JN
M985E1	DD8V92TA	TCJA
M985E1	DDA-HT740D	TCJG
M985E1	HYD SYS	TCJN
M992A2	DD8V71TLHR	TAWB
M992A2	HYD SYS	TAWN
M992A2	XTG-411-4	TAWH
M993	HMPT-500	TANG
M993	HMPT-500-3	TANH
M993	HMPT-500-3E	TANJ
M993	HMPT-500-B	TANK
M993	VTA-903T	TANA
M996	6.2 L DIESEL	BBBA
M996	THM-3L80	BBBG
M996	6.5 L DIESEL	BBBC
M996A1	6.2 L DIESEL	BBBB
M996A1	THM-3L80	BBBH
M996A1	6.5 L DIESEL	BBBD

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
M997	6.2 L DIESEL	BBAA
M997	THM-3L80	BBAG
M997	6.5 L DIESEL	BBAC
M997A1	6.2 L DIESEL	BBAB
M997A1	THM-3L80	BBAH
M997A1	6.5 L DIESEL	BBAD
M997A2	6.5 L DIESEL	BCAC
M997A2	THM-4L80E	BCAG
M998	6.2 L DIESEL	BBDA
M998	THM-3L80	BBDG
M998	6.5 L DIESEL	BBDD
M998A1	6.2 L DIESEL	BBDB
M998A1	THM-3L80	BBDH
M998A1	6.5 L DIESEL	BBDE
M998A2	6.5 L DIESEL	BCDC
M998A2	THM-4L80E	BCDG
MCD	4.236	NA6A
MCD	542-L1	NA6G
MCD	HYD SYS	NA6M
MEMP, TN	COE	LVEA
MEMP, TN	COE	LVFA
MEMP, TN	COE	LVGA
MEP-003A	D198ERX51	VCDB
MEP-003A	100-1345	VCDD
MEP-003	100-345	VCDC
MEP-004A	D198ERX51	VCDA
MEP-005A	D298ERX37	VCCA
MEP-006A	AC3500	VECA
MEP-007A	CAT-D333CT	VCGA
MEP-007B	CAT-76-4106	VDSA
MEP-009A	CAT-D343TA	VEGA
MEP-009B	CAT-D3434TA	TVCA
MEP-012A	KTA-2300G	VEPB
MEP-029A	VTA-1710G	VFJA
MEP-029A	VTA-28G1	VFJB
MEP-103A	D198ERX51	VCEA
MEP-104A	D298ERX37	VCFA
MEP-105A	AC3500	VEDA
MEP-106A	CAT-D333CT	VCHA
MEP-108A	CAT-D343TA	VEVA

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
MEP-113A	D198ERX51	VLFA
MEP-114A	D298ERX37	VLGA
MEP-115A	AC3500	VLHA
MEP-116A	CAT-D333CT	TVBA
MEP-208A	KTA-2300G	VEPA
MEP-360A	GTCP36-50(H)	UAGA
MEP-360A	HYD SYS	UAGN
MEP-362A	TT10-1	VKEA
MEP-36A	16-567-E4	TUSA
MEP-36A50	16-567-E4	VEIA
MEP-36A60	CAT-D398A	VEHA
MEP-404B	T62T32A	VIBA
MEP-802A	DN2M-1	VG2A
MEP-803A	DN4M	VG3A
MEP-804A	C-240PW-28	VG4A
MEP-805A	JD4039T	VG5A
MEP-806A	JD6059T	VG7A
MEP-812A	DN2M-1	VG2B
MEP-813A	DN4M	VG3B
MEP-814A	C-240PW-28	VN4B
MEP-815A	JD4039T	VN5A
MEP-816A	JD6059T	VN6A
MEP-903A	D722TB-11	VCJA
MEP-903B	D722TB-11	VCJB
MEP-903C	D722TB-11	VCJC
MHE-269	A38714	DJ4A
MHE-269	MHR18325	DJ4G
MHE-270	1102T1236210	DJ6G
MHE-270	4B3.9	DJ6A
MHE-270	HYD SYS	DJ6N
MHE-271	1102T1236210	DJ5G
MHE-271	4B3.9	DJ5A
MHE-271	HYD SYS	DJ5N
MLT6	ALS 3331-1	DJJG
MLT6	DD453N	DJJA
MLT6	HYD SYS	DJJN
MLT6-2	DD453N	DJBF
MLT6-2	HYD SYS	DJBN
MLT6-2	R28422-1	DJBG
MLT6CH	ALS 3331-1	DJLG

Non-Aeronautical Army JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
MLT6CH	DD453N	DJLA
MLT6CH	HYD SYS	DJLN
MQ-1C	1.7 HFE DIESEL	RJAA
MQ-1C	2.0 HFE DIESEL	RJAB
MQ-1C	UNIVERSAL GBX	GJAA
MT250	DD6V53N	ELAA
MT250	HYD SYS	ELAN
MW24C	CASE-504BD	EFQA
MW24C	CASE-A504BDT	EFQB
MW24C	HYD SYS	EFQN
MW24C	TT2421-1	EFQG
OH-58D	HYD SYS	HKAD
P250WDMH268	DEUTZ	DWTA
PACAR9999	NHC-250	XMAA
PPU85-4	GTCP85-127	VAAB
PPU85-5	GTCP85-127	VAFA
PU405A/M	D198ERX51	VCNA
PU406B/M	D298ERX37	VCMA
PU495A/G	CAT-D333CT	VCLA
PU495B/G	CAT-76-4106	VDTA
PU650B/G	AC3500	VEMA
PU699A/M	AC3500	VFBA
PU700A/M	AC3500	VFCA
PU707A/M	AC3500	VLMA
PU732M	100-1345	VLLA
PU753M	100-1345	VLNF
PU760M	D298ERX37	VLNA
PU797	DN2M	VLPA
PU797A	DN2M	VLPB
PU798	DN4M-1	VLPC
PU798A	DN4M-1	VLPD
PU799	DN4M-1	VLPE
PU799A	DN4M-1	VLPF
PU800	C-240PW-28	VLLD
PU801	C-240PW-28	VLLB
PU801A	C-240PW-28	VLLE
PU805	JD6059T	VLND
PU806	JD6059T	VLNE
R60SL-DC	F4L912W	TDCA
R60SL-DC	HYD SYS	TDCN

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
R60SL-DC	PR-2	TDCG
RAIL C 25T	D13,000	XDGA
RAIL C 40T	DD671	TXCA
RMS-250	DD6V53N	TVRA
RS28	DD453	EVPA
RS28	HYD SYS	EVPN
RT41AA	126HR183278	ELLG
RT41AA	D3400X289	ELLA
RT41AA	HYD SYS	ELLM
RT875CC	6CTA-8.3	DKDA
RT875CC	CLARK-C273.5	DKDG
RT875CC	HYD SYS	DKDN
RTFL	6BT5.9	DJWA
RTFL	FUNK-1723	DJWH
RTFL	HYD SYS	DJWN
RTL10	CRT 3531-1	DJHG
RTL10	DD6V53	DJHA
RTL10	HYD SYS	DJHN
RTL10-1	CRT 3531-1	DJDG
RTL10-1	DD6V53	DJDF
RTL10-1	HYD SYS	DJDN
SM50068003	D398A 3AC	VEJA
SM50068004	CAT-D398A	VEKA
SM54A	DEUTZ-F2L51	TETA
SP848	DD353	EUUA
SP848	HYD SYS	EUUN
ST	320	WAKB
ST-TUG-200	6DCMR 1879	WAKA
ST-TUG-600	3004	WALA
SU252G	CSG64916001H	NA8A
SU252G	C-6	NA8G
T449	180DAC	TWWB
T449	CAT-D375	TWWA
TC6DO42	350LIDV85.7L	NB4A
TC6DO42	AT545	NB4G
TC6DO42	3043LE	NA3G

Non-Aeronautical Army JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
TC6DO42	HYD SYS	NB4M
TMS-300-5	DD671	ELHA
TMS-300-5	HYD SYS	ELHN
TO730HKEG	6BT5.9	E45A
TO730HKEG	HYD SYS	E45N
TUG-900	6B5.9-G1	WA2A
TUG-900	KTA19-M3	WA2B
UNKNOWN	HYDRAULIC	XXHN
UNKNOWN	MINERAL	XXMX
UNKNOWN	SYNTHETIC	XXSX
US612ACD1	DEUTZ-91213	ZD8A
PU802	C-240PW-28	VLLC
PU803	JD4039T	VLNB
PU804	JD4039T	VLNC
US90CCD1	DD353	ZHCA
W150Y	28265	DJ7A
W150Y	AUTO79410	DJ7G
W150Y	HYD SYS	DJ7M
W15A	ENDT-673	TEVA
WC17	TMD	NB6A
WC17	W410TT	NB6G
WF1700/1000	DD8V92T	ZM3A
WF1700/1000	TD61-1168	ZM3G
WPS6006	JD4039T	VG6A
XJJL72	RCR4.078GAEA	NA3A
XJJL72	3043LE	NA3G
XJJL72	TCR4.01BGFEK	NB3B
XM104	AGT-1500	ARDA
XM104	X1100-3B	ARDG
XM104	HYD SYS	ARDM

Table 5 – Non-Aeronautical JOAP Type Equipment Codes Army Corps of Engineers Components

Non-Aeronautical Army Corps JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
10235100	DD2A102916	852A
10245102	DD2A0105034	854A
10245102	DD2A0105612	853A
10245102	DD2A0106018	656A
10245102	DD2A0106038	855A
10245102	DD2A0106177	857A
175DG1803	NT-855	858A
22BM	JN61	831A
250D33	CAT-D353	85DA
4031C	DD4A171904	819A
500FD63D47A	MT865PG270	85AA
599C	DD471	81BA
67110431	LCN8	822A
71637305	DD16VA019218	85CA
71637305	DD16VA019219	85BA
76SX9E	CAT-3304PC	85GA
80623400	DD6VF079684	8F1A
80827400	DD6VF079688	8F2A
80827402	DD80827402	EF3A
ALEXANDER	271	893B
ALEXANDER	DD12V71	893A
ALEXANDER	MG512	893G
B-40FT	DD453	811A
B-40FT	HYD SYS	811N
BAYFIELD	DD671	8D7A
BIENBILLE	371	8A2B
BIENBILLE	DD12V71	8A2A
BIENBILLE	MG514	8A2G
BRAY	DD692	81CA
BRETON	15MOL3J1A	899B
BRETON	DD8V71	899A
BRETON	MH20L	899G
BURRWOOD	271	898B
BURRWOOD	DD12V71T	898A
BURRWOOD	MG514	898G
C-1303-24	AI45MSX8	8D3A
CAT-130G	5R6192	861G
CAT-130G	5R6192	862G
CAT-130G	CAT-3304	85HA
CAT-130G	CAT-3304DI	862A
CAT-130G	CAT-3304DIT	861A
CAT-130G	HYD SYS	861N
CAT-130G	HYD SYS	862N
CAT-D4	CAT-3306	8B1A
CAT-D4	CAT-7R559	8B7G
CAT-D4	HYD SYS	8B1N
CAT-D5	CAT-3306	8B3A
CAT-D5	3S7094	8B3G
CAT-D5	HYD SYS	8B3N
CAT-D7E	CAT-3R2211	8B2G
CAT-D7E	HYD SYS	8B2N
CHALMETTE	8.0MDKD3CR	897B
CHALMETTE	DD8V71	897A
CHALMETTE	M20L	897G
D6	CAT-D333	8B4A
D7H	CAT-3306B	8B6A
DAVID BOYD	DD8V92	89EA
DULUTH	AI45M5X8	8D8A
DULUTH	GM271G3	8D8B
F800	C8.3	8C5A
FAIRCHILD	DD671	8D6A
FORNEY	DD371	8DAA
FREDERICK	DD271	8DBA
G-1	DD353	851A
GRANADA	271	896B
GRANADA	DD12V71T	896A
GRANADA	MG514	896G
H60XL-MIL	360311	841G
H60XL-MIL	HYD SYS	841N
H60XL-MIL	ISUZU-C240	841A
HAMMOND BAY	DD671	8D4A
HARVEY	DD371	814A

Non-Aeronautical Army Corps JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
HODGE	DD8V92	89CA
HURON	DD453	817A
JD550	HYD SYS	8B5N
JD550	JD4276TT01	8B5A
JD550	JDAT49678	8B5G
JOHN BOPP	8.0614D	895B
JOHN BOPP	DD8V92	895A
JOHN BOPP	MH20L	895G
KENT	16V1499	8A3A
KENT	DD671	8A1A
KENT	DD671	8A3B
KENT	MG540	8A3G
L9000	CAT-3406C	8C4A
LABORDE	11.0KWD	89BA
LABORDE	DD8V71	894A
LABORDE	MH20L	894G
LB-1	DD453	8E2A
LB-1	HYD SYS	8E2N
LT-18	GM3906	8D1A
LUDINGTON	GM371R641	8DCA
M109A5	DD8V71T	3E7A
M109A5	HYD SYS	3E7N
M109A5	XTG-411-2A	3E7G
M109A6	DD8V71T	3FCA
M109A6	HYD SYS	3FCN
M109A6	XTG-411-4	3FCG
M4K	CASE-207D	8C1A
M4K	CLK18340	8C1G
M4K	HYD SYS	8C1N
M50A1	DD671	8C2A
M578	DD8V71T	3LAA
M578	HYD SYS	3LAN
M578	XTG-411-2A	3LAG
MANITOWAC	DD353	812A
MT250	HYD SYS	831N
MW24C	CASE-504BD	871A
MW24C	HYD SYS	871N

Non-Aeronautical Army Corps JOAP TEC's		
EIMOD	**COMPMOD**	**JOAP TEC**
MW24C	TT24211	871G
N CENTRAL	DD8V71	89FA
NI9752	DD671	83CA
NICOLET	DD471	818A
P38	DD853	891A
PAJ	DD8V92	89DA
PB-1	GMC871	881A
PU406A/M	D298ERX37	85FA
RACINE	DD353	8D2A
RG4031C	DD4A171903	81AA
RT855B	CAT-3116	832A
RT855B	HYD SYS	832M
RT855B	R32620-4	832G
RTCH-MC	3P9094	MDAW
RTCH-MC	CAT-3408T	MDAC
RTCH-MC	CAT-5R3855	MDAJ
RTCH-MC	HYD SYS	MDAN
S2200	NTC-240	8C3B
S2200	NTC-300	8C3C
S2200	NTC-855	8C3A
SCOW #31	DD6068	815A
SCOW #32	DD671	816A
SHOALHUNTER	CAT-3406B	824A
SPD-1	DD371	8E4A
SPD-1	DD6V71	8E4B
SR-4	CAT-3304	85EA
TAWAS BAY	DDD671	8D9A
TBCL4	DD16V149	8A4A
TBCL4	DD671	8A4B
TBCL4	MG540	8A4G
TD-15C	IHDT-466B	8B8A
UPS-8	DD671	81DA
USCCBMK1	363CI	821A
VELER	DD371	813A
W-38	DDC671	892A
W-38	MG509	892G
W-46	8.0MKDB/1	89AB

Non-Aeronautical Army Corps JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
W-46	M20L	89AG
W-48	DD8V71	89AA
WHITEFISH	DD12V71	8D5A
XM93FOX	HP500 TYPE 6	559G
XM93FOX	HYD SYS	559N
XM93FOX	OM402A	559A
YF-865	DD371	8E6A
YF-865	DD6V149	8E6B
YSD-22	DD12V71	8E3A
YSD-22	DD471	8E3B

Non-Aeronautical Army Corps JOAP TEC's		
EIMOD	COMPMOD	JOAP TEC
YSD-59	DD12V71	8E5A
YSD-59	DD471	8E5B
YSD-67	DD671	823B
YSD-67	NTA855M	823A
YSD-78	DD353	8E7A
YSD-78	DD371	8E7B
YSD-78	DD671	8E7C
YSD-78	DD6V53	8E7D

Table 6 – Non-Aeronautical Type Equipment Codes US Air Force Components

EIMOD	COMPMOD	JOAP TEC
100KW-AF	NTC-380-1	LVAA
1750KW-AF	DSR38	LVBA
87H-AF	AIR-COMP	LVCA
FS136SC-AF	NORDBERG	LVDA
PWR GEN-AF	DSK38	VJAA
PWR GEN-AF	S-12NPTA	VJBA
SF256128-AF	AIR COMP	LVHA

Table 7 – Non-Aeronautical Type Equipment Codes
Flight Simulators and Aircraft Servicing Carts

END ITEM	COMPONENT	JOAP TEC
UH-60FS	Hydraulic Pump	HLAA
UH-1FS	Hydraulic Pump	HAA1
CH-47FS	Hydraulic Pump	HEAD
Oil Cart (PON-6)	MIL-PRF-83282	DRHA
Oil Servicing Cart/System	MIL-PRF-87257	DRHB
Oil Servicing Cart/System	MIL-PRF-23699	DRBA
Oil Servicing Cart/System	MIL-PRF-7808	DRAA
Oil Servicing Cart/System	MIL-PRF-8188	DRFA
Oil Servicing Cart/System	DOD-PRF-85734	DRGA

Table 8 – Non-Aeronautical Type Equipment US Navy Ships Equipment

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
	ANCHORS	
ALL	ANCHOR HYDRAULIC	1A01
ALL	ANCHOR 80-90	1A02
	CRANES	
ALL	CRANE 80-90	2A01
ALL	CRANE 17672 - 2135	2A02
ALL	CRANE 9250	2A03
ALL	CRANE 2190	2A04
ALL	CRANE 2104	2A05
ALL	CRANE 17672 – 2075	2A06
ALL	CRANE 5W-40	2A07
	HYDRAULIC EQUIPMENT	
ALL	HYDRAULIC POWER UNIT	3A01
ALL	HYDRAULIC MIL-PRF-17672 2075TH	3A02
ALL	HYDRAULIC MIL-PRF-17672 2110TH	3A03
ALL	HYDRAULIC MIL-PRF-17672 2135TH	3A04
ALL	HYDRAULIC MIL-DTL-32353	3A05
ALL	HYDRAULIC MIL-PRF-17331	3A06
	AIR CONDITIONING AND REFRIGERATION	
ALL	HFC-134a AIR CONDITIONING/REFRIGERATION POE 68	4001
ALL	R-114 AIR CONDITIONING/REFRIGERATION RC02	4002
ALL	HFC-236fa AIR CONDITIONING/REFRIGERATION POE 46	4004
ALL	HFC-134a AIR CONDITIONING/REFRIGERATION POE 32	4005

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
ALL	HFC-134a AIR CONDITIONING/REFRIGERATION POE 120	4006
ALL	HFC-134a AIR CONDITIONING/REFRIGERATION POE 170	4007
	MISCELLANEOUS EQUIPMENT	
ALL	MISCELLANEOUS EQUIPMENT 2190	5A01
ALL	MISCELLANEOUS EQUIPMENT 9250	5A02
ALL	MISCELLANEOUS EQUIPMENT 23699	5A03
ALL	MISCELLANEOUS EQUIPMENT HYDRAULIC	5A04
ALL	MISCELLANEOUS EQUIPMENT 80-90	5A05
ALL	MISCELLANEOUS EQUIPMENT 32353	5A06
	BLOWERS	
ALL	BLOWER 2190	6A0Y
	TURBO CHARGERS	
ALL	TURBO CHARGERS 9250	7001
	MISC GENERATORS	
ALL	MISC GENERATORS 9250	8001
ALL	MISC GENERATORS 2190	8002
	AIR COMPRESSORS	
ALL	AIR COMPRESSORS 2190	AA01
ALL	AIR COMPRESSORS 9250	AA02
ALL	AIR COMPRESSORS 23699	AA03
ALL	AIR COMPRESSORS HYDRAULIC	AA04
	BEARINGS	
ALL	BEARINGS 2190	B001

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
	CONTROLLABLE PITCH PROPELLERS	
CG 47 Class	ROLLS ROYCE NAVY MARINES 115652102	C80M
CG 66 Class	ROLLS ROYCE NAVY MARINES 115652103	C8AM
DDG 51 Class	ROLLS ROYCE NAVY MARINES 7309	CF1M
DDG 993 Class	ROLLS ROYCE NAVY MARINES 115657001	CF2M
LCAC Class	DOWDY CO. LTD.	CH0N
LHA-6 Class	LHA6 CPP	CI0M
LHD 1 Class	ROLLS ROYCE NAVY MARINES 80-3S-CP	CI1M
LHD-8 Class	LHD8 CPP	CI2M
LPD 17 Class	LPD CPP	CJ0M
LSD 41 Class	ROLLS ROYCE NAVY MARINES 112152001	CN0M
LSD 49 Class	ROLLS ROYCE NAVY MARINES 112157071	CP0M
MCM 1 Class	ROLLS ROYCE NAVY MARINES 7309	CR0M
MISC Class	MISC CPP	CH5M
WAGB 10 Class	ROLLS ROYCE NAVY MARINES	CU0M
WHEC 715 Class	ROLLS ROYCE NAVY MARINES	CV0M
WLB 200 Class	ROLLS ROYCE NAVY MARINES	CW0M
WMEC 620 Class	ROLLS ROYCE NAVY MARINES	
	DWG620WPC4301-51	CX0M
	GUIDED MISSLE SYSTEMS	
ALL	GUIDED MISSILE HYDRAULIC	D001
	EMERGENCY DIESEL GENERATORS	
CVN 65 Class	GENERAL MOTORS CORP. 16-567C	ED08
CVN 68 Class	GENERAL MOTORS CORP. LL16-645E5	EE08
CVN 68 Class	GENERAL MOTORS CORP. LL16-645E5N	EEA8
DDG 1000 Class	CATERPILLAR INC. C 18	EF01
LCC 19 Class	COLTEC INDUSTRIES INC. 6-38D8 1/8	EH13
LHD 1 Class	.ALCO 16 251C	EI13
MCM Class	MCM EDG	ER00
MCS 12 Class	COLTEC INDUSTRIES INC. 12-38D8 1/8	ER13
ALL	MISC EDG	EH50

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
SSBN 726 Class	COLTEC INDUSTRIES INC. 38ND8 1/8	ET03
SSN 21 Class	COLTEC INDUSTRIES INC. 38ND8 1/8	ET13
SSN 637 Class	COLTEC INDUSTRIES INC. 38F5 1/4	ET23
SSN 640 Class	COLTEC INDUSTRIES INC. 38F5 1/4	ET33
SSN 671 Class	COLTEC INDUSTRIES INC. 38F5 1/4	ET43
SSN 688 Class	COLTEC INDUSTRIES INC. 38ND8 1/8	ET53
WAGB 10 Class	DETROIT DIESEL CORP. 16V149	EU01
WLB 200 Class	CATERPILLER INC. 3406TA	EW02
WLB 277 Class	DETROIT DIESEL CORP. 8V-71	EW11
WLB 277 Class	CATERPILLER INC. 3306DI	EW12
WLIC 298 Class	DETROIT DIESEL CORP. #6-71	EW51
WLIC 75301 Class	DETROIT DIESEL CORP. #4-71	EW61
WLIC 75301 Class	DETROIT DIESEL CORP. #6-71	EWB1
WLM 540 Class	CATERPILLER INC. 406T	EW82
WLR 311 Class	DETROIT DIESEL CORP. #3-53	EW91
WLR 75401 Class	DETROIT DIESEL CORP. #4-71	EWY1
WMEC Class	CATERPILLER INC. 3306	EX02
WMEC Class	CATERPILLER INC. D348TA	EXA2
	FIN STABLIZIERS	
ALL	FIN STABILIZER HYDRAULIC	F001
	GAS TURBINE ENGINES	
CG 47 Class	STEWART & STEVENSON SERVICES INC 139A200	G80J
CG 47 Class	GENERAL ELECTRIC CO LM2500	G80O
DDG 51 Class	LM2500	GF1M
DDG 51 Class	ALLIED SIGNAL GTCP 100-82	GF1P
DDG 1000 Class	ROLLS ROYCE MT-30	GF2M
LCAC Class	AVCO-LYCOMING TF40B	GH0Q
LCAC Class	SUNDSTRAND T-62T-40-7	GH0R
LCS-1 Class	ROLLS ROYCE MT-30	GJ1M
LCS-2 Class	LM2500	GJ2M
LHA-6 Class	LM2500+	GK1M
LHD-8 Class	LM2500+	GL1M
MCM 1 Class	SOLAR T-1000S-28AA	GR0B

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
MCM 1 Class	SOLAR T-1302S-28AA	GRAB
WHEC Class	WHEC GTE	GV0M
	GAS TURBINE GENERATORS	
CG 47 Class	ALLISON 501-K17 2190	H80Y
CG 47 Class	ALLISON 501-K17 23699 (C/I)	H80Z
DDG 51 Class	ALLISON 501 2190	HF1Y
DDG 51 Class	ALLISON 501 23699 (C/I)	HF1Z
DDG 1000 Class	MT-5 23699 (HTS)	HF3Y
LCAC Class	ALLISON 501 2190	HH0Y
LCAC Class	ALLISON 501 23699	HH0Z
WHEC	WHEC GTG	HV00
	FANS	
ALL	SCAVENGER FAN HYDRAULIC	I001
	GEARS	
ALL	GEARS 2190	J001
ALL	GEARS 80-90	J002
ALL	GEARS 23699	J003
ALL	GEARS HYDRAULIC	J004
ALL	GEARS 9250	J005
ALL	GEARS 85W-140	J006
	ROCKER ARMS	
LSD 41 CLASS	COLTEC IND. INC. DIESEL ENG ROCKER ARMS	KN03
LSD 49 CLASS	COLTEC IND. INC. DIESEL ENG ROCKER ARMS	KP03
	ELEVATORS NON HYDRAULIC	
CG 47 CLASS	CG 47 ELEVATOR-NON HYDRAULIC	L800
CVN 65	WESTINGHOUSE	LD07
CVN 68 CLASS	JARED INDUSTRIES INC	LE0A

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
CVN 68 CLASS	RUCKER	LE0E
DD 963 CLASS	DD 963 ELEVATOR NON HYDRAULIC	LF00
LHD 1 CLASS	SCHINDLER ELEVATOR CORP	LI0S
MCS 12 CLASS	JARED INDUSTRIES INC	LR1A
	ELEVATORS HYDRAULIC	
CG 47 CLASS	CG 47 ELEVATOR HYDARULIC	L8A0
CVN 65	WESTINGHOUSE	LDA7
CVN 68 CLASS	RUCKER	LEAA
CVN 68 CLASS	JARED INDUSTRIED INC	LEAE
DD 963	DD 963 ELEVATOR HYDRAULI	LFA0
LHD 1 CLASS	SCHINDLER ELEVATOR CORP	LIBS
LPD 17 CLASS	CARGO WEAPONS ELEVATOR	LK01
MSC 12	JARED INDUSTRIED INC	LRAS
	MAIN DIESEL ENGINES	
LCS-1 CLASS	COLT PIELSTICK PA6B	ML01
LCS-2 CLASS	MTU 8000	ML02
LSD 41 CLASS	COLTEC INDUSTRIES INC. PC2.5V-LL1	MN03
LSD 41 CLASS	COLTEC INDUSTRIES INC. PC2.5V-LR1	MNA3
LSD 41 CLASS	COLTEC INDUSTRIES INC. PC2.5V-RL1	MNB3
LSD 41 CLASS	COLTEC INDUSTRIES INC. PC2.5V-RR1	MNC3
MCM 1 CLASS	ISOTTA FRASCHINI SPA. 36SS6V-AM	MR0F
MCM 1 CLASS	WAUKESHA L1616DSIN	MR0G
MHC 51 CLASS	ISOTTA FRASCHINI SPA. ID36SS8V-AM	MS0F
TWR CLASS	CATERPILLAR INC. 3512	MT62
MISC	MISC MDE	MH50
PC	PC MDE	MH30
WAGB 10 CLASS	ALCO PRODUCTS INC. 16-251-F	MU00
WAGB 10 CLASS	DETROIT DIESEL CORP. 6V53	MU01
WAGB 10 CLASS	CUMMINS ENGINE CO. INC. 4BT3.9M	MU04
WAGB 10 CLASS	FAIRBANKS MORRIS 12-38D8-1/8	MU09
WAGB 10 CLASS	SULZER 12ZA40S	MU0H
WHEC 715 CLASS	CUMMINS ENGINE CO. INC. 4BT3.9M	MV04
WHEC 715 CLASS	VOLVO PENTA OF AMERICA INC. B31B	MV06

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
WHEC 715 CLASS	FAIRBANKS MORRIS 12-38TD8-1/8	MV09
WHEC 716 CLASS	DETROIT DIESEL CORP. #3-53	MV01
WLB 200 CLASS	CATERPILLER INC. 3608	MW02
WLB 200 CLASS	CUMMINS ENGINE CO. INC. 4BT3.9M	MW04
WLB 277 CLASS	DETROIT DIESEL CORP. #3-53	MW11
WLB 277 CLASS	VOLVO PENTA OF AMERICA INC. B31B	MW16
WLB 277 CLASS	GENERAL MOTORS CORP. R8645E6	MW18
WLI 313 CLASS	CATERPILLER INC. D-353	MW32
WLI 65303 CLASS	DETROIT DIESEL CORP. 8V-71N	MW41
WLIC 298 CLASS	CATERPILLER INC. D-353D	MW52
WLIC 75301 CLASS	CATERPILLER INC. D-353E	MW62
WLIC 800 CLASS	CATERPILLER INC. D-379	MW72
WLM 540 CLASS	CATERPILLER INC. D-353	MW82
WLM 540 CLASS	CATERPILLER INC. D398LH	MWB2
WLM 540 CLASS	CATERPILLER INC. D398RH	MWC2
WLM 685 CLASS	CATERPILLER INC. 3508	MWA2
WLR 311 CLASS	CATERPILLER INC. D-379	MW92
WLR 65501 CLASS	CATERPILLER INC. D-353	MWX2
WLR 75401 CLASS	CATERPILLER INC. D-353	MWY2
WMEC CLASS	ALCO PRODUCTS INC. 16MS-251CE	MX00
WMEC CLASS	CUMMINS ENGINE CO. INC. 4BT3.9M	MX04
WMEC CLASS	VOLVO PENTA OF AMERICA INC. B31B	MX06
WMEC CLASS	GENERAL MOTORS CORP. 645	MX08
WMEC CLASS	FAIRBANKS MORRIS 38D8-1/8	MX09
WMEC CLASS	ALCO PRODUCTS INC. 251F18MS	MXA0
WPB 1301 CLASS	CATERPILLER INC. 3516	MY02
WPB 1301 CLASS	PAXMAN 16RP200M	MY0I
WPB 82333 CLASS	CATERPILLER INC. 3412	MY12
WTGB 101 CLASS	FAIRBANKS MORRIS 8-38D8-1/8	MZ09
WYTL 65601 CLASS	CATERPILLER INC. 3412	MZ12
YTB	YTB MDE	MH40
	NITROGEN GENERATION PLANT	
ALL	NITRO PLANT	2190

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
	SMALL BOYS DIESEL ENGINES	
CG 47 CLASS	DETROIT DIESEL CORP. 5062-3000	O801
CG 47 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	O804
CG 47 CLASS	VOLVO PENTA OF AMERICA INC AQAD41A-DP290A	O806
CG 47 CLASS	DETROIT DIESEL CORP. 5062-70006V53N	O8A1
CVN 65	DETROIT DIESEL CORP. 6072M6-71RC	OD01
CVN 65	WESTERBEKE CORP. 4-107	OD05
CVN 65	DETROIT DIESEL CORP. 64HN106-71RC19H	ODA1
CVN 65	DETROIT DIESEL CORP. 64HN9KCLG	ODB1
CVN 68 CLASS	DETROIT DIESEL CORP. 1062-6001	OE01
CVN 68 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	OE04
CVN 68 CLASS	WESTERBEKE CORP. 10488 SPEC B	OE05
CVN 68 CLASS	DETROIT DIESEL CORP. 1062-7000	OEA1
CVN 68 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M2	OEA4
CVN 68 CLASS	WESTERBEKE CORP. 108U-14088	OEA5
CVN 68 CLASS	DETROIT DIESEL CORP. 6072M6-71LC	OEB1
CVN 68 CLASS	DETROIT DIESEL CORP. 6072M6-71RC	OEC1
CVN 68 CLASS	DETROIT DIESEL CORP. 64HN9HTEXCH	OED1
CVN 68 CLASS	DETROIT DIESEL CORP. 64HN9KCLG	OEE1
DDG 51 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	OF14
DDG 51 CLASS	VOLVO PENTA OF AMERICA INC AQAD41A-DP290A	OF16
DDG 993 CLASS	DETROIT DIESEL CORP. 1062-6001	OF21
DDG 993 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	OF24
DDG 993 CLASS	VOLVO PENTA OF AMERICA INC AQAD41A-DP290A	OF26
LCC 19 CLASS	DETROIT DIESEL CORP. 5042-40004-53LD	OH11
LCC 19 CLASS	DETROIT DIESEL CORP. 6088M	OHA1
LCC 19 CLASS	DETROIT DIESEL CORP. 6088M-ALUM-6-71	OHB1
LCC 19 CLASS	DETROIT DIESEL CORP. 6121T6-71LC	OHC1
LCC 19 CLASS	DETROIT DIESEL CORP. 64HN9KCLG	OHD1
LHD 1 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	OI14
LHD 1 CLASS	VOLVO PENTA OF AMERICA INC 6AQAD40-867734	OI16
LHD 1 CLASS	VOLVO PENTA OF AMERICA 6AQAD40B-867936	OIA6
LHD 1 CLASS	DETROIT DIESEL CORP. 1062-7000	OIC1
LHD 1 CLASS	DETROIT DIESEL CORP. 7082-7399RC-8V71TI	OID1
LHD 1 CLASS	DETROIT DIESEL CORP. 8062-7403RC	OIE1
LSD 41 CLASS	DETROIT DIESEL CORP. 1062+D417-7000	ON01

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
LSD 41 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	ON04
LSD 41 CLASS	DETROIT DIESEL CORP. 6072M6-71RC	ONA1
LSD 41 CLASS	DETROIT DIESEL CORP. 7082-7399-8V71TI	ONB1
LSD 41 CLASS	DETROIT DIESEL CORP. 7082-7399RC-8V71TI	ONC1
LSD 41 CLASS	DETROIT DIESEL CORP. 7122-7000	OND1
LSD 41 CLASS	DETROIT DIESEL CORP. 8062-7403RC	ONE1
MCS 12	CUMMINS ENGINE CO. INC. 4B3.9-M	OR14
MCS 12	CUMMINS ENGINE CO. INC. 6BTA5.9-M	ORA4
ALL	MISC DIESEL ENGINE	OH50
	PUMPS	
ALL	PUMP 2190 LUBE	P001
ALL	PUMP 2190	P002
ALL	PUMP 9250	P003
	DAVIT	
ALL	DAVIT 2190 LUBE	Q001
ALL	DAVIT HYDRAULIC	Q002
ALL	DAVIT HYDRAULIC 17672 2075	Q003
	REDUCTION GEAR	
CG 47 CLASS	REDUCTION GEAR 2190	R80Y
CG 47 CLASS	REDUCTION GEAR 23699	R80Z
CVN 65 CLASS	REDUCTION GEAR 2190	RD0Y
DDG 51 CLASS	REDUCTION GEAR 23699	RF1Z
DDG 993 CLASS	REDUCTION GEAR 2190	RF2Y
LCAC CLASS	REDUCTION GEAR 23699	RH0Z
LCC 19 CLASS	REDUCTION GEAR 2190	RH1Y
LCU CLASS	REDUCTION GEAR 9250	RH2W
LCS-1 CLASS	REDUCTION GEAR 2190	RL1Y
LCS-2 CLASS	REDUCTION GEAR MOBIL DEVLAC	RL2Y
LHD-8 CLASS	REDUCTION GEAR 2190	RI2Y
LPD 17 CLASS	REDUCTION GEAR 2190	RJ1Y
LSD 41 CLASS	REDUCTION GEAR 2190	RN0Y

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
LSD 49 CLASS	REDUCTION GEAR 2190	RP0Y
MCM 1 CLASS	REDUCTION GEAR 9250	RR0W
MCM 1 CLASS	REDUCTION GEAR 23699	RR0Z
MHC 51 CLASS	REDUCTION GEAR 2190	RS0Y
TWR CLASS	REDUCTION GEAR 7241	RT62
ALL	REDUCTION GEAR 2190	R50Y
ALL	REDUCTION GEAR 23699	R50Z
ALL	REDUCTION GEAR 9250	R50W
PC CLASS	REDUCTION GEAR 9250	RH3W
SSN 688 CLASS	REDUCTION GEAR	RT50
WAGB CLASS	REDUCTION GEAR 9250	R40W
WAGB 10CLASS	REDUCTION GEAR 9250	RU0W
WHEC CLASS	REDUCTION GEAR 9250	RV0W
WHEC 715 CLASS	REDUCTION GEAR 23699	RV0Z
WIX CLASS	REDUCTION GEAR 9250	RV1W
WLB 200 CLASS	REDUCTION GEAR 9250	RW0W
WLB 277 CLASS	REDUCTION GEAR 9250	RW1W
WLIC 75401 CLASS	REDUCTION GEAR 9250	RW6W
WLM 540 CLASS	REDUCTION GEAR 9250	RW8W
WLR 311 CLASS	REDUCTION GEAR 9250	RW9W
WLR 65501 CLASS	REDUCTION GEAR 9250	RWXW
WMEC CLASS	REDUCTION GEAR 9250	RX0W
WPB 1301 CLASS	REDUCTION GEAR 9250	RY0W
WPB 82312 CLASS	REDUCTION GEAR 9250	RY1W
WYTL 65501 CLASS	REDUCTION GEAR 9250	RZ1W
YTB CLASS	REDUCTION GEAR 9250	RH4W
	SHIP SERVICE DIESEL GENERATORS	
LCC 19 CLASS	8CATERPILLAR 3508	SH13
LCS-1 CLASS	ISOTTA FRASCHINI V1708	SH1L
LCS-2 CLASS	MTU 396	SH2L
LCU CLASS	LCU SSDG	SH20
LHD 1 CLASS	LHD1 SSDG	SI10
LSD 41 CLASS	COLTEC INDUSTRIES INC.38ND8 1/8	SN03
MCM CLASS	MCM SSDG	SR00
TWR CLASS	CATERPILLAR INC. 3304	ST62

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
ALL	MISC SSDG	S500
PC CLASS	PC SSDG	SH30
WAGB 10 CLASS	ALCO PRODUCTS INC. 8-251-E	SU00
WAGB 10 CLASS	CATERPILLER INC. D-379	SU02
WHEC 715 CLASS	GENERAL MOTORS CORP. 8-645-E2	SV08
WHEC 715 CLASS	GENERAL MOTORS CORP. 8-645-E2	SVA8
WHEC 715 CLASS	GENERAL MOTORS CORP. 8-645-E2	SVB8
WHEC 715 CLASS	GENERAL MOTORS CORP. 8-645-E2	SVC8
WLB 225 CLASS	CATERPILLER INC. 3508	SW02
WLB 277 CLASS	DETROIT DIESEL CORP. 6V-92	SW11
WLB 297 CLASS	DETROIT DIESEL CORP. #6-71	SWA1
WLI 313 CLASS	DETROIT DIESEL CORP. #3-71	SW31
WLI 65303 CLASS	DETROIT DIESEL CORP. #2-71	SW41
WLIC 298 CLASS	DETROIT DIESEL CORP. #3-71	SW51
WLIC 298 CLASS	CATERPILLER INC. 3304	SW52
WLIC 800 CLASS	DETROIT DIESEL CORP. #4-71	SW71
WLM 540 CLASS	DETROIT DIESEL CORP. #6-71	SW81
WLM 540 CLASS	CATERPILLER INC.340TA	SW82
WLR 311 CLASS	DETROIT DIESEL CORP. #4-71	SW91
WLR 65501 CLASS	DETROIT DIESEL CORP. #3-71	SWX1
WLR 65501 CLASS	CATERPILLER INC. 3304	SWX2
WLR 75401 CLASS	DETROIT DIESEL CORP. #3-71	SWY1
WLR 75401 CLASS	CATERPILLER INC. 3304	SWY2
WMEC CLASS	CATERPILLER INC. 3406BDT	SX02
WMEC CLASS	CATERPILLER INC. D398B(TA)	SXA2
WPB 1301 CLASS	CATERPILLER INC. D3304BT	SY02
WPB 82333 CLASS	CUMMINS ENGINE CO. INC. 4B3.9GM	SY14
WTGB 101 CLASS	CATERPILLER INC. 3306B	SZ02
WTGB 101 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M2	SZ04
WTGB 101 CLASS	MURPHY MP-24T	SZ0K
WYTL 65601 CLASS	CATERPILLER INC. D-311	SZ12
YTB CLASS	YTB SSDG	SH40
	TANKS	
ALL	TANK 9250	T001
ALL	TANK 2190	T002

Non-Aeronautical JOAP TEC's US Navy Ships Equipment		
End Item	**Component**	**JOAP TEC**
ALL	TANK 23699	T003
ALL	TANK HYDRAULIC	T004
	GUN MOUNT	
ALL	GUN MOUNT HYDRAULIC	U001
	BOW THRUSTERS	
ALL	BOW THRUSTER HYDRAULIC	V001
	WINCHES	
ALL	WINCH HYDRAULIC	W001
ALL	WINCH 80-90	W002
ALL	WINCH 23699	W003
ALL	WINCH MIL-PRF-17111	W004
ALL	WINCH MIL-H-83282	W005
	WATERJETS	
LCS-1 Class	ROLLS ROYCE WATERJET	WJ01
LCS-2 Class	WARTSILLA WATERJET	WJ02
	STEAM TURBINE GENERATORS	
CVN 65	CV 65 STEAM TURBINE GENERATORS	YD00
CVN 68 CLASS	CV68 STEAM TURBINE GENERATORS	YE01
LCC 19 CLASS	LCC 19 STEAM TURBINE GENERATORS	YH11
LHD 1 CLASS	LHD 1 STEAM TURBINE GENERATORS	YI11
MCS 12	MCS 12 STEAM TURBINE GENERATORS	YR11
SSBN 726 CLASS	SSBN 726 STEAM TURBINE GENERATORS	YT01
SSN 640 CLASS	SSN 640 STEAM TURBINE GENERATORS	YT31
SSN 671 CLASS	SSN 671 STEAM TURBINE GENERATORS	YT41
SSN 688 CLASS	SSN 688 STEAM TURBINE GENERATORS	YT51

	AIR SUPPLY SYSTEMS	
ALL	AIR SUPPLY SYTEM 2190	Z001

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MAJOR COMMAND CODES

CODE	ACRONYM	COMMAND NAME
AC	IOC	Industrial Operations Command
AB	AMCOM	U.S. Army Aviation and Missile Command
A7	USAREUR	U.S. Army Europe
A4	FORSCOM	U.S. Army Forces Command
AD	USAJ	U.S. Army Japan
A1	AMC	U.S. Army Materiel Command
A5	USANGB	U.S. Army National Guard
A6	USAR	U.S. Army Reserves
AK	TACOM	U.S. Army Tank-Automotive and Armaments Command
A3	TRADOC	U.S. Army Training and Doctrine Command
AY	CECOM	U.S. Army Communication and Electronic Command
A8	USARPAC	U.S. Army Pacific Command
A2	EUSA	U.S. Eighth Army Korea
A9	USARSO	U.S. Army South
AG	USACE	U.S. Army Corps of Engineers
FF	AFMC	Air Force Materiel Command
FZ	AFNGB	Air Force National Guard
FU	AFRES	Air Force Reserves
FJ	AETC	Air Education and Training Command
FQ	AMC	Air Mobility Command
FR	PACAF	Pacific Air Force
FT	ACC	Air Combat Command
FD	USAFE	U.S. Air Force Europe
FP	AFSPC	Air Force Space Command
FS	AFSOC	Air Force Special Operations Command
FG	AFGSC	Air Force Global Strike Command
NH	MSC	Military Sealift Command
NF	AIRLANT	Naval Air Forces Atlantic Fleet
NR	AIRPAC	Naval Air Forces Pacific Fleet
NN	NAVAIR	Naval Air Systems Command
NX	NAVSEA	Naval Sea Systems Command
NA	SUBLANT	Naval Submarine Forces Atlantic Fleet
NB	SUBPAC	Naval Submarine Forces Pacific Fleet
NC	SURFLANT	Naval Surface Forces Atlantic Fleet
ND	SURFPAC	Naval Surface Forces Pacific Fleet
NG	CGAIR	U.S. Coast Guard (Aeronautical)
NL	CGCUTTER	U.S. Coast Guard (Cutters)
NM	USMC	U.S. Marine Corps
NJ	USMCR	U.S. Marine Corps Reserves
XW	CONTRAC	Contractor
XV	FOREIGN	Foreign
XE	OTHER	Other

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HABCO WATER TEST

1. Scope. This test method covers the determination of the total of dissolved water in hydraulic, transmission, and electronic cooling system fluids.

2. Summary of Method. The Habco Water Sensor is a small portable device that provides an electronic display reading of percent dissolved water through the use of in-system, bottle, or dipstick probes.

3. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Digital Angle Protractor PDA	Habco	SK2000DAP-100	6625-01-588-5333
Water Sensor Probe	Habco	HBWV37L-X or WV2037L	
Validation Vial	Habco	WV2037-V70	
Rubber Stopper	Habco	WV2037-VS	
PDA Charger	Habco	SK2000DAP-400	

4. Standards/Standardization/Calibration. This device was designed to provide accurate readings over its life without the need for periodic re-calibration. A validation vial is included to allow the user to ensure oil moisture validator is operating properly and to ensure results are within the allowed tolerance.

5. References/Guidelines. Habco HBWV37L-X Manual

6. Quick Use Instructions to Monitor Fluid Water Content.

   a. Charge unit. Plug power adapter into a 110V wall outlet for the recommended 4 hours prior to use.

   b. Connect sensor/probe. Attach sensor to the lower left connector on the DAP PDA marked ANGLE.

   c. Press and hold the POWER ON button for 3 seconds. Note: may take as long as 30 seconds for the PDA to boot.

   d. Select the correct oil to be analyzed using the pull down menu at the bottom of the screen.

   e. Insert probe into oil to be measured.

   f. Agitate probe in a slight up/down motion for a minimum of 30 seconds or until reading on screen has stabilized (no longer changing by an amount greater than +/- 5 PPM).

   g. Read and record the PPM water concentration shown on the screen.

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15 March 2021

ACID NUMBER (AN) BY POTENTIOMETRIC TITRATION LABORATORY PROCEDURES AND REQUIREMENTS

1. Scope. Additive depletion, acid contamination, and oxidation are common pathways of lubricant degradation. The Acid Number test by Potentiometric Titration is a method for quantifying the extent of lubricant degradation due to these mechanisms. AN measures the by-products, not the rate of oxidation.

NOTE

This work package is new and being added to this volume of the JOAP Manual for the first time. Changes are not marked with a line in the right margin.

2. Summary of Method. The principle of operation of the Acid Number by Potentiometric Titration is in accordance with reference a. A quantity of a given test substance is determined by the measured addition of a titrant until the entire test substance undergoes a reaction, and the potential difference between two electrodes is measured once a thermodynamic equilibrium is achieved. This test method is suitable for determining acid number of oils in the range of 0.1 mg/g KOH - 150 mg/g KOH.

3. References.

   a. ASTM D664: Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration.

   b. Quick Start Guide, HI 902 Color Automatic Potentiometric Titrator

4. Equipment/Apparatus/Materials/Reagents.

Table 1. Equipment/Apparatus/Materials

Description	Manufacturer	Part Number	NSN
Automatic Titration System	Hanna Instruments	HI902C	
Autosampler	Hanna Instruments	HI921	
pH Electrode	Hanna Instruments	HI1049B	
USB Keyboard (optional)			
200 mL tall form glass beakers			
Erlenmeyer flask, 250 ml	Fisher Scientific	S63271	
Graduated cylinder, 100 ml	Fisher Scientific	MS35943-7	6640-00-420-0000
Graduated cylinder, 500 ml	Fisher Scientific	S328561B	
Bottle, Amber Glass Safety Coated w/Cap (4L)	Fisher Scientific	06-451-323	
Disposable plastic pipettes			
Laboratory Notebook and pen			
Analytical Balance			
Magnetic stirrer			

Table 1. Equipment/Apparatus/Materials (Continued)

Description	Manufacturer	Part Number	NSN
Fume Hood			
Calibrated Stop Watch			
Stir Plate			

- See Figure 1 for Titrator System setup

NOTE

Manufacturers' names are provided as examples. Equivalent products obtained from another source are acceptable.

Table 2. Chemicals/Reagents

Description	Manufacturer	Part Number	NSN
Titrant Electrolyte	0.1 M KOH in IPA		
Titration Solvent (commercial)*	Fisher Scientific	ST93-4	6810-01-448-9743
Isopropyl Alcohol (IPA)	Isopropyl Alcohol (ACS Reagent Grade)	A464-4	6810-01-448-9253
Potassium Hydroxide (KOH) in IPA	Fisher Scientific	P246-3	
Toluene (ACS Reagent Grade)	Fisher Scientific	T-324-SK4 (4L)	
Potassium Hydrogen Phthalate (KHP)	Sigma Aldrich	P1088	
Non-aqueous electrolyte solution: 1M Lithium Chloride (LiCl) in Isopropyl Alcohol or 1M LiCl in Ethanol			
Aqueous 4.01 pH calibration buffer	Manufacturer Supplied		
Aqueous 10.01 pH calibration buffer	Manufacturer Supplied		
Deionized Water			

* If commercial product is not available, Titration Solvent can be prepared as described in step 6.a

NOTE

For HAZMAT items See Volume 2 WP HMWS for handling information.

Table 3. Protective Equipment

Description	Manufacturer	Part Number	NSN
Goggles, chemical splash	GSA	ANSIZ87 1.1989	4240-00-190-6432
Gloves, nitrile, medium	GSA		8415-01-492-0179
Gloves, nitrile, large	GSA		8415-01-492-0178
Gloves, nitrile, extra large	GSA		8415-01-492-0180
Lab Coat			

5. Testing Environment. Avoid severe vibrations, direct sunlight and explosion hazards. Ambient air temperature should be 10°C to 40°C (50°F to 104°F). Ambient relative humidity should be below 95% non-condensing. If these environmental conditions cannot be met, testing should be stopped and the facilities department contacted to have the lab environmental conditions brought back into specification.

6. Preparation of Method Specific Reagents and new Electrode.

a. Titration Solvent. Combine 500 mL toluene, 495 mL IPA and 5 mL deionized water.

b. Non-aqueous Titrant Electrolyte. Prepare a 1M Lithium Chloride (LiCl) in IPA solution (Note: pre-made reagent can be purchased. See Table 2).

(1) Prepare a 1M Lithium Chloride (LiCl) in IPA solution.

(a) Add 21.19 g of lithium chloride (LiCl) to a 500 mL volumetric flask with ~400 mL of IPA

(b) Dilute up to the 500 mL mark with IPA

(c) Using a stir plate, place stir bar in volumetric flask and stir for 12 hours.

c. New Electrode. Upon initial installation of a new electrode, remove the aqueous electrolyte

(1) Remove storage cap from the bottom of the electrode and remove electrode from the auto-sampler arm.

(2) Turn the electrode upside down and , remove the aqueous electrolyte using a disposable pipette.

(3) Add deionized water half way to the fill hole cover, invert, and then remove the electrode. Repeat two additional times.

(4) Add non-aqueous electrolyte half way to the fill hole cover, invert, and then remove from the electrode. Repeat two additional times.

(5) Refill the electrode with the non-aqueous electrolyte up to the fill hole and replace the fill hole cover (do not tighten completely).

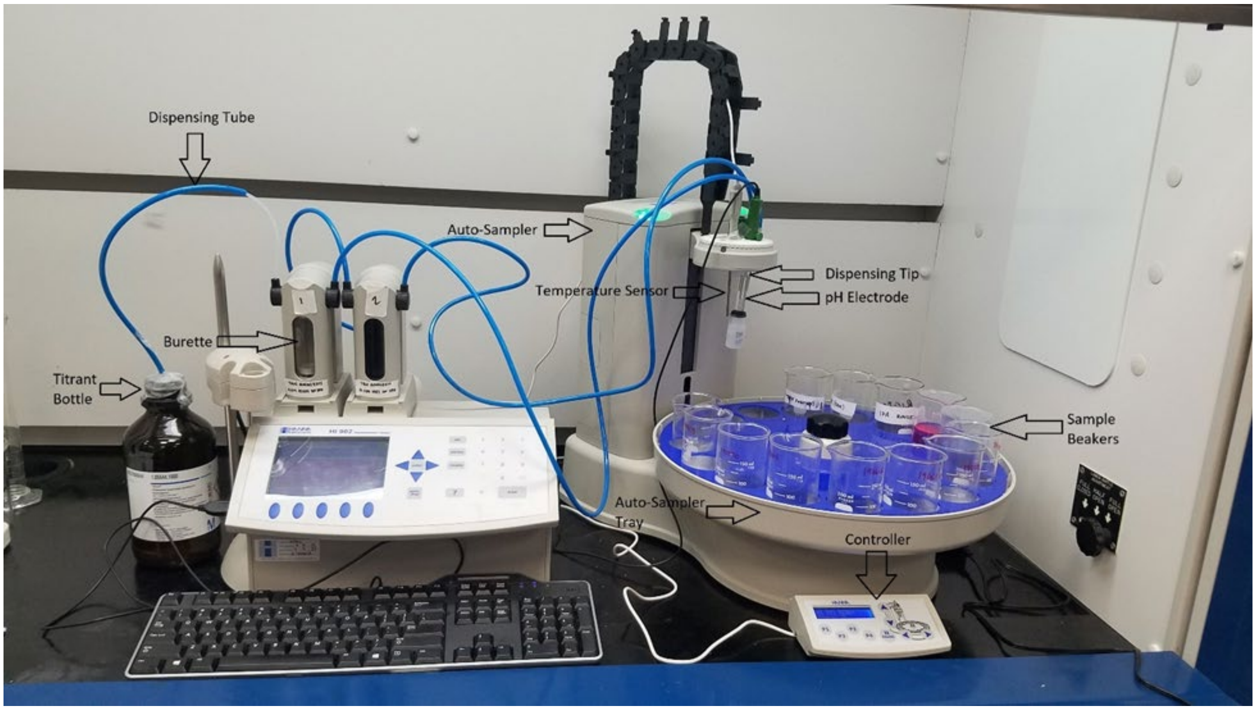


Figure 1 – Titrator with Auto-Sampler

7. Daily Procedures and Calibration Check. Prior to the first titration of the day.

   a. Check the level of non-aqueous electrolyte and top off the electrode up to the fill hole if necessary, replace the fill hole cover (do not tighten completely).

   b. Rehydrate the electrode in Rinse Beaker 2 (acidified deionized water) for 5 minutes. Refer to Step 9.a.(1)(b) for acidified deionized water preparation

   c. Calibration Check:

NOTE

Perform the Calibration Check procedure with fresh pH buffers daily, prior to running samples.

(1) Press the Device button so that “HI 921 Auto-sampler” is displayed top middle of the screen. Allow the instrument to count down from 9 to 0.

(2) Press the AutoSmp Setup button

(3) Press Aux Commands button.

(4) Press the pH Calibr button.

NOTE

Prior to performing the pH calibration, soak electrode in the acidified water beaker (Beaker 2) for at least 5 minutes with the stirrer engaged.

(5) Press Next or Previous Buffer button until pH 4.01 is displayed on the screen.

(6) Fill a beaker with approximately 100 ml of pH 4 buffer solution to submerge the electrode.

(7) Place the beaker in position 4 on the auto-sampler and lower the electrode into buffer solution.

(8) Press the stir button on the titrator to engage the stirrer.

(9) Press the start button on the calibrated stop watch.

(10) In the lab notebook, record the Potential (in mV) of the aqueous pH 4 buffer at 30 seconds and at 60 seconds. (Note: It is not necessary to push the Accept button as long as the results are recorded at the correct times).

(11) The preferred difference between the 30 second and the 60 second readings is ≤ 1mV.

(12). The acceptable difference between the 30 second and the 60 second readings is < 2 mV.

(13) Press “Stir” to disengage the stirrer. Rinse the probe with deionized water.

NOTE

Prior to performing the pH 10 calibration, soak electrode in the acidified water beaker (Beaker 2) for at least 1 minute.

(14) Press Next or Previous Buffer button until pH 10.01 is displayed on the screen

(15) Fill a beaker with approximately 100mL of pH 10 buffer solution to submerge the electrode.

(16) Remove the pH 4 beaker from the auto-sampler and place the beaker with the pH 10 buffer in position 4 on the auto-sampler.

(17) Lower the electrode into the pH 10 buffer solution.

(18) Press the stir button on the titrator to engage the stirrer.

(19) Press the start button on the calibrated stop watch.

(20) In the lab notebook, record the Potential (in mV) of the aqueous pH 10 buffer at 30 seconds and at 60 seconds. (Note: It is not necessary to push the Accept button as long as the results are recorded at the correct times).

(21) The preferred difference between the 30 second and the 60 second readings is ≤ 1 mV.

(22) Press “Stir” to disengage the stirrer. Rinse the probe with deionized water.

(23) Determine the Potential difference (in mV).

(a) Calculate Potential difference between the pH 4 and pH 10 measurements taken at 60 seconds.

(b) If the difference is ≥ 324 mV, the calibration check is acceptable.

(24) If the calibration check is unsat., repeat Section 7.c. with fresh buffer solutions.

(25) If the result is still unsat. after the second attempt, replace the aqueous electrolyte in the electrode by performing Section 7.a. and repeat the pH calibration.

(26) If the results remain unsat. the instrument shall be taken out of service and the manufacturer contacted for support.

d. Burette Preparation

NOTE

Priming the TAN Burette step should be performed bi-weekly to ensure the system tubing does not dry out or become clogged.

(1) Prior to Rinsing Tip or Priming Burette:

(a) Raise the auto-sampler arm by pressing ↥ on the controller.

(b) Move the auto-sampler arm to a position with an empty beaker by pressing ↔ on the controller.

(c) Lower the assembly by pressing ↧ on the controller.

(2) If there are no air bubbles in the burette proceed to Step 7.d.(3). If air bubbles are present, proceed to Step 7.d. (12)

(3) Press the Escape key.

(4) Press the Device button until “HI 921 Auto-sampler” is displayed top middle of the screen. Allow the instrument to count down from 9 to 0.

(5) Press the AutoSmp Setup button.

(6) Press Aux Commands button.

(7) Press the Manual Commands button.

(8) Press the Burette button.

(9) On the bottom of the screen, press the “Choose Pump” button.

(a) Highlight Pump 1 for TAN rinse and press the enter key.

(10) Highlight the “Rinse Tip” on the screen and press the enter key.

(11) Repeat the Rinse Tip step 5 times to help purge system. Proceed to Section 8.

(12) If there are air bubbles in the syringe or there is not a continuous flow of titrant, Prime Burette:

(a) Press the Device button until “HI 921 Auto-sampler” is displayed top middle of the screen. Allow the instrument to count down from 9 to 0.

(b) Press the AutoSmp Setup button.

(c) Press the Aux Commands button.

(d) Press the Manual Commands button.

(e) Press the Burette button.

(f) Press the Prime Burette button.

(g) Enter in “1” (TAN Burette) on the screen and press enter or accept key.

(h) Ensure that all the air bubbles have been removed. If not, perform another Prime Burette cycle. If all air bubbles have been removed from the burette, proceed to Section 8.

8. Procedure

a. Blank Titration

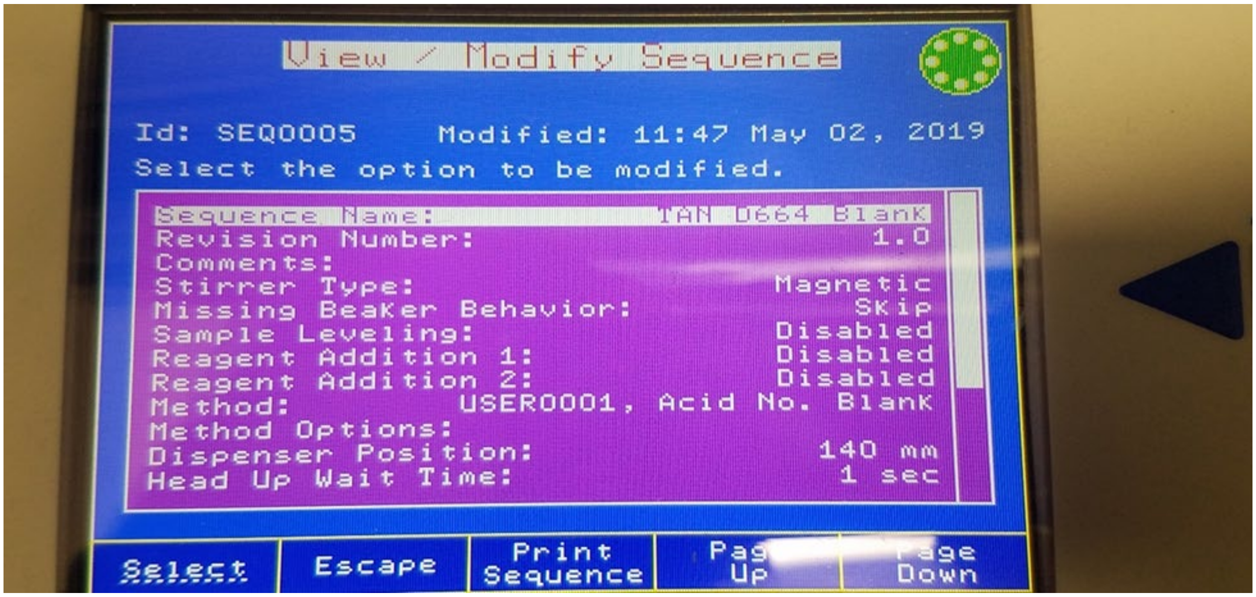
NOTE

Perform a blank test every time a new titration solvent is prepared.

(1) Press the Escape key twice.

(2) Press the “Select Sequence” button.

(3) Scroll down and highlight the "TAN D664 Blank" Sequence Name and press the enter key. (See Figure 2.)



Firgure 2 – View / Modify Sequence Screen with "TAN D664 Blank" Selected

(a) If "Warning – Reset Sample Table" appears, press "Continue" to reset the Sample Table.

(b) Press the Sequence Options button.

(c) Verify that the TAN method (Acid No. Blank) is selected as the Method. (See Figure 3).

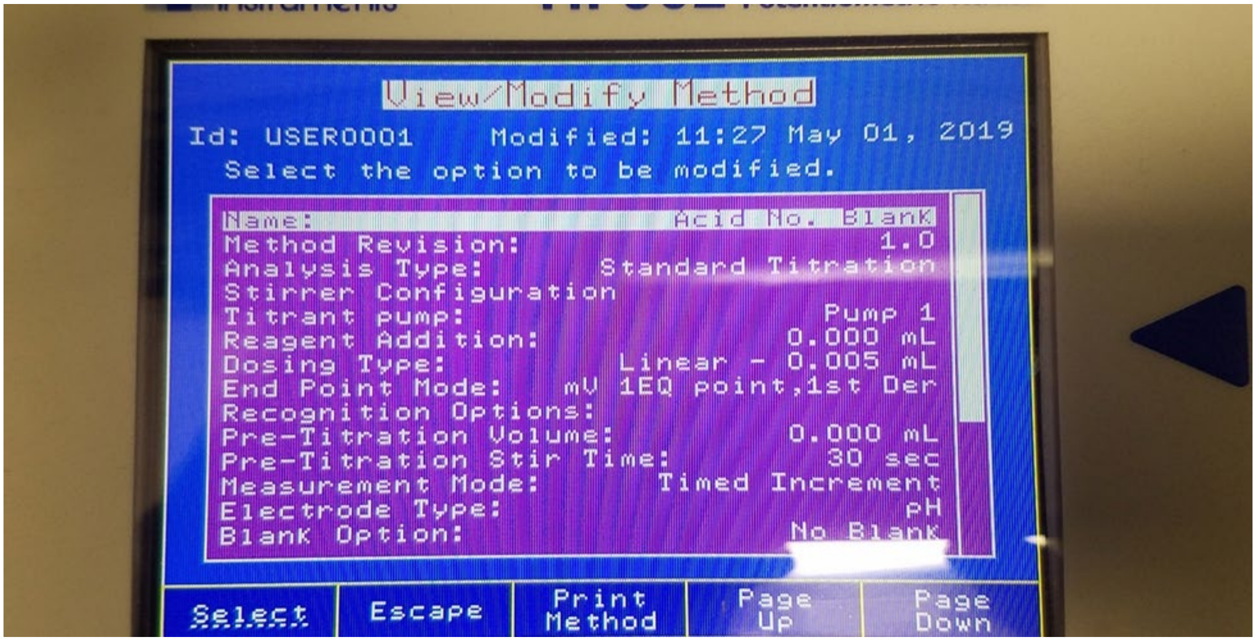


Figure 3 – View / Modify Method Screen with “Acid No. Blank” Selected

1. If the correct method is selected, press the escape key and continue to section 8.a.(4).

2. If the wrong method is displayed press the enter on “Method” scroll and highlight “Acid No. Blank”. Press the enter key.

3. Press the escape key.

4. If a change was made, the instrument will automatically prompt to save. Highlight “Save Sequence” and press the enter key.

(4) The first 3 beaker slots are reserved for rinse beakers. Verify the beaker cleanliness and volume of the liquid in each beaker at the beginning of each tray.

(a) Beaker 1: 125 mL of titration solvent.

(b) Beaker 2, acidified deionized water (also the storage beaker): 125 mL of deionized water with ~ 2 mL of pH 4.01 buffer.

(c) Beaker 3: 125 mL of IPA.

(5) Beakers 4 through 16 are reserved for samples.

(a) Using a graduated cylinder, transfer 100 mL of titration solvent into a dry, clean 200 mL glass beaker along with a stir bar in beaker slot 4.

(b) Highlight Line # 4 on the display screen which should be the first empty beaker slot and press the Enter Button. Enter in the name “Blank” and press the enter key or accept key.

(c) Press the “Start/Stop” button. At the end of each titration, the stirrer assembly will go through the rinse sequence before moving to the next sample. At the end of all sample titrations, the stirrer assembly will automatically return to the storage beaker

(d) At the end of sample titration, the results can be accessed using the sample table.

(e) Remove any titrated samples and dispose of per section 8.c.(1)

(f) Results are displayed as Liters of titrant. Record results in the lab note book.

b. Total Acid Number Sample Titration

(1) If only performing a blank, press AutoSmp Setup, otherwise, continue below.

(2) Press the “Select Sequence” key on the screen.

(3) Scroll down and select the Sequence Name “TAN D664 Used Sample” (See Figure 4).

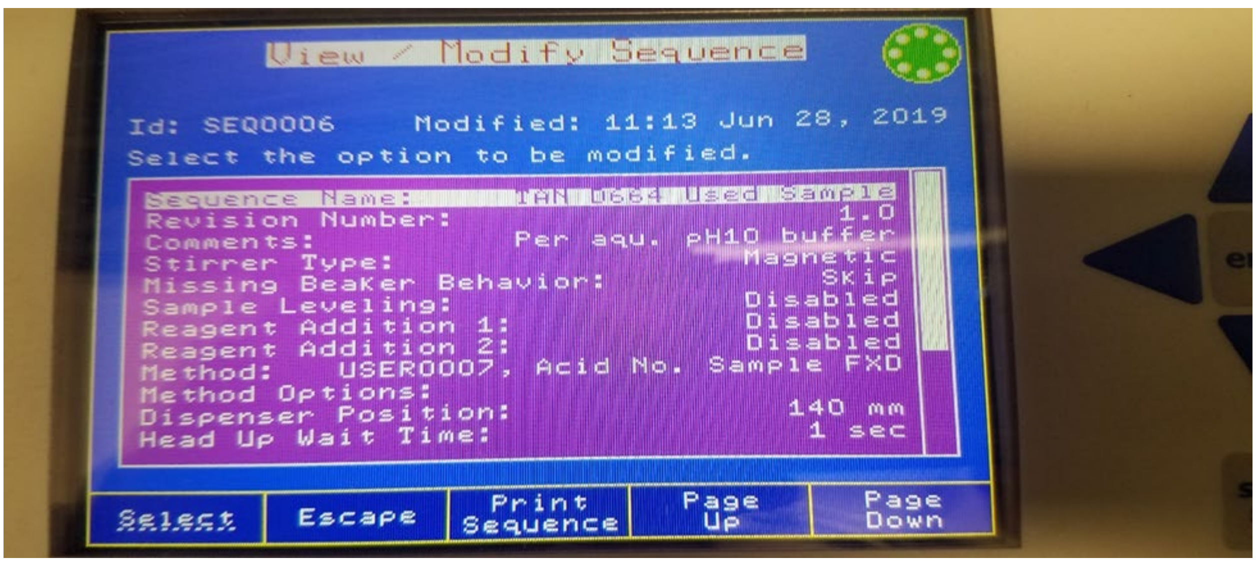


Figure 4 – View / Modify Sequence Screen with “TAN D664 Used Sample” Selected

(4) Press enter key to select the sequence.

(a) If the “Warning: Reset Sample Table” screen appears, press “Continue” to reset the Sample Table.

(5) Press the Sequence Options button on the screen and scroll down to Method and verify that "Acid No. Sample FXD" is selected.

(a) If the wrong method is selected scroll down to Method and press the enter key.

(b) Scroll down and highlight the TAN method "Acid No. Sample FXD". (See Figure 5).

(c) Press the enter key.

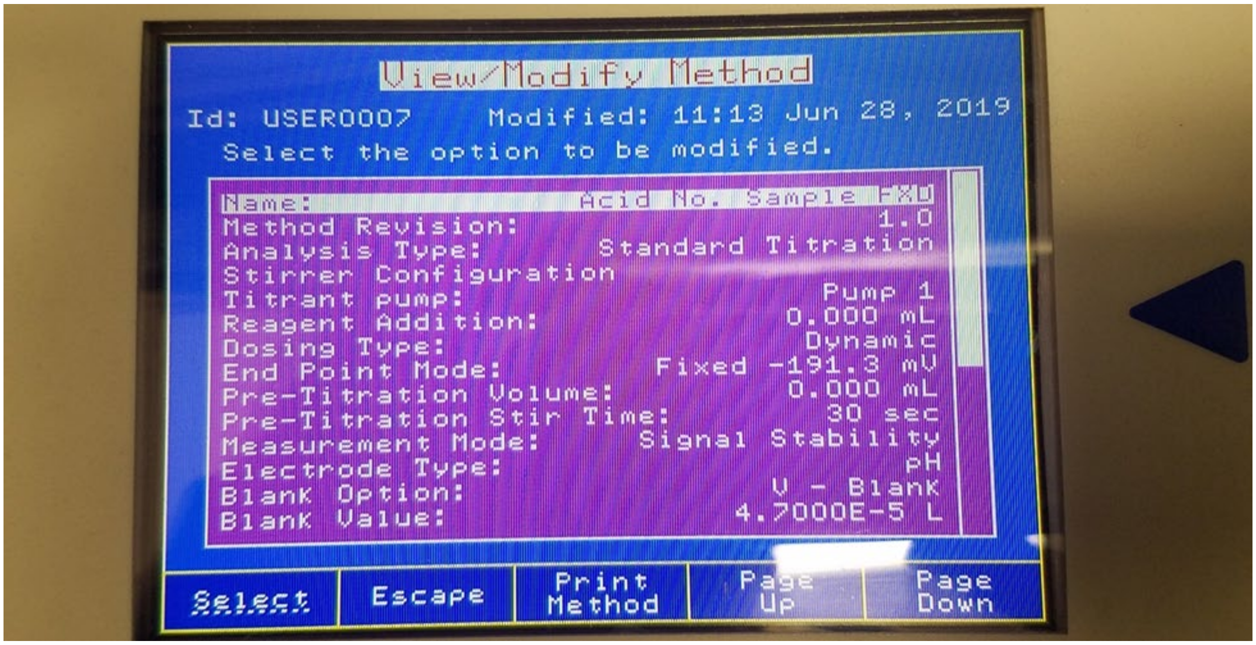


Figure 5 – View / Modify Method Screen "Acid No. Sample FXD Selected

(6) Scroll down to Method Options and press enter.

(a) Scroll to End Point Mode and press enter.

1. Scroll to End Point Mode and press enter.

a. Select Fixed End Point (mV) and press enter.

b. Enter the 60 seconds measurement (in mV) of the pH 10 buffer and press enter. (This number can be negative)

2. Scroll down to Blank Value and press enter.

NOTE

A blank test should be performed every time the titration solvent is prepared. If the Blank has already been performed on the titrant, verify that correct blank reading is entered.

a. Enter in the volume of the Blank sample and press enter.

3. Scroll down to Titrant Concentration. Enter or verify the value on the bottle of premade potassium hydroxide solution isopropanol. This value should be 0.1000 M (mol/L). This value should remain unchanged if the correct pre-made reagent is purchased.

4. Press the Escape button. If changes were made, the instrument will prompt to save method. Highlight “Save Method” and press the enter key.

(7) The first three beaker slots are reserved for rinse beakers. Verify the levels of the beakers before starting. Replace the beakers if they are visibly dirty or cloudy

NOTE

Before testing starts, check to ensure that all beakers that are being used during testing have a stir bar.

(a) Beaker 1: 125 mL of titration solvent.

(b) Beaker 2: acidified deionized water (also the storage beaker): 125 mL of deionized water with approximately 2 mL of pH 4.01 buffer.

(c) Beaker 3: 125 mL IPA.

(d) Beaker slots 4 through 16 are reserved for samples.

1. For each sample, place a dry, clean 200 mL tall form glass beaker on an analytical balance and tare the balance.

2. Weigh the oil samples directly into the beaker (See Table 4, TAN for sample sizes). Record exact value.

3. Using a graduated cylinder, transfer exactly 100 mL of titration solvent to the beaker along with a stir bar.

(8) Press the Sample Table button.

(a) If previous titration run is listed, press the Reset Table button.

(b) Press the “Reset” button to confirm.

(9) Select desired sample location and press the Add Sample button.

(10) Use the ↑ key on the key board and enter in sample name. Press the "Accept" button on the screen.

(11) Input the weight of the sample and press the enter key.

(12) Repeat section 8.b.(9) to 8.b.(11) for each sample.

(13) After all sample information has been entered, make sure that all sample beakers are in the correct position on the carousel with a stir bar in each beaker and press the "Start / Stop" button. At the end of each titration, the stirrer assembly will go through the rinse sequence before moving to the next sample. At the end of all sample titrations, the stirrer assembly will move to the storage beaker.

(a) At the end of each sample titration, results can be viewed in the sample table. At the end of all sample titrations, the full tray report can be accessed.

(b) Results are displayed as mg/g KOH.

(c) Dispose of titrated samples per section 8.c.(1).

(d) All results can be accessed by pressing the "Result" button on the titrator.

(e) Scroll down and select "Available Tray Reports". A list of all past test reports will be displayed. Highlight and press the enter key to view report data.

(f) Press the "Print Report" button on the screen to print the Analysis Report.

(g) To run additional samples, repeat procedure starting at step 8.b.(7).

.

Table 4. Recommended TAN Sample Size Table

Acid Number	Mass of Test Portion (g)	Accuracy of Weighing (g)
0.05 - < 1.0	20.0 ± 2.0	0.10
1.0 - < 5.0	5.0 ± 0.5	0.02
5 - < 20	1.0 ± 0.1	0.005
20 - < 100	0.25 ± 0.02	0.001
100 - < 260	0.1 ± 0.01	0.0005

NOTE

If a smaller than recommended sample size is available, test can still be performed. The sample size used shall be documented with a note that results may not be equivalent to results obtained with the recommended sample size.

c. Clean Up

(1) Dispose of all reagents, solvents and cleaning solutions by approved methods. Refer to the SDS for the chemicals to identify chemical hazards. Follow all applicable regulations regarding disposal of chemical waste.

(2) All glassware beakers are dedicated and should be cleaned with titration solvent only.

d. Storage

(1) Short-term storage:

(a) Store the electrode in acidified deionized water, Beaker 2 (125 mL of deionized water with approximately 2 mL of pH 4.01 buffer).

(b) Before use each day, be sure to hydrate the electrode by placing it in deionized water for at least 5 minutes.

(2) Long-term storage:

(a) Store the electrode in non-aqueous titrant electrolyte (1.0 M LiCl in IPA or 1M LiCl in Ethanol).

(b) Prior to running titrations, rehydrate the electrode in acidified deionized water for 5 minutes

FDM 6001 FUEL DILUTION METER LABORATORY OPERATING PROCEDURE

1. Scope. This method is to be used for analysis of lubricating fluids to evaluate the contamination of the lubricant with diesel fuel, gasoline, or jet fuel. Fuel dilution is an important indicator of the ability of lubricating fluids such as MIL-PRF-9000 and MIL-PRF-2104 to effectively lubricate naval machinery. Excessive fuel dilution can depress the flashpoint and viscosity of lubricants; resulting in insufficient lubricating film thickness, increasing the risk of damage to machinery.

2. Summary of Method. The typical sample does not require preparation. The principle of operation of the Fuel Dilution Meter is based on determination of the amount of volatile fuel components present in the headspace above the liquid sample using Surface Acoustic Wave (SAW) detector technology, reference a. Interference with operation may be caused by other volatile materials or water vapor.

3. References.

   a. ASTM D8004, Standard Test Method for Fuel Dilution of In-Service Lubricants Using Surface Acoustic Wave Sensing

   b. NSTM Chapter 262: Lubricating Oils, Greases, Specialty Lubricants, and Lubrication Systems

   c. Q6000 Series Fuel Dilution Meter User's Manual, Doc. p/n FDM 6000

   d. FDM 6000 Equipment Logistics Support Supplement (ELSS) at https://www.jtdi.mil/group/noap/physical-properties-tests

4. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Fuel Dilution Meter (FDM 6001)	AMETEK Spectro Scientific	800-00133	
Tweezers	Supplied with instrument	24099-00	
FDM Vial Kit (includes sample vial and felt discs)	Supplied with instrument	346162035	
Disc insertion tool	Supplied with instrument	450-00069	
Disposable 500 µL pipette tips	Supplied with instrument	346162036	
Positive Displacement Pipette (PDP) – adjustable from 100 to 1000 µL	Supplied with instrument (LLG Labware)	9.280 005	
100 mL graduated cylinders			6640-00-420-0000
100 mL volumetric flask (optional)	Cole Parmer	EW-34502-83	
Kim Wipes	GSA	A-A-1432A	7920-00-721-8884
Paper Towels	GSA		7920-00-823-9773
Calibrated thermometer	Omega Engineering Inc.	HH81A	6685-01-521-9690
Notebook and Pen			
Calibrated digital timer	Traceable	UX-94461-16	

NOTE

The Fuel Dilution Meter itself must be manufactured by the company listed in the above table. For all other items the manufacturer's name is provided as an example. Equivalent products obtained from other sources are acceptable

Table 2. Chemicals / Reagents

Description	Manufacturer	Part Number	NSN
Virgin, Unused Oil (same oil type as test sample)	N/A	N/A	N/A
F-76 Fuel	N/A	N/A	N/A

NOTE

For HAZMAT items See Volume 2 WP HMWS for handling information.

5. Testing Environment. Avoid severe vibrations, direct sunlight and explosion hazards. Ambient air temperature range should be 5°C to 35°C (41°F to 95°F). Ambient relative humidity should be below 90% non-condensing. If these environmental conditions cannot be met, testing should be stopped and the facilities department contacted to have the lab environmental conditions restored within specifications.

6. Procedure.

NOTE

Refer to the Q-6000 Series Fuel Dilution Meter User's Manual for initial setup of the instrument

NOTE

The instrument can be operated using the built-in battery. However, if electrical supply is available, connect the electrical cord to the DC input on the back of the unit, and plug into an AC outlet.

a. Turn on the instrument by moving the switch located on the underside of the unit to the "RUN" position.

b. The instrument will start a purging routine, followed by a sensor warm-up process.

NOTE

Warm-up may take several minutes

c. Upon completion of the warm-up, the Main Menu will be displayed, with the following options: Setup, Calibrate, and Measure.

d. The instrument is to be calibrated daily prior to testing samples, with a 5% fuel dilution standard. Refer to Section 7. for calibration procedure.

NOTE

Prior to performing calibration, run a blank measurement to purge the instrument, by following steps o. through x. below. If the result is higher than 0.2 %, repeat the steps until the reading is 0 %.

e. Using a calibrated thermometer, measure the room ambient temperature and record in the lab notebook.

NOTE

Monitor ambient temperature during testing. If during the course of the testing, the room temperature changes by more than +/- 2° C, recalibrate the instrument.

f. Remove the plastic cap from sample vial and using tweezers, place a single felt disc into the bottom of the vial.

g. Using the disc insertion tool press the disc down ensuring it lies flat on the bottom of the vial (Figure 1).

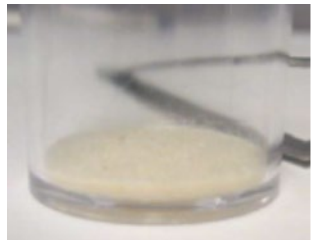


Figure 1. Proper Insertion of Disc

h. Ensure the Positive Displacement Pipette (PDP) is set to 500 µL using the knob at the top of the plunger.

i. Seat the plastic pipette tip onto the PDP.

NOTE

The PDP may have one or two stop positions at the bottom of piston travel.

j. Depress the plunger to the first stop.

k. Dip the tip into the oil sample, under the liquid surface. Smoothly release the plunger to draw up oil. Slowly withdraw the pipette tip from the oil

NOTE

Ensure no air bubbles are visible in the in the pipette tip. If bubbles are present, expel the sample and repeat step k.

l. As the pipette tip withdrawn from the sample bottle, scrape the pipette tip against the sides of the sample bottle to remove any excess liquid. Do not use a kimwipe or paper towel to clean off the pipette tip.

m. Slowly dispense the sample onto the center of the felt disc, ensuring the pipette tip does not make contact with the disc, and no sample drips onto the sides of the vial. Lower plunger to the first stop position to dispense the sample.

NOTE

Discard the oil remaining in the pipette tip into a waste container by pressing the plunger fully.

n. Leave the vial open for 60 seconds, then close with the plastic cap.

o. Press the measure icon on the instrument display to open the “Select Fuel to Measure” screen.

p. Press the “DIESEL” icon.

q. Press the “EDIT” icon under Sample ID and enter Sample information.

r. Press the arrow icon. The new Sample ID is now displayed along with the Sample #.

s. Press the arrow icon again. A prompt to place the sample in the Sample Chamber will be displayed.

t. Place the vial in the Sample Chamber and close the lid firmly, ensuring that the vial cap is punctured by the lid. Ensure that the tab on the vial cap fits between the two prongs at the front of the sample chamber.

u. Press the arrow icon to start the analysis. (Typical analysis time is approximately 1 minute.)

v. When the test is complete, “Remove Vial” is displayed on the screen. Open the chamber and remove the vial.

w. Close the chamber lid, then press the arrow icon to start the automatic purge cycle. Test results will be displayed on the screen after the cycle is complete.

x. Record the results in the notebook.

y. All samples are to be tested in duplicate to determine the final measurement. Repeat steps f. through x for each sample.

z. Discard the vials.

aa. Discard the pipette tip by pressing the knob on the side of the pipette plunger.

bb. Calculate test repeatability (r) for each sample using the following formula:

r = 0.4722(Xavg + 0.0001)0.6126 % by mass (fuel dilution)

where Xavg is the average of the two test results (round average values to one decimal place)

EXAMPLE:

Fuel Dilution, 1st run = X1 = 1.4%

Fuel Dilution, 2nd run = X2 = 1.8%

Xavg = (1.4 + 1.8) / 2 = 1.6

r = 0.4722 (1.6 + 0.0001)0.6126% = 0.6%

X2 – X1 = 0.4%

0.4% is less than 0.6%, therefore the test result is acceptable and can be reported

cc. If the difference between two measurements is less than the calculated value of “r,” report average of the two measurements as the final result.

dd. If the difference between two measurements is greater than the calculated value of “r,” repeat steps f. through x.

ee. If result of step bb. is still UNSAT, recalibrate the instrument per Section 7 and repeat steps f. through x.

ff. If still UNSAT, contact NSWCPD, C/331 at NSWCPD_Lubricants@navy.mil and/or the instrument manufacturer. See reference d.

7. Calibration. Required daily, prior to testing.

NOTE

Prepare individual standards for the oil types that are expected to undergo testing; i.e. MIL-PRF-2104, MIL-PRF-9000. If the standards are already prepared, start with section 7.c.

a. 5% Standard Preparation.

(1) Add 50 mL of virgin, unused oil to a clean 100 mL graduated cylinder

(2) Pipette exactly 5 mL of F-76 fuel into the graduated cylinder

(3) Add virgin, unused oil until the level reaches the 100 mL mark on the graduated cylinder.

(4) Transfer the solution to a re-sealable bottle, e.g. clean sample bottle.

(5) Label the bottle as “5% Fuel Dilution Calibration Standard.” Additionally, include the following information: oil type, fuel type, date prepared, and expiration date. Expiration date is 6 months from date of preparation.

(6) Cap the bottle tightly and swirl for 30 seconds.

(7) Place the bottle on a level surface and remove the cap.

(8) Allow the sample to sit uncapped for 60 minutes to let the lighter volatile fuel fractions to evaporate.

(9) Recap the bottle.

b. 2% Standard Preparation.

(1) Repeat steps from section 7.a., with the exception of adding 2 mL instead of 5 mL in step (2).

(2) Label the bottle as 2%, correspondingly.

c. On the Main Menu, press the “Calibrate” icon to open the “Select Fuel to Measure” screen.

d. Press the “Diesel” icon to open the “Update Standard Concentration” screen.

NOTE

The default instrument setting is 5% fuel dilution; this parameter can be adjusted using the + and – buttons as necessary for custom calibration standards.

e. Set the Standard Concentration to 5%.

f. Prepare a vial with the 5% calibration standard as described in Section 5.f. through 5.n.

g. Place the vial in the Sample Chamber and close the lid firmly, ensuring that the vial cap is punctured by the lid.

h. Press the arrow button to start the analysis. (Typical analysis time is approximately 1 minute).

i. When the test is complete, “Remove Vial” is displayed on the screen. Open the chamber and remove the vial. Close the chamber lid, then press the right arrow icon to start the automatic purge cycle.

j. Discard the vial.

NOTE

If the measurement is within acceptable range of the previous calibration, the instrument will purge automatically and return to the main menu; allowing samples to be tested. If the calibration fails, “Calibration Factor out of Normal Range” message will be displayed on the screen. If this occurs, repeat the calibration procedure, ensuring that the vial was prepared correctly with the appropriate standard. If the calibration fails again, prepare a new calibration standard and repeat the Calibration Procedure. If the instrument remains out of the Normal Range, contact NSWCPD, C/331 at NSWCPD_Lubricants@navy.mil and/or the instrument manufacturer. See reference d.

k. Validate the calibration by rerunning the 5% and the 2% calibration standards as samples. The values should be within +/- 10% of the known standard value. i.e., for the 5% calibration standard, the acceptable range is 4.5% to 5.5%; and for the 2% calibration standard, the acceptable range is 1.8% to 2.2%.

l. If the standard checks fail, recalibrate the instrument and re-run both of the checks.

m. If the standard checks fail again, prepare new 5% and 2% standards and repeat the calibration procedure.

n. If the standard checks fail again, take the instrument out of service and contact the instrument manufacturer. Notify NSWCPD, C/331 by emailing NSWCPD_Lubricants@navy.mil. See reference d.

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NAVIFLASH FLASH POINT ANALYZER LABORATORY OPERATING PROCEDURE

NOTE

This work package is new and being added to this volume of the JOAP Manual for the first time. Changes are not marked with a line in the right margin.

1. Scope. This method, based on ASTM D6450, covers the determination of the flash point of lubricating fluids by a continuously closed cup (CCCFP) Tester. Decreased flash point can be indicative of thermal cracking of lubricating oils, or of the presence of highly volatile and flammable materials in a relatively nonvolatile or nonflammable material, e.g. the contamination of lubricating oils by diesel fuel or gasoline. Flashpoint is the lowest temperature of the test specimen at which application of an ignition source causes the vapors of the test specimen to ignite momentarily. This test method is suitable for testing samples with a flash point from 10 ºC to 250 ºC (50 ºF to 482 ºF).

2. Summary of Method. A sample cup is filled with 1 mL volume of test specimen. The cup is raised and pressed against a lid, creating a closed but unsealed test chamber. The lid is heated at a prescribed rate and a spark is introduced periodically followed by injection of small volume of air until a flash of the sample occurs; this temperature is recorded as the flash point. Test completion is indicated by an audible signal and red/yellow/green visual indicator lights on the NAVIFLASH front panel. The flash point temperature is displayed on the LCD Data Readout screen.

3. References.

    a. ASTM D6450: Standard Test Method for Flashpoint by Continuously Closed Cup (CCCFP) Tester

    b. NSTM 262: Lubricating Oils, Greases, Specialty Lubricants, and Lubrication Systems

    c. Shipboard Fuel Acceptance and Fuel Dilution Meter, NAVIFLASH Operating Manual

4. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Naviflash Flash Point Analyzer	Ametek (Petrolab/Grabner)	44001	6625-01-472-6783
Sample Cup Carrier	Supplied with instrument	40013	6636-01-571-6526
Sample Cup	Supplied with instrument	40012	6636-01-571-6523
Disposable Plastic Pipettes			
Paper Towels	GSA		7920-00-823-9773
Brass Arc cleaning tool	Supplied with instrument	40016	
Suitable waste containers			
Laboratory Notebook and pen			

NOTE

Manufacturers' names are provided as examples. Equivalent products obtained from another source are acceptable.

Table 2. Method Specific Reagents

Description	Manufacturer	Part Number	NSN
n-Dodecane flash point calibration kit, 24 x 10 mL vials	Supplied with instrument	40007	6810-01-419-2677

NOTE

For HAZMAT items See Volume II WP HMWS for handling information.

Table 3. Protective Equipment

Description	Manufacturer	Part Number	NSN
Goggles, chemical splash	GSA	ANSIZ87 1.1989	4240-00-190-6432
Gloves, nitrile, medium	GSA		8415-01-492-0179
Gloves, nitrile, large	GSA		8415-01-492-0178
Gloves, nitrile, extra large	GSA		8415-01-492-0180
Lab Coat			

5. Testing Environment. Avoid severe vibrations, direct sunlight and explosion hazards. Ambient air temperature should be 10°C to 40°C (50°F to 104°F). Ambient relative humidity should be below 95% non-condensing.

6. Calibration - required monthly.

   a. Ensure NAVIFLASH unit has been calibrated within the last month. If calibrated, skip to step 7. to begin method procedures.

   b. With the NAVIFLASH unit turned off, switch unit to NAVIFLASH mode (calibration) from MINIFLASH mode (flash point testing and/or standard check mode), move cursor to the left arrow field and press the 'TASK' key. Move cursor to the 'SETUP' field; press the 'TASK' key.

   c. Move cursor to 'LOCK' and press the 'TASK' key twice. Display will now read, NAVIFLASH Tester.

   d. Using the up and down arrow keys select function, FUEL ACCEPTANCE CALIBRATION; remove sample cup from oven and press the 'TASK' key.

e. Oven will heat up; fill sample cup with 1mL of n-dodecane standard and follow prompts. Results will display as SAT or UNSAT with a numeric percentage to follow (e.g. SAT 96.0 %). Record results in lab notebook.

f. Remove sample cup from oven and empty sample into a suitable waste container labeled ‘used n-dodecane’.

f. Thoroughly clean NAVIFLASH unit sample cup with a paper towel.

g. To perform a standard check for n-dodecane, follow steps 1.1.11 through 1.1.12

NOTE

Method set up is identical for n-dodecane standard check and flash point method. Ensure you are entering the relevant program number (e.g. program No: 2, Dodecane; program No: 8, D6450)

h. For n-dodecane standard check, select program No: 2 (Dodecane) in MINIFLASH mode. Parameters of 2.0 ºF, 10.0/min, A=0.6s with an oven range of 110-250 ºF should be displayed. Always verify parameters have not changed prior to use.

i. Results should equal 174 ºF +/- 5 ºF. If not, repeat (steps 1.1.11 through 1.1.12) using a different sample cup.

NOTE

Ensure sample cup is wiped and clean with paper towel prior to use.

j. Remove sample cup from oven and empty sample into a suitable waste container labeled ‘used n-dodecane’.

CAUTION

Sample cup may still be hot!

k. Wipe clean NAVIFLASH unit sample cup with a paper towel.

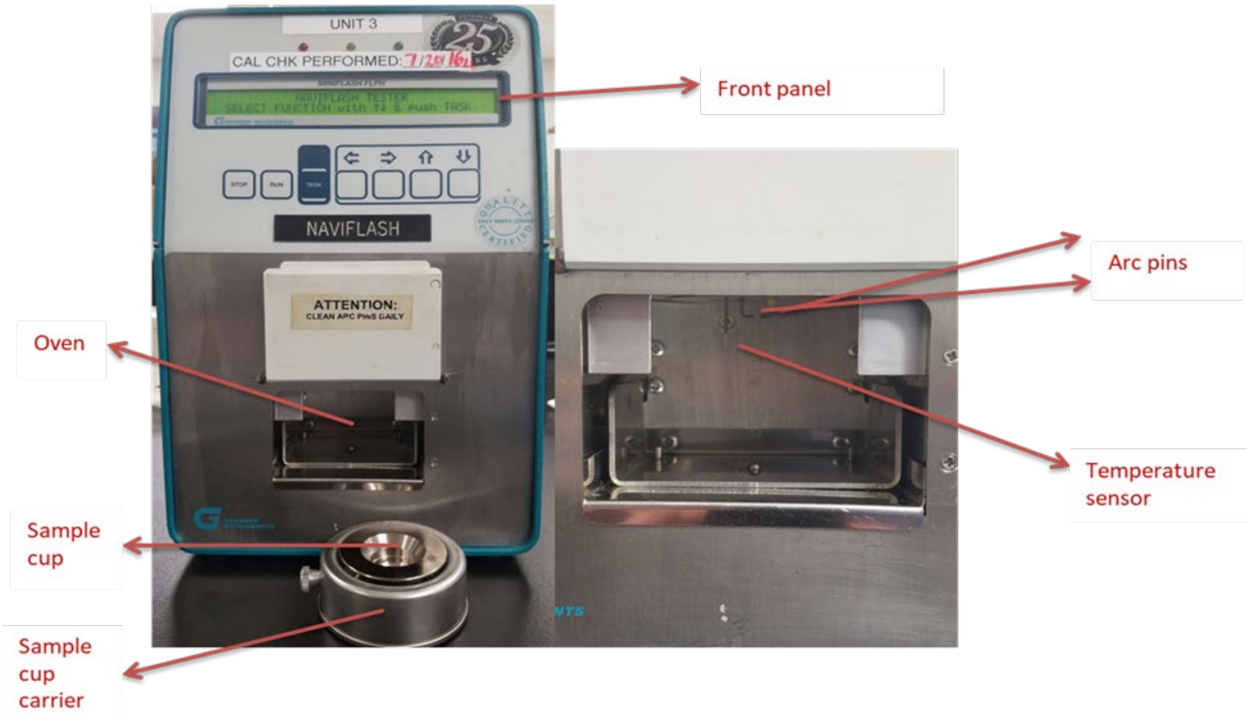

Figure 1 - NAVIFLASH

7. Flash Point Method Setup.

   a. For method setup, unit must be in MINIFLASH mode. With the NAVIFLASH off, switch unit from NAVIFLASH mode (for calibration) to MINIFLASH mode (flash point testing and/or standard check mode) by depressing simultaneously the ‘STOP’ and the ‘→’ (right arrow) keys while turning on the tester.

   b. The display will now read ‘CCA-FLPH ver. X.XXN’.

   c. With cursor on ‘MEASURE’ field, press the ‘TASK’ key.

   d. Use the ‘↑↓’ (up/down arrow) keys to scroll to program No: 8 (D6450). Verify that the parameters are preset as follows: 2.0 ºF, 10.0/min, A=0.6s with an oven range of 350-450 ºF should be set. NAVIFLASH is now ready to perform a flash point test for lube oil.

   e. If temperature parameters need to be set, use right/left arrow keys to move the cursor to the ‘Ti’ (temperature, initial) field and enter 350. Move cursor to ‘Tf’ (temperature, final) and enter 450.

   f. Program No: 8 is the permanent procedure for NAVIFLASH test of 2190TEP lube oil. Always verify parameters have not changed prior to use.

8. Flash Point Testing

   a. Shake sample prior to testing. Smell the oil to check for any volatile (chemical), burnt, or gasoline type odor. Record any abnormal odor in lab notebook.

b. With cursor blinking over the * (asterisks symbol), press the 'RUN' key to initiate oven heating. Oven will regulate to Ti (temperature, initial) 350 ºF.

NOTE

Ensure sample cup is wiped clean with a paper towel prior to use

c. Follow prompt - Fill sample (using approximately 1 mL – the inner first line in the cup). Place sample cup in heated oven with sample cup carrier handle facing out.

d. Ensure cup is secured by allowing cup to 'lock in' on small notch on the floor of the oven. There is an indention on the bottom of sample cup carrier that will align with the notch.

e. Press 'RUN' to start test. Results are displayed and test completion is indicated by an audible signal and red/yellow/green visual indicator lights.

f. Record results as one of the following: Tflash<Ti (a flashpoint below 350 ºF), No flash (flash point is above 450 ºF), or the actual numerical value displayed.

g. Press the 'STOP' key. Prompt will indicate 'COOLING'. Once cooled, move cursor to the far left on the * and press the 'STOP' key.

h. Remove sample cup from oven and empty sample into a suitable waste container labeled 'residual oil waste'. Wipe sample cup clean with dry paper towel after every test.

CAUTION

Sample cup may still be hot!

i. Run a second flash point test on a second sample from the same bottle. Use a different sample cup or wait for sample cup to cool down to room temperature.

j. If a numerical value is obtained, results should be within 10 ºF of each other. If not, re-run until test results are consistent.

k. Wipe clean NAVIFLASH unit sample cup with a paper towel.

NOTE

Allow oven temperature to reach room temperature BEFORE turning off the instrument

l. Gently clean the arc electrode pins with the brass wire brush.

NOTE

Clean oven chamber and arc pins approximately every 5 runs. See l. and m.

CAUTION

Oven chamber may be hot!

m. Carefully clean any residual oil on the top of the oven compartment around the arc electrodes and the temperature electrode with a paper towel.

CANNON MINIAV-X VISCOMETER LABORATORY OPERATING PROCEDURE

NOTE

This work package is new and being added to this volume of the JOAP Manual for the first time. Changes are not marked with a line in the right margin.

1. Scope. Kinematic viscosity is a measure of internal resistance to flow of a fluid under gravity. The time of flow of a fixed volume of fluid is directly proportional to its kinematic viscosity. This procedure is used to determine the kinematic viscosity of transparent and opaque liquid petroleum liquids in accordance with reference a., by measuring the time for a volume of liquid to flow under gravity through a calibrated glass capillary viscometer. Based on the tube range of 2/200, equipment is able to test viscosities between 2 and 200 centistokes (cSt) in accordance with reference a.

2. Summary of Method. The miniAV-X Automatic Viscometer is designed to automate the sample testing and cleaning operations required for determination of kinematic viscosity. The operator places the test samples(s) in small vials in the sample holder, enters sample identification information using the keyboard, and initiates testing with software keypad commands.

3. References.

   a. ASTM D445: Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

   b. NSTM 262: Lubricating Oils, Greases, Specialty Lubricants, and Lubrication Systems

   c. Cannon miniAV-X Automatic Viscometer with VISCPRO Instruction and Operation Manual Version 1.0

4. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
miniAV-X Automatic Viscometer	Cannon Instrument Company	9725-A85	
PC, Windows 10-compatible, with keyboard and mouse	Supplied with instrument		
VISCPRO software	Supplied with instrument (pre-installed on PC)		
Printer	Supplied with instrument		
Reference Thermometer	Supplied with instrument		
Glass vials (20 mL)	Supplied with instrument		
Disposable Plastic Pipettes			
Bottle, Amber Glass Safety Coated w/Cap (4L), qty: 4	Fisher Scientific	06-451-323	
Paper Towels	GSA		7920-00-823-9773
Suitable waste containers			
Laboratory Notebook and Pen			

NOTE

Manufacturers' names are provided as examples. Equivalent products obtained from another source are acceptable.

Table 2. Chemicals / Reagents

Description	Manufacturer	Part Number	NSN
n-Heptane	Acros Organics	AC120340010	
N35 Certified Viscosity Reference Standard	Cannon Instrument Company		
N75 Certified Viscosity Reference Standard	Cannon Instrument Company		
N140 Certified Viscosity Reference Standard	Cannon Instrument Company		

NOTE

For HAZMAT items See Volume II WP HMWS for handling information. Manufacturers' names are provided as examples. Equivalent products obtained from another source are acceptable.

Table 3. Protective Equipment

Description	Manufacturer	Part Number	NSN
Goggles, chemical splash	GSA	ANSIZ87 1.1989	4240-00-190-6432
Gloves, nitrile, medium	GSA		8415-01-492-0179
Gloves, nitrile, large	GSA		8415-01-492-0178
Gloves, nitrile, extra large	GSA		8415-01-492-0180
Lab Coat			

NOTE

It is highly recommended to connect the PC to a Back-UPS with surge protection and battery backup to prevent hard shutdowns.

It is recommended to leave the instrument running continuously, once it is setup; without powering down or closing the software. For initial startup procedure, see section 9.

5. Testing Environment. Avoid severe vibrations, direct sunlight and explosion hazards. Ambient air temperature should be between 15°C to 30°C (59°F to 86°F). Ambient relative humidity should be between 10% and 90% non-condensing. If these environmental conditions cannot be met, testing should be stopped and the facilities department contacted to have the lab environmental conditions restored within specifications.

6. Procedure.

   a. Standard Verification.

NOTE

Monitor the temperature of the silicon bath by checking the provided external thermometer a few times over the course of approximately 5 minutes prior to initial testing to ensure the bath temperature is stable as set. If the bath temperature fluctuates by more than +/- 0.02 ºC, contact the instrument vendor for assistance.

NOTE

Perform viscosity standard check with appropriate standards prior to testing samples. For example, use N35 for ISO 32 oil; N75 for ISO 68 oil, including 2190 TEP and 2190-S; N140 for diesel engine oils. The standard check can be performed along with regular sample testing by including these vials in the set that is being tested.

(1) Fill vials with sample approximately halfway to the top (about 10 mL).

WARNING

Do not overfill the vials past halfway. The viscometer tube displaces fluid during testing so the sample may overflow, and prevent proper cleaning.

NOTE

Naval machinery fluids require viscosity values measured at 40.0°C or 100.0°C, as specified in the relevant documentation. Contact NSWCPD C/331 (NSWCPD_Lubricants@navy.mil) if measurement of viscosity at a different temperature is requested.

(2) Place the sample vials into the carousel, along with standard check vial(s). Keep track of each sample location in the carousel.

(3) If the Instrument Group window in not already open, click “View Instrument” in the Main menu, select the desired instrument group from the list box, and click “OK.”

(4) If any Sample IDs are already assigned, clear them by right clicking on the Sample ID, then clicking delete.

(5) Double click on the Sample ID and enter identifying information for the standard, including lot number. Press Enter to complete the entry.

NOTE

The number in parentheses after the Sample ID refers to the number on the carousel. For example, if information is entered for Sample ID (1), the instrument will automatically draw fluid from the sample vial in carousel slot 1.

(6) Highlight the Sample ID for the standard, and click the Right mouse button to access the sample action options. Choose 2: Verify KV from the list box and click the Left mouse button. Once chosen, the Viscosity Action window will open automatically. The standard bottle label contains a Temperature-Viscosity table. Enter the corresponding kinematic viscosity under “Check Standard kV” and click OK to complete the entry.

Verify that “pause tray if measured kV and check standard kV are not within 0.36%” is checked.

To revise or confirm the standard data, right-click on the desired standard ID from the list box and select Configure from the popup menu

NOTE

The default setting is that the “Pause tray if measured kV and check standard kV are not within: 0.36%” box is checked, and helps ensure that results are accurate. This means that if the standard fails, testing will be paused and the samples will not be automatically run.

b. Sample Preparation

(1) Double click on the Sample ID and enter identifying information for the samples, e.g. lab number. Press enter to complete the entry.

(2) Repeat the above step for all samples.

NOTE

Samples and standards can be placed at any location on the carousel and identifying information can be as limited or descriptive as desired.

NOTE

The default task assigned as each sample description is entered is “Measure Kinematic Viscosity.” If no sample ID is entered, the sample is automatically labeled as “Unknown.”

c. Testing

(1) When data entry is complete, check the Machine Status and Tray Status information (displayed to the right of the Instrument Group window) to verify that all trays are ready for testing. Machine Status should be “Ready” and Tray Status should say “IDLE.” Click on the RUN button at the bottom of the sample Input window.

NOTE

To temporarily pause testing, click the Pause button in the Sample Input window and select the desired Pause action in the Select Tray window. “Pause Now” immediately pauses the test action; “Pause After Current Sample” pauses after the current test is complete. To resume testing, click Resume button in the Sample Input window. To abort testing, click the Abort button in the Sample Input window. Click OK to continue the action.

(2) After testing is complete, ensure that the sample tray is in the lowered position, Machine Status is “Ready,” and the Tray Status is “IDLE.”

(3) The instrument automatically draws two samples from each vial and the final result is the average of the two measurements, as long as the difference between them is less than 1.0%. A third sample is tested if this condition is not satisfied. The kinematic viscosity of the tested samples (and standards) will be displayed in the Sample Action column in the action list for the selected tubes.

(4) The instrument automatically cleans the vials as part of the testing process by rinsing them with the rinsing solvent. Wipe off any excess oil from the carousel using paper towels, as necessary.

NOTE

The instrument should be left in operational mode. If shutdown is necessary, contact the lab manager for assistance.

7. Calibration.

   a. The miniAV-X is calibrated onsite during installation. Calibration periodicity is annual and is performed by the equipment vendor. If there are concerns with the calibration, contact the vendor for instructions.

   b. If there are concerns with the temperature calibrations, contact the lab manager for assistance.

8. Viewing results.

   a. Open the results window (if not already open).

      (1) Click Analyses/View Analysis.

      (2) Open the drop-down menu for Basic Package

      (3) Select CAV Data Table/Last 8 hours.

      (4) Click OK.

   b. Configure results table to view samples that were tested prior to the 8 hours ago.

      (1) Click Analyses --> Configure Analysis --> Last 8 hours CAV Data Table.

      (2) Select "Use Fixed Date and Time"

      (3) Enter date and time of interest and click "OK"

      (4) When prompted whether you want to save the new configuration, select "NO."

9. Initial startup, if necessary.

   a. If the instrument is off, turn on the miniAV-X Bath unit using the power switch on the front of the Power Supply unit. Turn on the PC and the monitor. Open the miniAV-X software by double clicking the VISCPRO II.exe. icon on the desktop.

   b. Check the temperature setting using the following sequence:

      Configure → 1MiniAV:COM2 → 1COM2 1h:2330 →6 Tray Settings: 4 Restore Instrument and Tray Settings

   c. To change the bath temperature between calibrated temperatures, login to Service Mode.

      (1) Click on Main --> Login (...)

(2) Select "Cannon Instrument Co" and enter the password.

NOTE

The password will be provided by the lab manager.

(3) Repeat step b.

(4) Place a check mark in the box for "Restore Instrument Settings and Restore Tray Settings."

(5) Select the desired test method (40 deg C or 100 deg C) and click OK.

(6) Once the temperature has been changed, switch to "Technician" mode by selecting Main --> Logout (...)

NOTE

The miniAV-X is calibrated for 40 ºC and 100 ºC only.

10. Trouble Shooting.

a. Sample Input window doesn't appear when software loads.

(1) Click View Instruments in Main menu and select the instrument.

b. Available Instrument Box is blank.

(1) The miniAV-X instrument is not online. Check cable connections and ensure unit is powered ON.

c. Sample carousel trapped in up position.

(1) To lower sample tray select Service --> 1 Mini AV: COM 1 --> 1 COM1 1h: 2330 --> 3 mini AV Motor Control. For Tray position select 1. For Up/Down Position: select Down. Then select Start. Once sample tray has lowered click “Close”.

d. If the temperature of silicon bath is fluctuating > 0.02°C.

(1) Contact vendor for support.

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SVM 3001 VISCOMETER LABORATORY OPERATING PROCEDURE

NOTE

This work package is new and being added to this volume of the JOAP Manual for the first time via this revision. Changes are not marked with a line in the right margin.

1. Scope. This procedure can be used to determine the dynamic viscosity, kinematic viscosity, and density of liquid petroleum products and crude oils with a typical working range 10 to 600 cSt (kinematic viscosity). This test method is derived from references a. and b. The result obtained from this test method is dependent on the behavior of the sample and is intended for application to liquids for which the shear stress and shear rate are proportional (Newtonian flow behavior).

2. Summary of Method. The typical sample does not require any preparation (if no large particulates are present). The test specimen is introduced into the measuring cells which are held at a closely controlled and known temperature. The measuring cells consist of a pair or rotating concentric cylinders and an oscillating U-tube. The dynamic viscosity is determined from the equilibrium rotational speed of the inner cylinder under the influence of the shear stress of the test specimen and an eddy current brake in conjunction with adjustment data. The density is determined by the oscillation frequency of the U-tube in conjunction with adjustment data. The kinematic viscosity is calculated by dividing the measured dynamic viscosity by the density of the fluid. All values are displayed concurrently on the instrument.

3. References.

   a. ASTM D445, Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

   b. ASTM D2270, Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 ºC and 100 ºC

   c. ASTM D4052, Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter

   d. ASTM D7042, Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

   e. Instruction Manual. SVM 3001 Stabinger Viscometer

4. Equipment/Apparatus/Materials.

Table 1. Equipment / Apparatus / Materials

Description	Manufacturer	Part Number	NSN
Viscometer	Anton Paar	SVM 3001	
Syringe, 5mL Luer or similar	Anton Paar	6772	
Screen, 75 um apperture			
Kim Wipes	GSA		7920-00-721-8884
Paper Towels	GSA		7920-00-823-9773

Table 2. Chemicals / Reagents

Description	Manufacturer	Part Number	NSN
Biotek HI-solv (cleaning solvent)	Bio-Tek	134 HI-Solv	6850-01-277-0595
Heptane (cleaning solvent)	Fisher Scientific		6810-01-448-7151
Petroleum Ether REA (drying solvent), technical grade or better			6810-01-962-2018
Cannon Certified Viscosity Standard (S60)	Fisher Scientific	22-288-552	
N35 Certified Viscosity Reference Standard	Cannon Instrument Company		
N75 Certified Viscosity Reference Standard	Cannon Instrument Company		
N140 Certified Viscosity Reference Standard	Cannon Instrument Company		

NOTE

Manufacturers' names are provided as examples. Equivalent products obtained from another source are acceptable.

NOTE

For HAZMAT items See Volume II WP HMWS for handling information.

Table 3. Protective Equipment

Description	Manufacturer	Part Number	NSN
Goggles, chemical splash	GSA	ANSIZ87.1989	4240-00-190-6432
Gloves, nitrile, medium	GSA		8415-01-492-0179
Gloves, nitrile, large	GSA		8415-01-492-0178
Gloves, nitrile, extra large	GSA		8415-01-492-0180
Lab Coat			

5. Testing Evironment. Avoid severe vibrations, direct sunlight and explosion hazards. Ambient air temperature range should be 5°C to 35°C (41°F to 95°F). Ambient relative humidity should be below 80% non-condensing. If these environmental conditions cannot be met, testing should be stopped and the facilities department contacted to have the lab environmental conditions restored within specifications.

6. Procedure. Consult the operating procedures manual supplied with the viscometer.

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