(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

30 August 2013
Change 1 – 1 June 2015

TECHNICAL MANUAL

JOINT OIL ANALYSIS PROGRAM MANUAL

VOLUME II

SPECTROMETRIC AND PHYSICAL TEST LABORATORY OPERATING REQUIREMENTS AND PROCEDURES

This manual supersedes NAVAIR 17-15-50.2 dated 31 July 2012.

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	30 Aug 2013		1	1 June 2015

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 Dispose of the superseded issues of the technical manuals. Superseded classified technical information shall be destroyed in accordance with applicable regulations.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 or the change symbol "R" 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 I of this manual is 408.

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

30 August 2013
Change 1 – 1 June 2015

WP Number	Title	Total Number of Pages	Change No.
	LUBRICANTS ANALYSIS AND RESEARCH APPLICATION (LARA)		
003 04	NAVY OAP – LARA TOOLBOX OPERATIONS GUIDE	1 thru 14	1
003 05	NAVY OAP – SHAREPOINT OPERATIONS GUIDE	1 thru 14	1
004 00	AIR FORCE OIL ANALYSIS PROGRAM LABORATORIES OPERATING REQUIREMENTS AND PROCEDURES	1 thru 2	1
004 01	AIR FORCE OAP – GENERAL LABORATORY OPERATING PROCEDURES	1 thru 4	1
004 02	AIR FORCE OAP – LABORATORY EQUIPMENT AND CONFIGURATION REQUIREMENTS	1 thru 2	1
004 03	AIR FORCE OAP - DATA RECORDING, PROCESSING, AND WAREHOUSING	1 thru 2	1
005 00	TOTAL ACID NUMBER (TAN) LABORATORY OPERATING PROCEDURES	1 thru 4	1
006 00	BROOKFIELD SCANNING VISCOMETER LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 12	0
007 00	CAMBRIDGE VISCOMETER LABORATORY PROCEDURES	1 thru 6	1
008 00	CRACKLE TEST LABORATORY PROCEDURES	1 thru 2	0
009 00	AQUATEST 2010 (KARL FISCHER WATER TEST) LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 14	1
010 00	AQUATEST VIII LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 8	0
011 00	PALL WATER TEST LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 2	0
012 00	BLOTTER (SPOT) TEST LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 2	0
013 00	FERROGRAPHY LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 12	0
014 00	FOURIER TRANSFORM INFRA-RED (FT-IR) LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 6	0
015 00	SETAFLASH LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 4	0
016 00	FUEL DILUTION METER LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 6	1
017 00	MICROSCOPIC ANALYSIS LABORATORY PROCEDURES AND REQUIREMENTS	1 thru 2	0
018 00	PODS PARTICLE COUNTER PROCEDURE	1 thru 2	1
019 00	USAF B-2 COOLANT TEST	1 thru 20	0
020 00	CONTAMINATION TESTING OF COOLANT	1 thru 16	0
021 00	FLUID CONTAMINATION	1 thru 6	0
022 00	VISCOSITY BY ANTON PARR	1 thru 2	1

30 August 2013
Change 1 – 1 June 2015

WP Number	Title	Total Number of Pages	Change No.
023 00	TYPE EQUIPMENT CODES	1 thru 56	1
024 00	MAJOR COMMAND CODES	1 thru 2	1

30 August 2013
Change 1 – 1 June 2015

NAVAL AIR SYSTEMS COMMAND TECHNICAL MANUAL PROGRAM
LIST OF TECHNICAL PUBLICATIONS DEFICIENCY REPORTS INCORPORATED

1. The TPDRs listed below have been incorporated in this issue.

Activity	Report Control Number	Location
JOAP Executive Committee	N00421-15-1140	WP HMWS
JOAP Executive Committee	N00421-15-1141	WP 001 00
Navy Oil Analysis Program Team	N00421-15-1142	WP 003 00
Navy Oil Analysis Program Team	N00421-15-1143	WP 003 01
Navy Oil Analysis Program Team	N00421-15-1144	WP 003 02
Navy Oil Analysis Program Team	N00421-15-1145	WP 003 03
Navy Oil Analysis Program Team	N00421-15-1146	WP 003 04
AF Oil Analysis Program Team	N00421-15-1147	WP 004 00
AF Oil Analysis Program Team	N00421-15-1148	WP 004 01
AF Oil Analysis Program Team	N00421-15-1149	WP 004 02
AF Oil Analysis Program Team	N00421-15-1150	WP 004 03
Navy Oil Analysis Program Team	N00421-15-1151	WP 005 00
Navy Oil Analysis Program Team	N00421-15-1152	WP 007 00
Navy Oil Analysis Program Team	N00421-15-1153	WP 016 00
Navy Oil Analysis Program Team	N00421-15-1154	WP 018 00
Navy Oil Analysis Program Team	N00421-15-1155	WP 022 00
JOAP Executive Committee	N00421-15-1156	WP 023 00
JOAP Executive Committee	N00421-15-1157	WP 024 00

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Change 1 - 1 June 2015

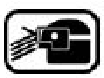
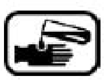
WARNINGS APPLICABLE TO HAZARDOUS MATERIALS

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, personnel 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.

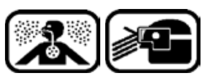
In the text of the manual, the caption “WARNING” is not used for hazardous material warnings. Hazards are cited with appropriate icon(s), the nomenclature of the hazardous material, and the numeric identifier that relates to the complete warnings. Users of hazardous materials shall refer to the complete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

	**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.
	**Chemical**	The symbol of a liquid dripping onto a hand shows that the material will cause burns or irritation to human skin or tissue.
	**Fire**	The symbol of a fire shows that the material may ignite or overheat and cause burns.
	**Poison**	The symbol of a skull and crossbones shows that the material is poisonous or is a danger to life.
	**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.

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.

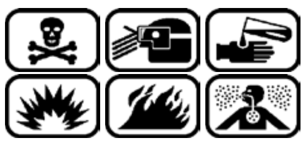
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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.

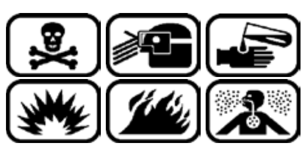
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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.

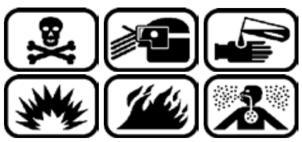
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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.

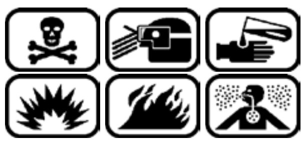
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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.

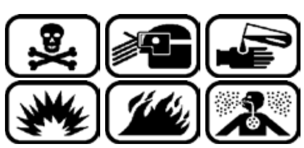
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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)

INDEX	MATERIAL	WARNING
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.

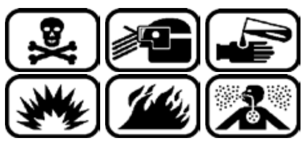
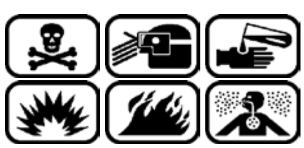
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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.

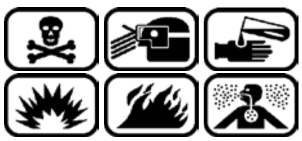
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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.

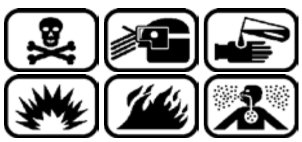
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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)

INDEX	MATERIAL	WARNING
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.

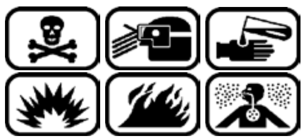
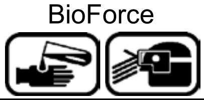
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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)

INDEX	MATERIAL	WARNING
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.

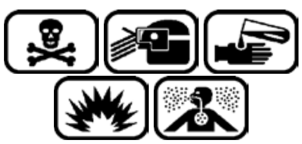
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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)

INDEX	MATERIAL	WARNING
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,

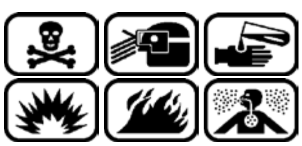
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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.

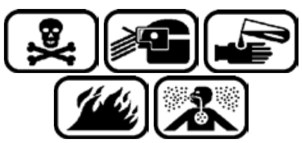
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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)

INDEX	MATERIAL	WARNING
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.

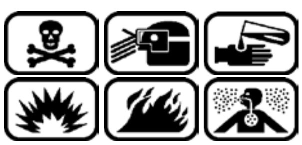
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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.

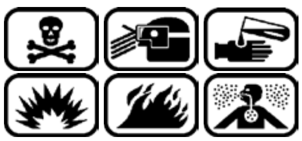
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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.

HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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)

INDEX	MATERIAL	WARNING
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.

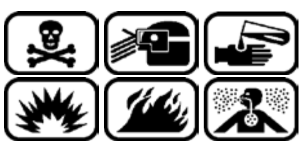
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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.

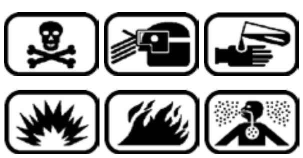
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

INDEX	MATERIAL	WARNING
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.

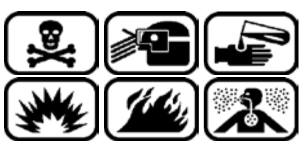
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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.

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.

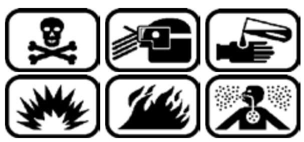
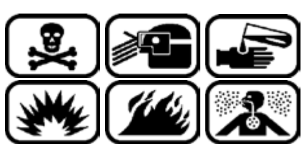
HAZARDOUS MATERIALS WARNINGS (CONTINUED)

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 II INCLUDING MINIMUM REQUIREMENTS AND SPECTROMETER OPERATING PRODCURES FOR JOAP LABORATORIES

Table of Contents

1. Introduction. The Purpose of Volume II 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 courses available.

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

Title	Course No.
Atomic Emission Spectrometer with Physical Properties Testing and Filter Debris Analysis (FDA)	Navy CIN: A-491-0017
Atomic Emission Spectrometer	J3AZP2A752-000

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

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. Adjustment of the source frequency is made with a control that has been placed in the burn chamber.

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).

(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 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 The DoD eMall, https://dod-emall.dla.mil/acct/.

(a) Standards available.

Table 1. Available Standards

Designation	***Elements	Available Concentrations	Shelf Life
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

NOTES:

* Shelf/service life assigned to Spectrometric Oil Standards is finite with no extensions allowed. Standards reaching service life shall be locally disposed of in accordance with applicable service regulations. Report any attempt to extend shelf life of the spectrometric standards to the service program manager.

** The 5 PPM concentration is not applicable to AOAP 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 and D12 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

NOTE

Only spectrometer standards obtained using the National Stock Numbers listed above 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 DoD eMall, https://dod-emall.dla.mil/acct/. 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 6640-01-042-6583, with nomenclature of Cap, Screw, Bottle & Jar, P/N 24-3600, 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. They may be obtained either through normal supply channels or by open purchase. A suggested six-month supply is listed in table 5.

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.

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
Disk Filter	47 mm 100's	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

(3) Electron solvent has been approved for use in the JOAP program as a replacement for Trichloroethane. See Table 7 for units of issue and NSN's.

7. Forms Required.

a. Oil Analysis Record (DD Form 2027) is required for those laboratories performing manual recording of oil analysis data and is available through normal forms distribution channels.

b. 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).

c. 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. All oil analysis laboratories.

(1) Message Address Directory: Army DA Pamphlet 25-11, 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 non-aeronautical equipment should have Volume IV.

(3) Spectro, Inc. Model M/N Operation and User Maintenance Manual, U. S. Air Force T.O. 33B4-2-29-11, 33B4-2-29-1, 33B4-2-29-21, 33B4-2-29-22,33B4-2-29-31 and 33B4-2-29-32 (depends on Spectrometer series) and U.S. Navy NA 17-15BF-95.

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 III and IV.

   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). 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 prior to 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 testing samples. Correct frequency, or breaks per half cycle, is essential for repeatable results. 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. At a minimum, these checks will be made when switching from 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 to oil analysis equipment, sample preparation areas, or ADP 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 electrodes (either rod, disc, or both), or a change in lot or batch number of the same manufacturer occurs, a disc offset daily standardization check must be performed using the new 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 6640-01-042-6583) will be used as sample vessels for all sample analyses except when analyzing low flash point fluids. 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 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 WP 002, WP 003, and WP 004 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 I, 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:

LOGSA
AMXLS-GO BUILDING 3307
REDSTONE ARSENAL AL 35898
AOAP Hot Line DSN: 645-0869 / (256) 955-0869
Data Facsimile: 645-0869 / (256) 955-9078
DDN address:usarmy.redstone.logsa.mbx.aoap@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 II Work Packages 002 (Army), 003 (Navy) and 004 (Air Force).

b. Automated laboratories. Detailed information concerning automated systems to access the computer file data and for entry of variable sample data into the computer files.

(1) 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.

(2) DD Form 2027 is not normally used by automated laboratories unless required for backup or temporary records in the event of automated system failure.

(3) The requirements for assignment of sample numbers by service activities is the same as that specified in paragraph .12.c(3)(b) for non-automated laboratories.

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) DD Form 2026 is used as a source document to locate existing DD Form 2027 and complete the variable data section or to initiate new DD Form 2027. The DD Form 2026 is also 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.

(2) DD Form 2027 (Figure 1) is used as an historical record of equipment monitored. Non-Air Force activities that are not designated to transfer data to the data base shall complete DD Form 2027 using information from the DD Form 2026 and laboratory analysis data and retain DD Form 2027 on file as the historical record for each item of equipment monitored. These laboratories may use either coded or plain language data entries, whichever is locally desired. Laboratories will comply with individual service directives for sending non-automated data into the JOAP database.

(3) Data from the DD Form 2026 are transferred to the DD Form 2027 as follows:

(a) Permanent data section: The information for this section is provided by the oil analysis request (DD Form 2026). This data once entered on the DD Form 2027, rarely changes but should be verified at the time of each subsequent data entry.

NOTE

When instructions for a data entry item specify, "leave blank", laboratory personnel may use these data entry blocks for any purpose desired locally. Each laboratory supervisor will determine which, if any, of the data entry blocks will be used locally and for what purpose.

1. Component Control Number (CCN) - leave blank.

2. Equipment Model/APL - enter the equipment/component model name from DD Form 2026 and/or the appropriate model code from Volume II WP 023 00 Type Equipment Codes (TEC).

3. Equipment Serial Number - enter the equipment/component serial number being monitored (Engine, Gearbox, etc. that was sampled).

4. Type Equipment Code - leave blank.

5. Customer - enter the major command listed on the DD Form 2026 or the appropriate code from Volume II WP 024 00.

6. Customer Identification - enter the activity's name and unit identification code (UIC). (USAF- enter base code.)

7. Lab - enter your laboratory name..

8. End Item Model/Hull Number - enter End Item Model/Hull number as given on DD Form 2026 and/or the appropriate code from Volume II WP 023 00.

9. End Item Serial Number - enter end item serial/bureau number.

10. Type Oil - leave blank.

(b) Variable data section: The information for this section is also provided by the oil analysis request (DD Form 2026) but changes with each sample processed and recorded.

1. Sample Number - Laboratories shall enter sample number.

a. If no customer sample number is assigned, Navy laboratories will assign a temporary control number, process the sample in the normal manner and contact the customer by appropriate means, depending upon customer location and request a sample number. The omission of a sample number shall not delay the processing of a sample or the customer notification of analysis results.

b. The monthly reporting period shall be the first through the last day of each month. The first digit of the sample number will be monthly designator identified as follows:

1 - Jan	4 - Apr	7 - Jul	O - Oct
2 - Feb	5 - May	8 - Aug	N - Nov
3 - Mar	6 - Jun	9 - Sep	D - Dec

c. The second part of the sample number shall be composed of three numerical digits and will follow the monthly designator. Sequence numbers will be assigned in ascending order beginning with 001 each month, e.g., 234th sample submitted in Feb will be reflected as sample number 2234.

2. Data Index - USN leave blank. USAF leave blank for routine documentation. For file maintenance actions, see Appendices A and E.

3. Date Sample Analyzed - enter Julian date sample analyzed.

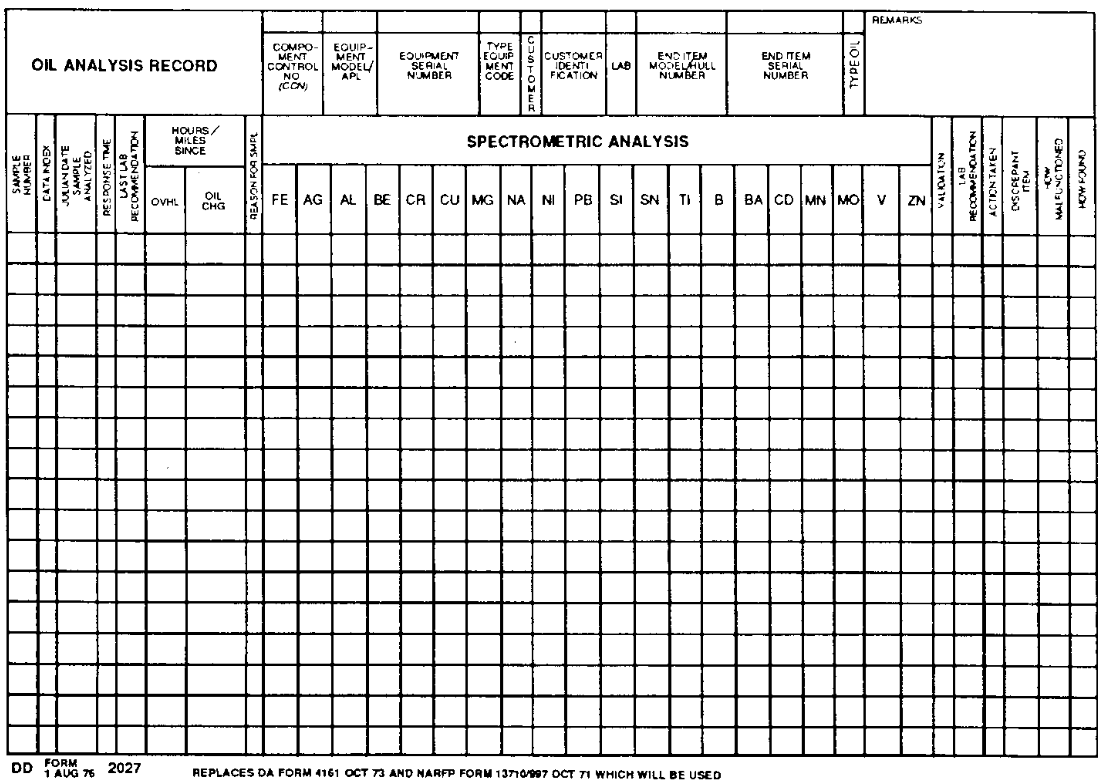
4. Response/Turn Around Time - enter the number of days in transit as calculated by subtracting the date the sample was taken from the date the sample was analyzed. Air Force laboratories will enter the total sample response time in whole hours to include elapsed hours from the time that the sample was taken to the time that the laboratory completed sample processing and issues laboratory recommendation. (Army laboratories - leave blank.)

5. Last Lab Recommendation - leave blank.

6. Hours/Miles Since Overhaul - enter the number of hours/miles since new or overhauled as applicable

7. Hours/Miles Oil Change - enter the number of hours/miles since oil change.

8. Reason for Sample - enter the appropriate reason sample submitted code from Volume I WP 005 00, Table 5.



OIL ANALYSIS RECORD

COMPONENT CONTROL NO (CCN)	EQUIPMENT MODEL/APL	EQUIPMENT SERIAL NUMBER	TYPE EQUIPMENT CODE	CUSTOMER	CUSTOMER IDENTIFICATION	LAB	END ITEM MODEL/HULL NUMBER	END ITEM SERIAL NUMBER	TYPE OIL	REMARKS

SAMPLE NUMBER	DATA INDEX	JULIAN DATE SAMPLE ANALYZED	RESPONSE TIME	LAST LAB RECOMMENDATION	HOURS/MILES SINCE OVHL	HOURS/MILES SINCE OIL CHG	REASON FOR SMPL	FE	AG	AL	BE	CR	CU	MG	NA	NI	PB	SI	SN	TI	B	BA	CD	MN	MO	V	ZN	VALIDATION	LAB RECOMMENDATION	ACTION TAKEN	DISCREPANT ITEM	HOW MALFUNCTIONED	HOW FOUND

(SPECTROMETRIC ANALYSIS: FE through ZN)

DD FORM 1 AUG 76 2027 REPLACES DA FORM 4161 OCT 73 AND NARFP FORM 13710/997 OCT 71 WHICH WILL BE USED

FIGURE 1. Oil Analysis Record (DD Form 2027)

NOTE

If the DD 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 DD2026, 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.

(c) Post analysis data:

1. Validation - this block is normally left blank. However, it may be used to identify the laboratory operator/evaluator for laboratory management purposes.

2. Laboratory Recommendation - after laboratory evaluation of sample results, enter the appropriate recommendation code from Volume I WP 005 00.

(d) Feedback data (if applicable):

1. Action Taken - enter the appropriate action taken code from Volume I WP 005 00.

2. Discrepant Item - enter the appropriate discrepant item code from Volume I WP 005 00.

3. How Malfunctioned - enter the appropriate how malfunctioned code from Volume I WP 005 00.

4. How Found - enter the appropriate how found code from Volume I WP 005 00.

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

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 III and IV.

(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 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 once 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 or by telephone 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.

(2) 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.

(3) 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.

(4) 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 III or IV 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/indent 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 mail 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 2027, refer to figure 1, 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 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 provides 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.

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. 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. JOAP Certification and Correlation Programs. The JOAP Certification and Correlation Programs are primary elements of the JOAP quality assurance initiative to ensure standardization of procedures and quality of oil analysis by the JOAP laboratories. Follow the specific spectrometer operators' manual for any additional special standardization recommendations/requirements prior to the analysis of correlation samples such as optical alignment or a check of the source frequency using a test meter or an oscilloscope. Participation in these programs is mandatory for all atomic emission rotrode spectrometer oil analysis laboratories, organic or under contract to a US military service for analyzing used oils from U.S. government equipment.

a. Certification program. Based upon laboratory facilities, personnel qualifications, and JOAP Correlation Program scores, laboratory spectrometers are categorized as certified or uncertified.

(1) Certified laboratories are authorized to provide oil analysis support to all authorized and approved customers, intraservice and interservice, as well as other DoD authorized customers. Uncertified laboratories 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) on file with the program management office granting the waiver.

(2) The JOAP Certification Program is described in detail in Volume I WP 004 00.

b. Correlation program.

(1) 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.

(2) Perform complete spectrometer standardization. Immediately following the standardization, perform a daily standardization check with at least three standards prior to correlation samples analysis to ensure that the standardization was successful. If the results are not within the required tolerances, repeat the complete spectrometer standardization until the daily standardization checks are acceptable.

NOTE

Correlation printouts, including all standardization data and left over correlation oil, shall be retained for three months. 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.

(3) Ensure that the samples are analyzed on the spectrometer whose serial number is on the mailing label. Follow the spectrometer operating manual for additional special standardization recommendations/requirements prior to the analysis of correlation samples such as optical alignment or a check of the source frequency using a test meter or an oscilloscope.

(4) Analyze each sample a minimum of three (3) times and average the results.

NOTE

When averaging results ensure any inconsistent burns are removed prior to calculating the average.

(5) Retain remaining oil for 3 months, in the event a resubmittal is required.

(6) Air Force labs are required to report correlation results via the AETC External (see 33-1-37-2 WP 004) software screen C. Other services, report results on the MS Word template via e-mail. Figure 2 is an example of a completed report template ready for submission to OAPCORR@US.AF.MIL as an attachment to the email message. Do Not modify the template, simply enter the required information. A copy of the MS Word report template may be obtained from your respective OA program manager. When utilizing the MS Word template the email subject must contain the Base Name, Serial Number and Month.

(7) If a “0” (zero) reading is obtained immediately contact your service program manager for further guidance.

(8) Record R/M if one or more elements are inoperative.

(9) Submit results to the correlation team as soon as possible after receipt of the samples, but within 5 duty days. Current month results are to be submitted by the 21st of the month. Results received after the 21st will not be used to help calculate the trim mean. JOAP certified laboratories should 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 base name, spectrometer serial number and month on the email SUBJECT line

(10) Comply with any other special instructions received with the correlation samples.

(11) Score computation.

(a) General. Correlation scores for all participating laboratory spectrometers are based on reproducibility 1 and reproducibility 2 results. A correlation test results report is sent to each service program manager each month for all spectrometers enrolled in the program. If either reproducibility 1 (R1) or reproducibility 2 (R2) fails the criteria for any of the required elements, points are subtracted. Each sample pair accounts for 50 possible points for a total of 100 points.

(b) Late results.

1. Non-submission (NS). If the score sheet indicates N/S for the current month and results were submitted, contact the 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, base name, spectrometer serial number, and month. For JOAP Certified labs, non-submission of data can jeopardize JOAP certification.

2. 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. Table 8 lists all JOAP fluids currently used in equipment monitored in the JOAP.

CORRELATION PROGRAM RESULTS FOR: APR13 CORRELATION

From: USS BATAAN
JOAP Code: AXO
Serial Number: 693
Model: SPECTROILM
Org e-mail: NOAP@LHD5.NAVY.MIL
Address: USS BATAAN
Address (cont.): IM02 / AIMD FPO AP 96554
FED-EX INFORMATION-No PSC/APO Addresses for OCONUS.
Physical Address: XXXX

Commercial Phone: 7574437398

	Fe	Ag	Al	Cr	Cu	Mg	Na	Ni	Pb	Si	Sn	Ti	B	Mo	Zn
#1	6	6	13	6	10	6	24	13	7	6	7	6	7	7	7
#2	7	7	12	7	10	7	22	13	8	7	8	7	6	6	6
#3	11	11	11	9	15	11	35	21	11	9	20	12	17	16	21
#4	9	9	9	8	13	9	28	17	9	8	17	10	15	14	18

Date Received (m/dd/yyyy) 04/05/2013
Date Analyzed (m/dd/yyyy) 04/09/2013

ELECTRODES
Disc lot: 031031
Rod lot: 021030

STANDARDS	BATCH/LOT	MFG DATE	EXP DATE
0 PPM	HFKP913	09/27/2011	03/28/2014
D12-100	NUW996	11/2010	05/28/2014
D3-100	GADT716	04/09/2012	04/28/2013

OTHER INFORMATION
Comments: USS BATAAN
Office Phone (DSN): 0
Operator: AD1 GANESHAN / AD2 KELLY
Operator e-mail: GANESHAN@LHD5.NAVY.MIL
Supervisor: ADCS PRZYBYLSKI
Supervisor e-mail: PRZYBYLS@LHD5.NAVY.MIL
Commander Name/Rank: LCDR CURRY

FIGURE 2. Sample Correlation Results Report in MS Word Template

TABLE 8. JOAP Fluids

The following fluids are the types now used in the Joint Oil Analysis Program for all JOAP engines, transmissions 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-L-9000	0278	M
9150-00-664-4449	OIL REFRIGERANT COMPRESSOR	VV-L-825	0283	

NOTE: M – Mineral, S - Synthetic

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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 03 01 – General Laboratory operating procedures and operator training requirements.

   WP 03 02 – Laboratory Equipment / Configuration Requirements

   WP 03 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. 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. 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.

3. Staffing Requirements. A certified evaluator must be present during all hours of laboratory operations. All Army laboratories must employ two certified evaluators full-time. The role of an evaluator in Army Oil Analysis Program (AOAP) laboratories is to make diagnostic and prognostic recommendations based on analytical instrument test data. Program Manager AOAP must certify all evaluators serving in Army laboratories according to the following procedure:

Certification Requirements

a. Requests for evaluator certification must:

(1) Be provided to the AOAP PMO by the AOAP Lab Chief or government office responsible for the laboratory.

(2) Include the completed applicant Training Plan for Aeronautical / Non-aeronautical testing and evaluation certification (LOGSA AOAP PMO-01 R).

b. Requirements for evaluator certification are:

(1) Applicant must have the ability to be certified for both aeronautical and nonaeronautical equipment. Individuals in laboratories that analyze only nonaeronautical samples or only aeronautical samples will receive limited evaluator certification.

(2) Applicant must successfully pass a written test and a performance evaluation administered by the AOAP Program Management Office (PMO). If the applicant fails either, the individual must wait at least 2 months before requesting certification again. The additional time will permit the applicant to receive additional training in those areas where additional knowledge is required.

c. When an applicant has successfully passed the written and performance examinations, the applicant will be given a 3 month interim certification. The AOAP PMO will monitor the applicant's evaluations during this period and upon completion will award full certification if appropriate.

d. Requirements for evaluator certification in Ferrography:

(1) In addition to the requirements outlined in paragraphs N-2 above, the following are applicable to Army laboratory personnel who are to be certified to evaluate grease samples through the use of Ferrography.

(2) Must be a certified aeronautical AOAP evaluator and;

(a) Should have completed the ferrographic instrument manufacturer's 1 week Introduction to Ferrography Course and least 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. Test administration:

(1) Written test:

(a) Will be given at the AOAP PMO laboratory located at Redstone Arsenal, Alabama.

(b) The test will examine the applicant's knowledge of Army Oil Analysis and Joint Oil Analysis Program processes and procedures.

(2) Performance test. Will be given in conjunction with the written test, and will evaluate the applicants ability to utilize all analytical laboratory test equipment and arrive at the appropriate conclusion with a high level of accuracy.

Required Training and Experience:

a. Defense Joint Oil Analysis Program (JOAP) Course (course: J3AZP2A752-003).

b. Noria Oil Analysis I Course.

c. Advanced Machine Condition Analysis Course (Ferrography).

d. Knowledge of AOAP publications, to include:

(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.

e. A minimum of 6 (six) months working closely with an AOAP laboratory technician processing samples on all analytical equipment, followed by a minimum of 3 (three) months working closely with a certified AOAP evaluator. All training will be documented in the Training Plan for Aeronautical / Non-aeronautical testing and evaluation certification (LOGSA AOAP PMO-01R) 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 testing will be given.

DECERTIFICATION.

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

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

(2) An evaluator willingly disregards AOAP policies or procedures.

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

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

RECERTIFICATION

a. Shall be required for all individuals who were certified evaluators at one time, were decertified, and desire to be certified again. Applicants requesting recertification must meet the requirements outlined in the Certification Section above.

b. For those whose decertification was directed by the AOAP Program Manager:

(1) Recertification may not be requested for 1 year.

(2) The reason for decertification must be mitigated and satisfactorily resolved.

GENERAL NOTES

a. If an evaluator originally receives limited certification (to evaluate nonaeronautical or aeronautical samples only) and later wants to be fully certified, he/she must take written and performance tests to qualify for full certification (both aeronautical and nonaeronautical evaluation). Procedures for requesting and administering the tests are the same as those for initial certification described in this appendix.

b. b. If an evaluator originally receives full certification to evaluate both nonaeronautical and aeronautical samples, and continues to be employed as an evaluator but evaluates only nonaeronautical or only aeronautical samples, he/she does not lose full certification.

4. JOAP Training.

a. Training courses available.

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

Title	**Course No.**
Atomic Emission Spectrometer	J3AZP2A752-000
Physical Properties Testing	J3AZP2A752-003
Ferrography Testing	J3AZP2A752-004

NOTE

Air Force Non-Destructive Inspection (NDI) course, J3ABP2A732-000 (or equivalent), includes evaluator training and operation/maintenance of the Model M spectrometer equivalent to training provided in course J3AZP2A752-000.

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

NOTE

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

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

10. 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 25-11, 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).

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 4-1 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 4-1. 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 certified evaluator must be present during all hours of laboratory operations. All Army laboratories must employ two certified evaluators full-time. The role of an evaluator in Army Oil Analysis Program (AOAP) laboratories is to make diagnostic and prognostic recommendations based on analytical instrument test data. Program Manager AOAP must certify all evaluators serving in Army laboratories according to the following procedure:

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.

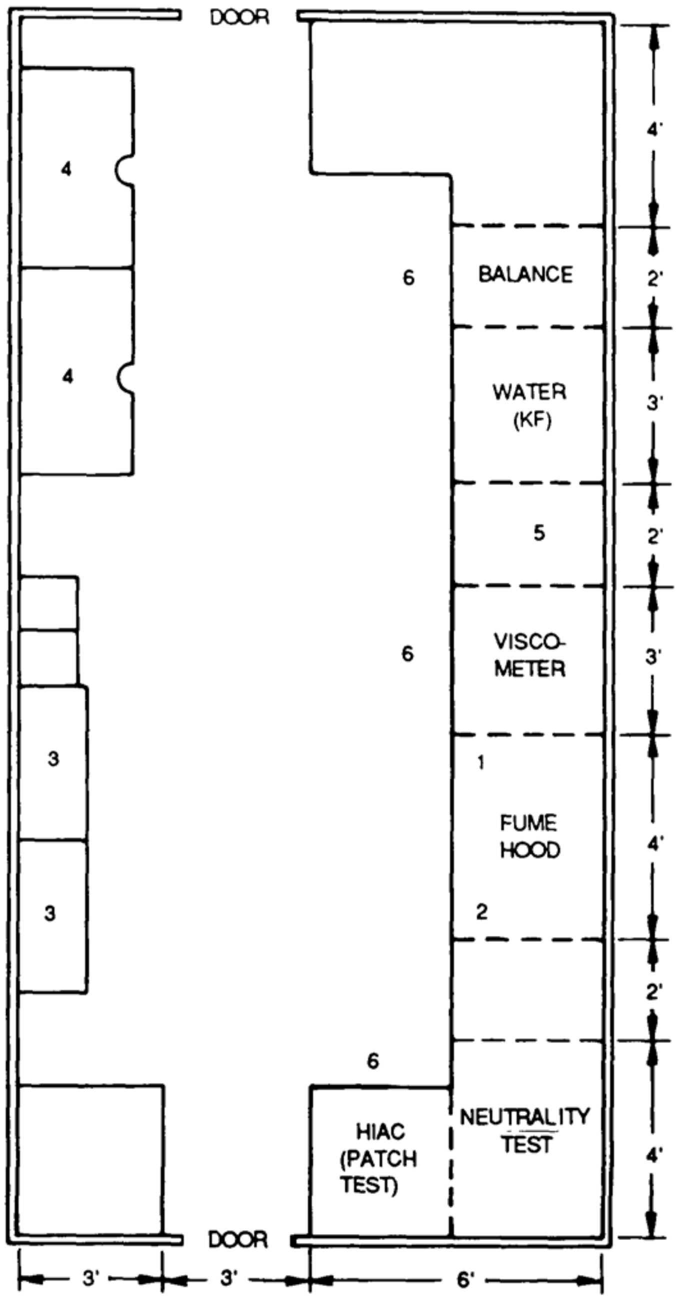
(3) Water by Karl Fischer Titration. If water contamination exceeds the guidelines, the laboratory shall recommend flushing the system and replacing the fluid.

(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.
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. Fall - 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.
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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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
USAMC LOGISTICS SUPPORT ACTIVITY
ATTN AMXLS-GO BUILDING 3661
REDSTONE ARSENAL AL 35898-7466
AOAP Hot Line DSN: 645-0869 / (256) 955-0869
Data Facsimile: 746-9344 / (256) 876-9344
DDN address: usarmy.redstone.logsa.mbx.aoap@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

NON-AERONAUTICAL
065 OIL ANALYSIS MONTHLY ACTIVITY REPORT
FOR SAMPLE AND ANALYZED DURING JANUARY, 1992
REPORT DATE: 11 APRIL 1994
UIC NO. :WOXY26
COMMAND : FORSCOM
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	LAB ADVICE NORMAL RESAMPLE ASAP NORMAL
NHC-250	750697	10377	2501	01/30/92	8	2270	1814	ROUTINE	NORMAL
5R82	1078	61G1060	1532	01/21/92	4	UNKNOWN	UNKNOWN	ROUTINE	NORMAL
DD6V92	N2956535	6JD032163	2499	01/30/92	3	UNKNOWN	UNKNOWN	ROUTINE	NORMAL
CAT D333	2S13372	75E1091	168	01/06/92	3	UNKNOWN	510	ROUTINE	NORMAL
3R2211	2368	75E1738	2511	01/30/92	3	UNKNOWN	53	ROUTINE	NORMAL
5R6192	IHC00725	7GB00662	2436	01/29/92	6	UNKNOWN	2705	ROUTINE	NORMAL
5R6192	IHC00726	7GB00664	2437	01/29/92	6	UNKNOWN	1720	ROUTINE	NORMAL
DD6V92	06VF163109	8JD032164	2532	01/31/92	2	UNKNOWN	UNKNOWN	ROUTINE	NORMAL
HT750DRD	2510124937	8JD032164	2531	01/31/92	2	UNKNOWN	UNKNOWN	ROUTINE	NORMAL
DD6V92	N2956544	8JD032164	2534	01/31/92	2	UNKNOWN	UNKNOWN	ROUTINE	CHANGE OIL &
CASE 504BD	10367709	9160408	2500	01/30/92	3	UNKNOWN	863	ROUTINE	RESAMPLE AFTER
CASE 504BD	10367789	9160413	185	01/06/92	3	UNKNOWN	19	LAB REQUEST	NORMAL
CASE 504BD	10367511	9160420	186	01/06/92	3	UNKNOWN	965	LAB REQUEST	NORMAL
CASE 504BD	10367511	9160420	2199	01/28/92	4	UNKNOWN	UNKNOWN	LAB REQUEST	NORMAL
TT2421-1	5110142354	9160420	2438	01/29/92	6	UNKNOWN	UNKNOWN	ROUTINE	NORMAL
360311	130805	A177B26354K	2510	01/30/92	3	UNKNOWN	UNKNOWN	ROUTINE	NORMAL
ISUZU C240	709267	A177B26354K	2497	01/30/92	3	UNKNOWN	UNKNOWN	ROUTINE	NORMAL
NHC-250	10265252	C12610198	2498	01/30/92	3	UNKNOWN	UNKNOWN	ROUTINE	NORMAL
NHC-250	752034	C12610356	2435	01/29/92	6	UNKNOWN	UNKNOWN	ROUTINE	NORMAL
NHC-250	10287488	C14010023	2533	01/31/92	2	UNKNOWN	13	ROUTINE	NORMAL
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	

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

SORT CODE: 212

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

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

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

REPORT PERIOD ENDING
31 Mar 94

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

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 HRS/DAY	INTDATE 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------						------TYPE SAMPLE------			--LAB RECOMMENDATION--			
	END ITEMS	EI % UNK	USG COMP.	% DEL.	REQ'D	FEEDBKS TOTAL	ROUTINE	LAB REQ.	OTHER	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	DAYS DELINQ	DATE FEEDBACK	DATE SAMP	REQUIRED NO.	REQUIRED DATE	REMARKS
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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Change 1 - 1 June 2015

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 three sections (subordinate work packages):

   WP 03 01 – General Laboratory Operating Requirements and Procedures.

   WP 03 02 – Laboratory Equipment / Configuration Requirements

   WP 03 03 – Lubricant Analysis and Research Application (LARA) Software Operations Guide

   WP 03 04 – LARA Toolbox Operations Guide

   WP 03 05 – SharePoint Operations Guide

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Change 1 - 1 June 2015

NAVY OIL ANALYSIS PROGRAM - GENERAL LABORATORY OPERATING PROCEDURES

Table of Contents

Page

1. Lab Operator and Instructor Training and Certification.

a. All NOAP Laboratory Operators must be trained by taking Defense Joint Oil Analysis Program (Physical Properties Testing) Course Identification Number (CIN) A-491-0017, and obtaining 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 Lab Technician is highly recommended for lab operators who are re-engaging in NOAP Lab testing operations after a hiatus of a year or more. Contact the NOAP Program Team Lead by sending an email to NOAP@navy.mil for more information about OJT.

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

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

2. Marine Lab 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 Technician, 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-491-0017, meet all Lab operator training and certification requirements, and have 3 years minimum experience working as a certified laboratory evaluator.

2. Lab Operator SharePoint Registration. Laboratory Operators must register with the Navy Oil Analysis Program Team Lead for access to the NOAP SharePoint sites. Contact the NOAP Program Team Lead at noap@navy.mil in order to begin the registration process.

Lab Operators who have already registered for SharePoint access shall report changes in duty station (including reassignment to a different NOAP Laboratory), email address or phone number(s) by sending an email to NOAP@navy.mil.

Lab Operators shall refer to Volume II WP 003 05 for additional information about the registration process and the NOAP SharePoint sites.

3. NOAP Lab Email Account. Each lab must establish a unique email account with their email service provider, some examples: NOAPlab@cvn65.navy.mil; NOAPLabPaxRiver@navy.mil. The NOAP Team Lead 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.

4. Sample Processing and Turnaround Requirements. Laboratory Operators are required to test all samples received for which they have the proper test equipment required and staffing level (See WP 003 02) regardless of the sample's source. If a NOAP lab does not have the proper 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.

Lab Operators are required to report results from received samples (report results) 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). Weekends and holidays are excluded.

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). Weekends and holidays are excluded.

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:

Abnormal results which necessitate advising the submitting activity to take action, i.e. change oil, re-sample, ground aircraft, etc. must be sent 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 III or Volume IV of this manual.

For aviation equipment samples, Lab Operators shall issue a code of “X” (Analysis results supplied to customer; no recommendation required) and return the results to the customer without a recommendation if Volume III or Volume IV does not contain an applicable work package for the specific component. Contact noap@navy.mil for additional guidance on testing and evaluating aviation equipment samples.

For shipboard equipment samples, Lab Operators should first check Volume IV WP 101 00 for limits on the physical / chemical properties for the specific lubricant. Contact lubricants.nswccd@navy.mil for additional guidance on testing and evaluating shipboard equipment samples.

6. Reports. Reports are generated by the Lubricant Analysis and Research Application (LARA) software program. See Work Package WP 003 03 for specific instructions on preparing and distributing reports. The following reports shall be produced once a week:

   a. Equipment Sample Log. This report shall be used to list the UICs and CSNs served by the lab for the current month. The date range is specified by the two "Dates Between" dropdown options. As a minimum these dates should cover the preceding week (7 days) however two weeks are recommended to avoid missing data.

   b. Oil Analysis Monthly Activity Report. This report shall be emailed to each UIC or command that has submitted samples to the lab in the last seven days (one week). Each UIC listed in the Equipment Sample Log for the last seven days shall receive an Oil Analysis Monthly Activity Report. This requirement may be waived provided: 1) the data is being captured in LARA, 2) the LARA data is uploaded to the SharePoint website weekly, 3) the LARA History Listing Report is provided to the Command or UIC within 72 hours as required by paragraph 4.b above, and 4) the Command or UIC is in agreement that the monthly report is not needed.

   c. Components Enrolled. This report shall be provided to each UIC or command for the time-period specified in the Equipment Sample Log.

   d. History Listing Report. This report shall be provided to each CSN listed in the Equipment Sample Log for the time-period specified in the Equipment Sample Log.

NOTE: If any of these reports cannot be generated using the LARA software, contact the NOAP Office for guidance.

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 I 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 Actions. Navy laboratories shall maintain a log with the most recent service date logged for each lab testing instrument. (See Figure 1).

   b. Data Transfers. Navy laboratories shall maintain a log of their transfers of data to the NOAP Master Database. (See Figure 2).

   c. Laboratory Operators Log. A lab operator log, with the LARA username, full name of all lab personnel, their start date at the lab, their training level and the date of training listed. If staff rotates out of the lab, the date of rotation must also be listed (See Figure 3).

9. Data submission to master database on SharePoint.

Once a week, each NOAP lab shall submit an Export File to the applicable NOAP SharePoint site.

Once a month, each NOAP lab shall submit a Backup File to the applicable NOAP SharePoint site. NOAP labs are encouraged to submit Backup Files to the applicable NOAP SharePoint site on a weekly basis if possible.

Procedures for creating both the Export File and the Backup File are provided in WP 003 04 and procedures for uploading both the Export File and the Backup File to SharePoint are provided in WP 003 05.

NOTE: In accordance with JOAP policy, laboratory operators are required to test all samples received for which they have the proper 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 applicable NOAP SharePoint site in place of submitting an Export File.

The Export File and the Backup File provide critical data to the engineering support teams and are essential to flight safety. On more than one occasion, NOAP data has saved the lives of DoD personnel, and avoided additional hardship, costs and workload to DoD personnel. NOAP Labs provide a tremendous service to many levels throughout the DoD, by accurately assessing equipment health, and reducing the risk of equipment failures. Thus, the NOAP Program Manager has the authority to suspend and/or revoke a NOAP lab's certification to operate if weekly/monthly data submissions are not occurring. A NOAP lab shall immediately contact the NOAP Program Manager at noap@navy.mil in the event the data submission requirement cannot be met.

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

11. Spectrometer Maintenance and Inspections.

Lab Operators are required to ensure that all daily maintenance actions outlined in Table 1, the periodic maintenance inspections outlined in Table 2, and the excitation source inspections outlined in Table 3 are performed prior to spectrometer use.

12. NOAP Team Responsibilities.

The main purpose of the Navy Oil Analysis Program (NOAP) Office is to provide leadership and guidance in oil analysis and guidelines for normal and contingency operating procedures of shore based, deployed, sea based and mobile NOAP laboratories. It is formed by a team that manages and supports the NOAP laboratories equipment and operators.

a. NOAP Team. The Team consists of the following:

(1). Program Manager/Team Lead, responsible for providing technical and scientific advice and guidance to the staff level personnel of the major command in the Navy oil analysis area and to field level oil analysis laboratory and equipment maintenance personnel.

(2). Tech Reps, responsible for providing maintenance support, troubleshooting issues with equipment and providing refresh and maintenance training for all NOAP lab equipment and operators. The intent of this refresh and maintenance training is to increase self sufficiency of the operators and to instill in them the knowledge to perform maintenance with the direction of the technical representative using distance support to minimize the requirement for on-site technical assist visit.

(3) IT Software Support, responsible for the development and deployment of the laboratory automatic data acquisition and analysis system including logistic support and maintenance plan, monitor operations of data analysis systems to support engineering and logistics disciplines performing life cycle management.

(4). Specialized Technical Expertise, responsible for writing and revising the specifications, test methods and manuals needed for NOAP laboratory capabilities and operations in order to achieve the best support for the operational availability required by the service user. Responsible for lab equipment specification input to acquisition managers.

b. NOAP Lab equipment. All NOAP lab equipment onboard ships belongs to the AIMD and all NOAP lab equipment on shore based labs belong to their respective command.

c NOAP Lab equipment purchase. The Spectroil M/N spectrometers, Filter Debris Analysis instruments (FDA), the PODS Particle Counters, and the Aquatest 2010 water testers are periodically purchased and distributed by PMA-260 when possible. If the funding is not available to PMA-260 the using command will be responsible for purchasing the necessary equipment.

d. The NOAP Team coordinates with CNAF and PMA-260 the establishment, relocation and distribution of equipment for all NOAP Labs.

e. The NOAP Office maintains a pool of spare spectrometers and FDA units that can be used to replace broken instruments in the fleet. It also maintains a rotating pool of PODS particle counters so that they can be sent off for annual re-calibration. The NOAP Labs are required to contact the Program Manager/Team Lead for availability of equipment

f. It is the responsibility of each NOAP Lab's owner and respective command to purchase any repair parts as well as operating supplies for all of their NOAP lab equipment.

g. The NOAP Office (Team) provides support in establishing plans for Navy lab equipment, facilities and training.

13. <u>NOAP Office Plain Language Address (PLA)</u>.

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.

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

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 LAB DATA TRANSFER LOG			
DATE	**FILES TRANSFERRED**	**LAB OPERATOR**	**TRANSFERRED TO**
e.g. 01/17/201)	*e.g. NOAPTRANSFER.TXT*	*e.g. AD1 John Doe*	*e.g. SharePoint*

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

Change 1 - 1 June 2015

NAVY OIL ANALYSIS PROGRAM - LABORATORY EQUIPMENT AND CONFIGURATION REQUIREMENTS

1. NOAP Laboratory Categories. NOAP Laboratories are classified in one of three categories depending on the types and volume of samples they are required to process.

   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. NOAP Laboratories shall be outfitted to test the properties listed in Figure 1. The preferred testing instruments are listed following the property:

   a. Shore and Ship Laboratories

      1. Wear Metals: Spectroil M/N
      2. Viscosity: Anton Parr SVM3000 Stabinger viscometer (preferred), Cambridge Viscolab 3000 or an ASTM D445 viscometer
      3. Total Acid Number: Digitrate Pro 50mL
      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 Inc. Q600 Fuel Sniffer
      6. Water: Aquatest 2010
      7. Particle Counter: HACH PODS
      8. Lubricant Crackle Test: Hot Plate and Thermometer

   b. Aviation Only Laboratories.

      1. Wear Metals: Spectroil M/N
      2. Water: Aquatest 2010, Pall Water Sensor

NOTE

Properties shall be measured using only the appropriate testing instruments. If assistance is needed in determining the appropriate testing instrument for a specific property then contact the NOAP Program Office at noap@navy.mil.

HACH PODS shall be used only for particle counting measurements.

Brookfield Viscometers are being phased out. They measure dynamic viscosity and produce results in centi-Poise. Laboratories that have Brookfield Viscometers must have a digital density meter to accurately measure the density of the fluid. Dividing the centi-Poise result by the density of the fluid will produce the desired reading in centi-Stokes.

3. Special Testing Capabilities. Designated NOAP Laboratories may be required to perform special tests in support of specific aircraft of systems. Several laboratories have FC-400 Filter Debris Analyzers which are used to support the J52 engine in the EA-6B aircraft. The operation and maintenance of the FC-400 Filter Debris Analyzers is governed by NAVAIR 19-20FDA-M-2. Questions about the FC-400 Filter Debris Analyzers shall be directed to the NOAP Program Manager at noap@navy.mil.

4. Facilities.

   a. Shore laboratories. 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 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-491-0017A, 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 Spectrometer, filter debris analysis via the FC400, and various physical and chemical properties of the oils.

	Aviation Tests				Ship Equipment Tests				
Lab ID	Wear Metals	Filter Debris Analysis	Water by Karl Fischer Test	Paticle Counting	Viscosity	Total Acid Number	Fuel Dilution	Water by Crackle Test	Flash Point Test
1-Atsugi Japan - ANN	√		√	√	√	√	√	√	
1-Bahrain - ANC	√		√	**√**	√	**√**	**√**	**√**	
1-Mayport FL - ANP	√		√	√	√	√	√	√	
1-Kings Bay GA - ANO	√		√	√	√	√	√	√	
1-Norfolk VA - ANK	√		√	√	√	√	√	√	
1-Patuxent River MD NFLCFT - ANB	√	√	√	√	√	√	√	√	
1-Pearl Harbor HI - ANR	√		√	√	√	√	√	√	
1-San Diego - ANS	√		√	√	√	√	√	√	√
2-CVN-68 - Nimitz - AXN	√		√	√	√	**√**	**√**	√	
2-CVN-69 - Dwight Eisenhower - AXC	√		√	√	√	**√**	**√**	√	
2-CVN-70 - Carl Vinson - AXV	√		√	√	√	√	**√**	**√**	
2-CVN-71 - Theodore Roosevelt - AX9	√		√	√	**√**	**√**	**√**	**√**	
2-CVN-72 - Abraham Lincoln - AXX	√		√	√	√	√	√	√	
2-CVN-73 - George Washington - AX1	√		√	**√**	√	**√**	√	√	
2-CVN-74 - John Stennis - AXD	√		√	√	√	**√**	**√**	√	
2-CVN-75 - Harry Truman - AXZ	√		√	√	√	**√**	√	√	
2-CVN-76 - Ronald Reagan - AXK	√		√	√	√	**√**	√	√	
2-CVN-77 - George Bush - AXT	√		√	√	√	**√**	**√**	**√**	
2-LHA-6 - America - AX6	√		√	√	√	√	√	√	
2-LHD-1 - Wasp - AXW	√		√	√	√	√	√	√	
2-LHD-2 - Essex - AX5	√		√	√	√	√	**√**	√	
2-LHD-3 - Kearsarge - AXY	√		√	√	**√**	**√**	**√**	**√**	
2-LHD-4 - Boxer - AXJ	√		√	√	√	**√**	**√**	√	
2-LHD-5 - Bataan - AXO	√		√	√	**√**	**√**	**√**	√	
2-LHD-6 - Bonhomme Richard - AXH	√		√	√	√	**√**	**√**	**√**	
2-LHD-7 - Iwo Jima - AXG	√		√	√	√	**√**	√	√	
2-LHD-8 - Makin Island - AXB	√		√	**√**	**√**	**√**	**√**	**√**	
3-Cherry Point NC FRC East - AN4	√	√		√	√	√	√	√	√
3-Corpus Christi TX - ANQ	√			√					
3-Fallon NV FRC West Det - ANV	√								
3-Fallon NV NSAWC - ANE	√								
3-Jacksonville FL - AN9	√	√	√					√	
3-Key West FL - ANJ	√		√						
3-Lemoore CA FRC West - ANA	√		√						
3-MALS 12 - Iwakuni Japan - AN8	√	√	√						
3-MALS 13 - Yuma AZ – ANY & AY3	√		√						
3-MALS 14 - VMAQ-3 - AN2	√	√							
3-MALS 16 – Miramar CA - ALD	√								
3-MALS 31 - Beaufort SC - ALB	√								
3-MALS 39 - Camp Pendleton CA - AN5	√								
3-MALS 40 - AN1	√								
3-MALS 70 - Camp Bastion - ANC	√								
3-Patuxent River MD AIMD - ANM	√		√						
3-Pensacola - ANH	√		√		√				
3-Quantico VA HMX-1 S0976 - ANX	√								
3-Quantico VA HMX-1 S6262 - ANX	√		√						
3-Sigonella Italy AIMD - AND	√		√	**√**	**√**	**√**	**√**	**√**	**√**
3-Whidbey Island FRC North West - ANL & AY1	√								
4-JOAP School	√	√	√	√	√	√	**√**	√	

√ Instrument in Lab

√ Capability Needed

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

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Change 1 - 1 June 2015

LUBRICANTS ANALYSIS AND RESEARCH APPLICATION (LARA) NOAP LABORATORY MANAGEMENT SOFTWARE OPERATIONS GUIDE

Table of Contents

1. Introduction.

   a. LARA (Lubricants Analysis and Research Application) was designed to make sample reporting quicker and easier for the lab operator, while retaining information about a component. LARA is designed to be used while connected to a Spectrometer, allowing the lab operator to capture sample results directly from the Spectrometer. Currently LARA will not run on NMCI.

   b. All data captured and generated from LARA is used to support various Navy programs. The software has several reports required by Maintenance Officers, Squadrons and other Navy personnel. The lab operator is required to provide results, reports and data as requested by any Department of Defense staff.

   c. A central database is maintained by NOAP staff. This database is created by transfer files provided by all NOAP lab operators. Since data is routinely requested from the NOAP Office, data is required by NOAP lab operators. Each lab operators must regularly upload or email data to the NOAP Office in order for the NOAP Office to report to the Department of Defense.

   d. Contact the NOAP Office (NOAP@navy.mil) with any questions or concerns regarding LARA or oil analysis. Refer to the WP 003 01 for contact information.

2. Using LARA

   a. LARA Login. LARA is installed and available on all Spectrometer computers. The LARA program icon can be seen on the computer's Desktop.

      (1). Double click on the LARA icon and you will see the Login Screen (Figure 1). Enter your username and password then press OK. If you need a username and password, contact the lab administrator. If no one is assigned the duty of lab administrator, then contact the NOAP Office.

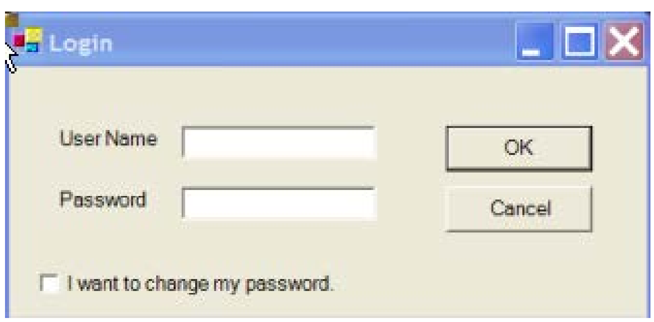


Figure 1. Login Screen

      (2). On Tuesday or Friday the NOAP Transfer Reminder message (Figure 2) will appear to remind you to send your data to the NOAP Office so that your samples and results can be reported to Navy personnel. Data submission is required by Volume II WP 003 01 and instructions for data submission can be found in Volume II WP 003 04.

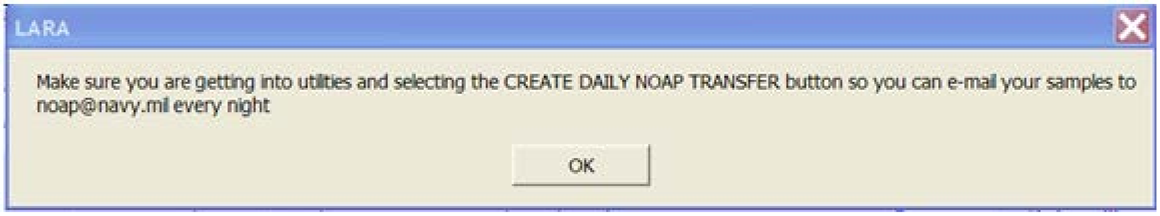


Figure 2. NOAP Transfer Reminder

(3). Users are Lab Operators who have been set up in LARA. Users are required to use their own login when using LARA. Therefore, it is required that a new user change his/her password when they are set up. This password is required to be private and not shared with other personnel.

b. Changing User's Password. The procedure to change a user's password is as follows:

(1). When logging in check the "I want to change my password" box (Figure 3). Changing the password should be done when an account is first created or when you feel your password has been compromised.

Figure 3. Change Password Checkbox

(2). Press OK.

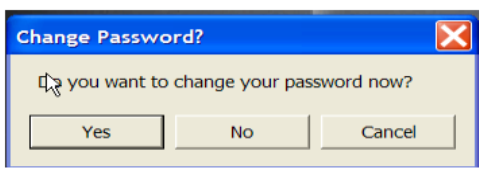


Figure 4. Confirm Password Change

(3). Press Yes to continue (Figure 4).

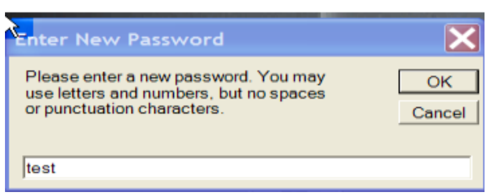


Figure 5. Enter New Password

(4). Type what you want your new password to be and press OK (Figure 5).

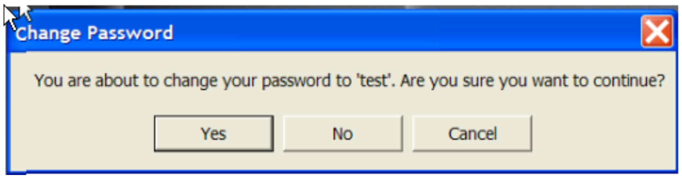


Figure 6. Change Password

(5). Press Yes to verify the new password (Figure 6).

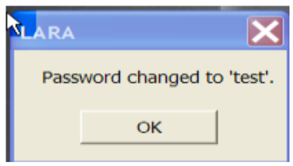


Figure 7. Confirm Password Change

(6). Press OK on the Confirm Password Change screen to continue to sample screen (Figure 7).

3 SAMPLE RECEIVING AND TESTING

a. Sample Receipt. Oil samples are received by the NOAP Lab for testing. The samples will arrive with a DD 2026 Form. This form will provide the lab operator with the necessary information pertaining to the sample. If the DD 2026 Form is not clearly filled out, or if it appears to have missing data, contact the originator of the sample or the personnel responsible for the sample, and request clarification of missing information. A lab may also request a new DD 2026 be submitted for an existing sample. In order to test oil samples, the lab operator is provided with a series of screens in LARA which assist in identifying the sample, characteristics of the sample, and ultimately reporting results. After logging into LARA you will see the following screen (Figure 8).

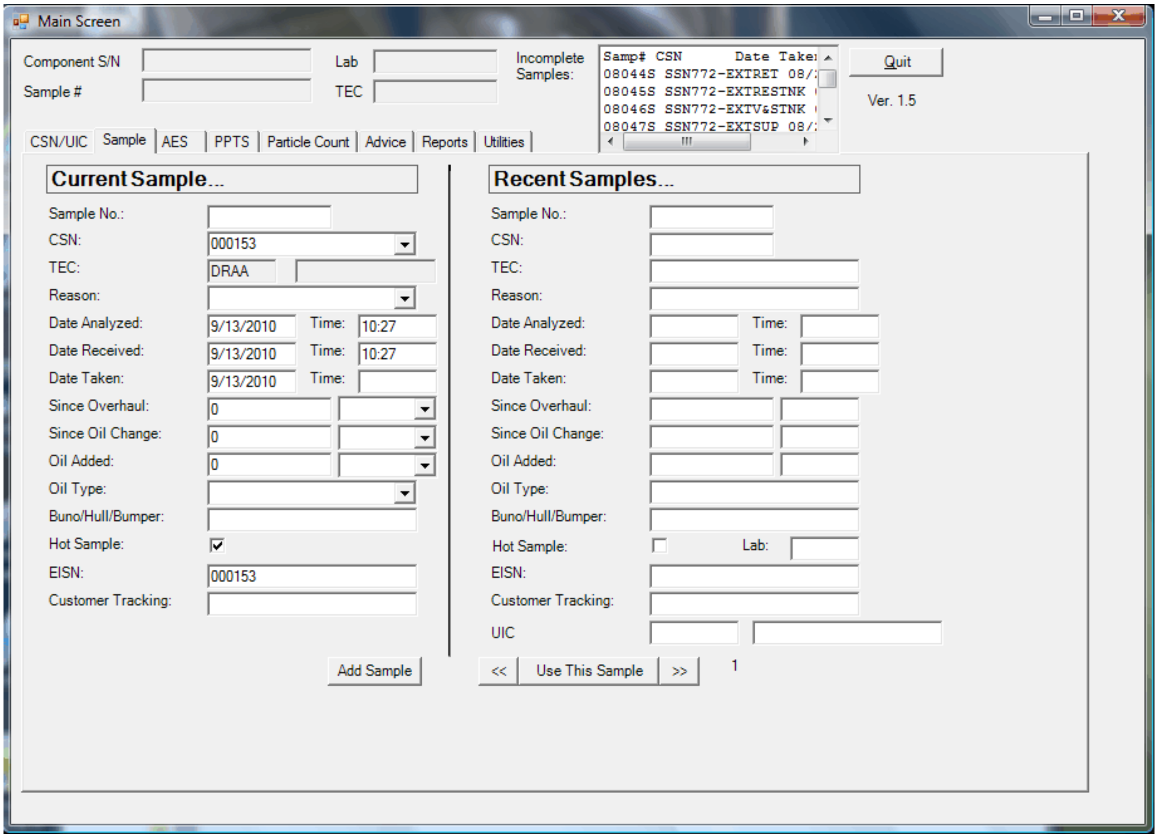


Figure 8. Main Screen

b. <u>Entering a Sample into LARA</u>. Procedures to enter a sample (also called "receiving a sample" and "logging a sample") are as follows:

(1). Enter a unique sample number created with first character as the last number of the year, followed by the month number (October = O, November = N and December = D) then a sequential number. Example 03001 first sample for the month of March in the year 2010. If the sample number entered has already been used the Sample Number message will appear (Figure 9). Press OK and enter a unique sample number.

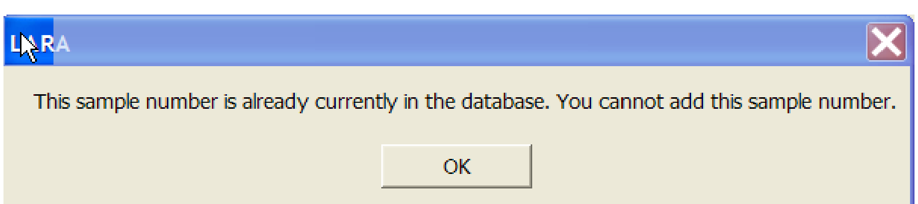


Figure 9. Sample Number

(2) Use the pull down to select a CSN (component serial number). Highlight the correct CSN and press enter.

(3) The TEC is entered under CSN/UIC (unit identification code). If this is incorrect you must change it in CSN/UIC before adding the sample.
(4) Use the pull down to select the reason.
(5) Enter date analyzed if different from today.
(6) Enter date received if different from today.
(7) Enter date taken from the DD2026 form.
(8) Enter since overhaul from the DD2026 form.
(9) Enter since oil change from the DD2026 form. If overhaul or oil change is less than the last sample the Since Overhaul message will appear (Figure 10). If you have typed in the correct numbers just press OK and continue.

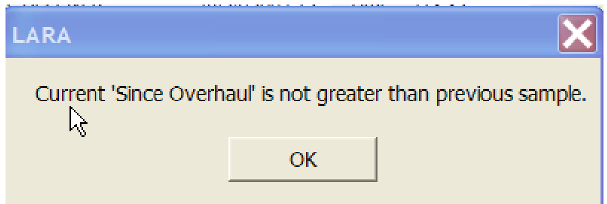


Figure 10. Since Overhaul Screen

(10) Enter oil added from the DD2026 form.
(11) Enter oil type from the DD2026 form.
(12) Enter buno/hull/bumper from the DD2026 form.
(13) Check hot sample from the DD2026 form.
(14) The EISN (end item serial number) is entered under CSN/UIC. If this is incorrect you can change it.
(15) Enter customer tracking from the sample number on the DD2026 form.

Note

If the UIC is incorrect you must change it in CSN/UIC before adding the sample.

(16) Press add sample.

Note

At the top right corner there are incomplete samples. These are samples that have not been completed. Meaning they have not been all the way through history listing. They will stay there until they are completed. Not completing samples in the incomplete samples box will stop you from transferring data to another lab.

On the right side of the screen are recent completed samples. You can use the right and left arrows to look through all previous samples for that CSN. Press “use this sample” to see the test results for a given sample.

If the TEC requires an AES test the AES tab will appear (Figure 11). If not the PPTS or Particle Count screen will appear depending on the oil type chosen.

c. Entering Spectrometer Data. Select manual or automatic: Manual will let you type in the spectrometer data. Automatic will allow the data to be transmitted directly from the spectrometer. Automatic is preferred. Please ensure all cables are connected to the Spectrometer and LARA computer to perform Automatic data transfer. If there is a problem using this method, contact the NOAP Office immediately.

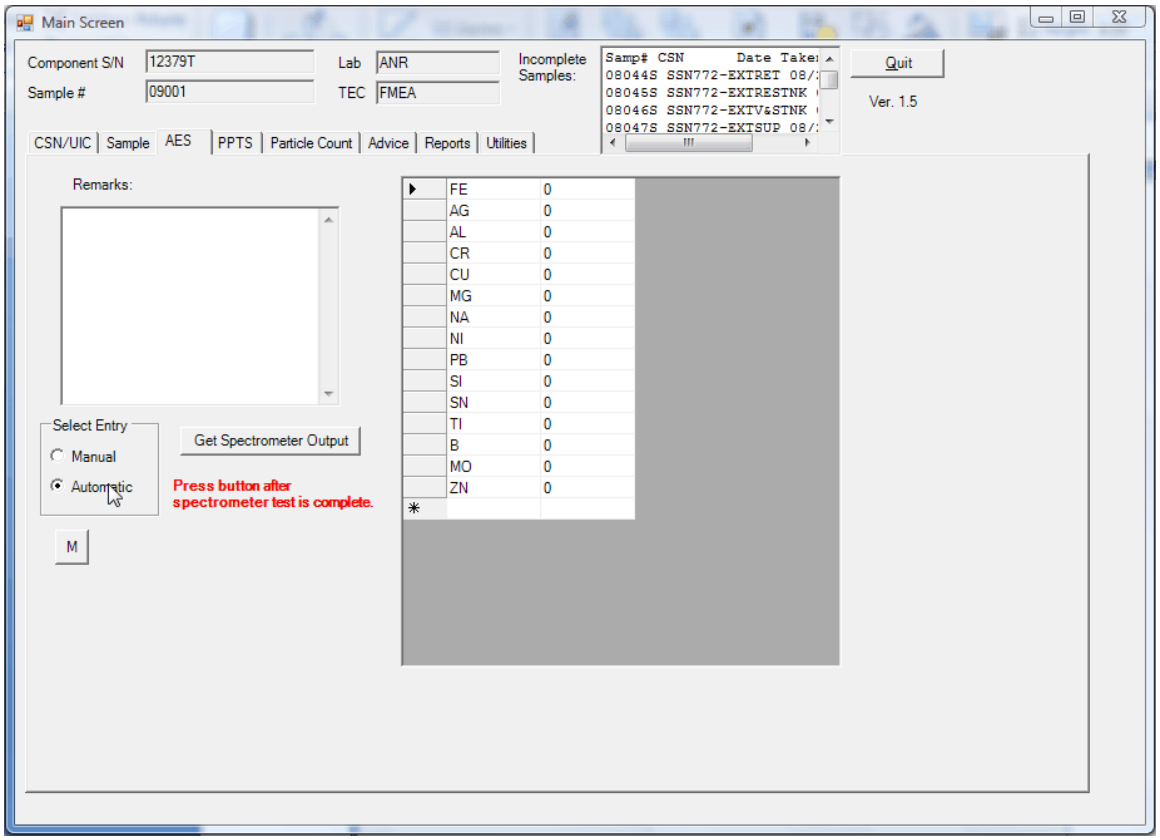


Figure 11. AES Tab

(1). If automatic is selected press “Get Spectrometer Output” after the “Written to Com1” message appears on the upper left hand corner of the spectrometer monitor.

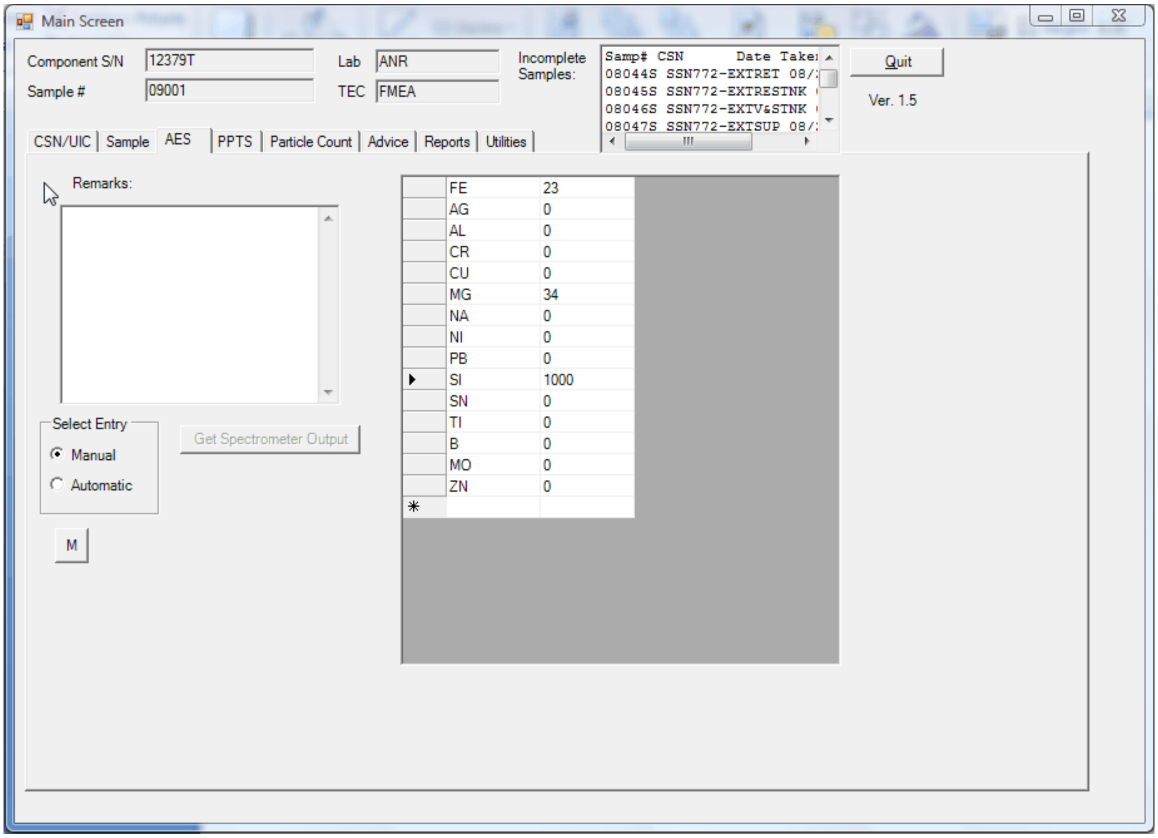


Figure 12. AES Manual Entry

(2). If manual is selected, type the spectrometer data into the column to the right of the corresponding element. If you choose to add spectrometer data without completing the record press the M to save the data and select the next record in the incomplete box. (Figure 12)

(3). If tests are completed press the "Advice" tab and skip to the advice page.

d. Entering Physical Property Test Sample (PPTS) Data. If physical property test data is required, press the "PPTS" tab and the next screen will appear (Figure 13).

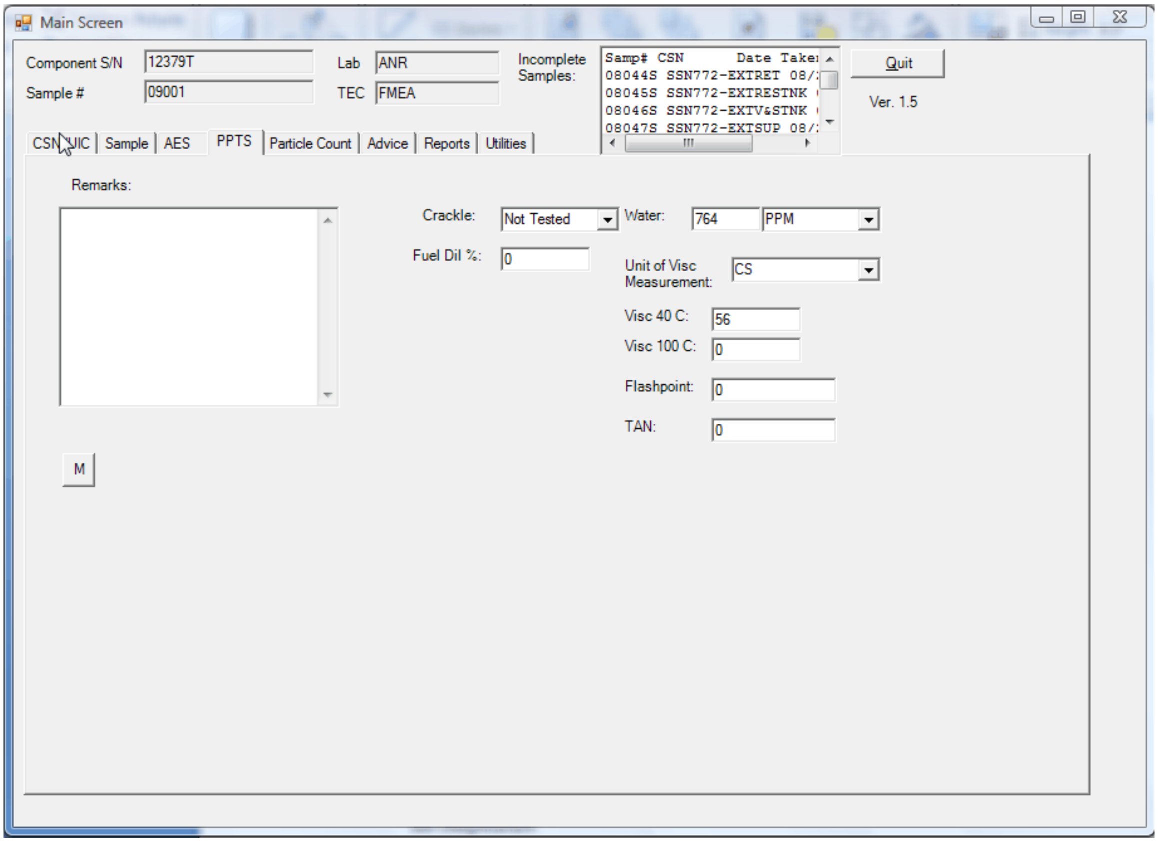


Figure 13. PPTS Tab

(1) Crackle test is pass or fail.
(2) For the water test enter amount and choose PPM or %.
(3) Fuel Dilution enter amount.
(4) Viscosity is CS or CP then enter amount in Visc 40 C or Visc 100 C depending on the temperature.
(5) Flashpoint, enter the amount.
(6) TAN (Total Acid Number), enter the amount.
(7) Add any remarks if needed.
(8) If you choose to add PPTS data without completing the record press the M to save the data and select the next record in the incomplete box.

e. Entering Particle Count Data. Press the “Particle Count” tab if that test is required and the next screen will appear or press the advice tab and skip to the advice page (Figure 14).

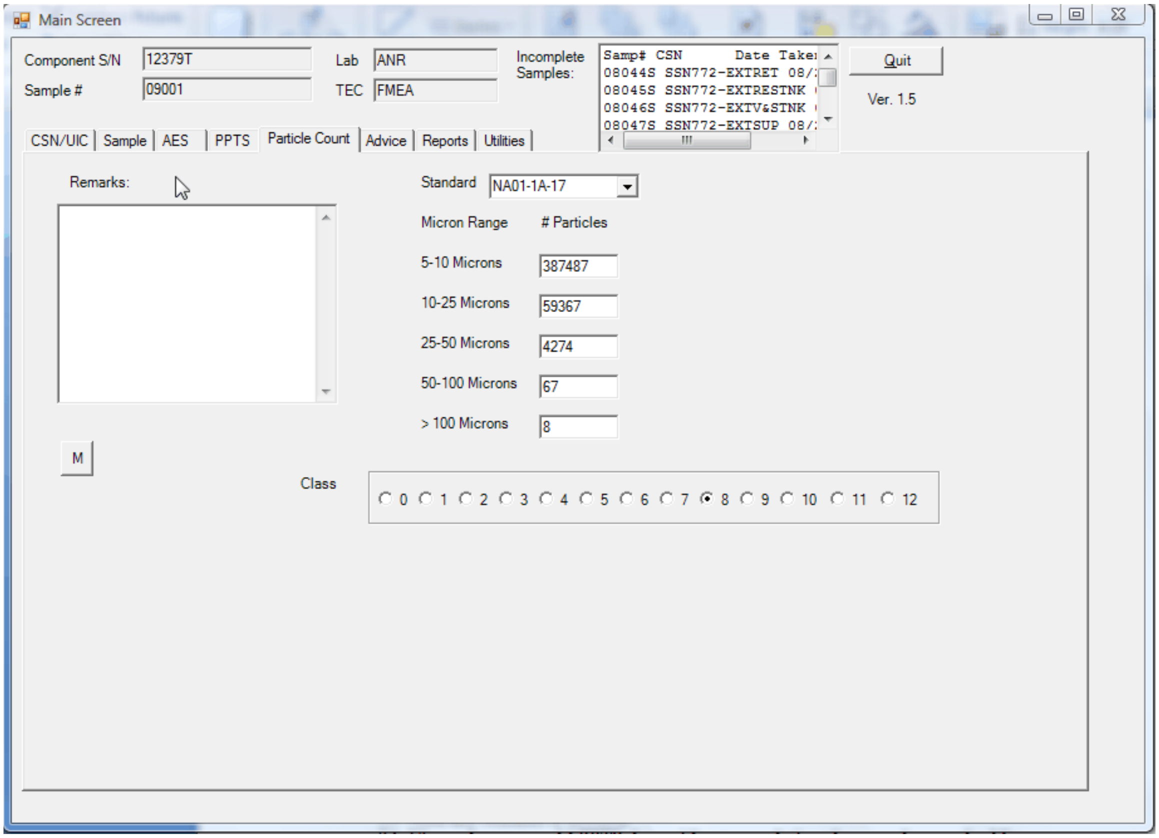


Figure 14. Particle Count

(1). Use the pull down to choose the standard.
(2). Enter the amounts for all the ranges.
(3). Select the Class.
(4). Add any remarks if needed.
(5). If you choose to add PPTS data without completing the record press the M to save the data and select the next record in the incomplete box.
(6). Press the advice tab to continue to the next screen (Figure 15).

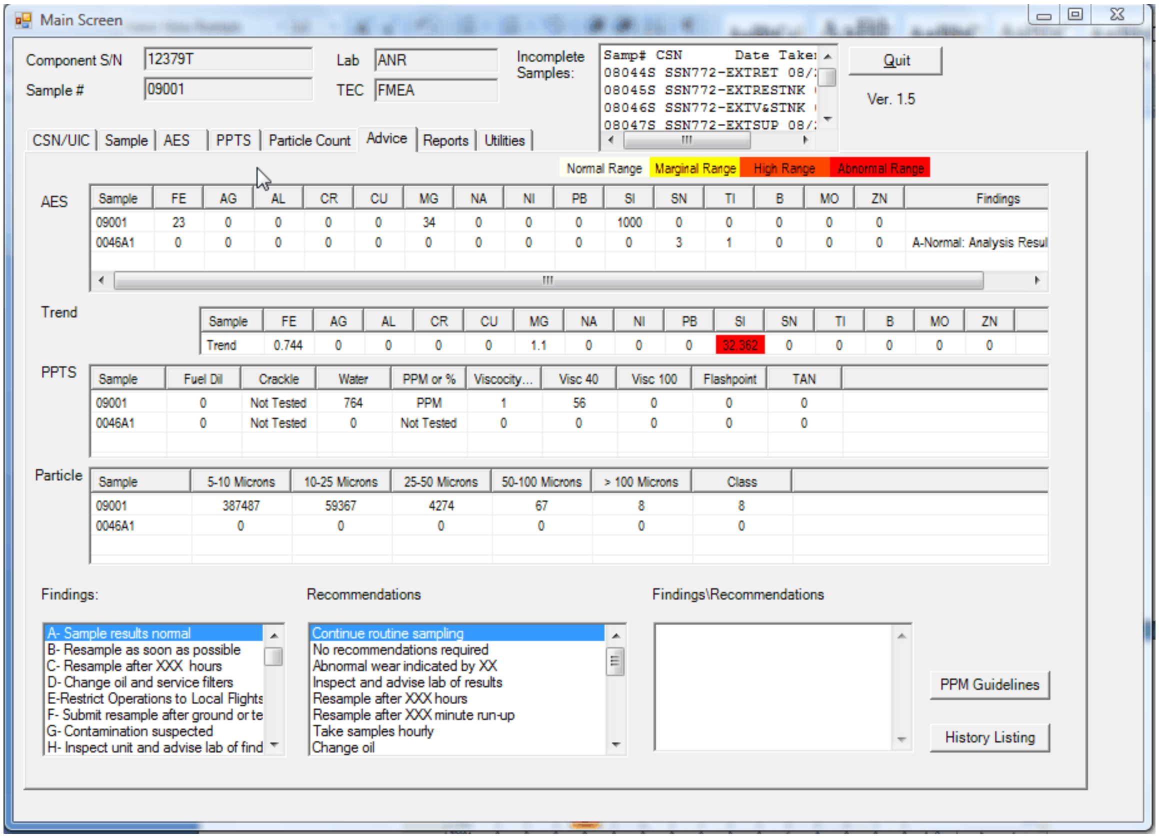


Figure 15. Advice Tab

f. Entering Findings, Recommendations, and Advice. Select the "Advice" tab and the above screen will appear. The AES results will be highlighted in red if the element fails.

Note

The JOAP manual contains the most recent limits. Verify all results with the JOAP Manual.

The trend can also fail and will be highlighted in red. Trend is calculated by taking the last two samples change in overhaul divided in change in element times 10.

(1) Select the correct finding and then recommendations. Where you see XX or XXX is an indication that you are to replace the XX or XXX with a number. That number is your judgment call. Multiple findings and recommendations can be selected (Figure 16).

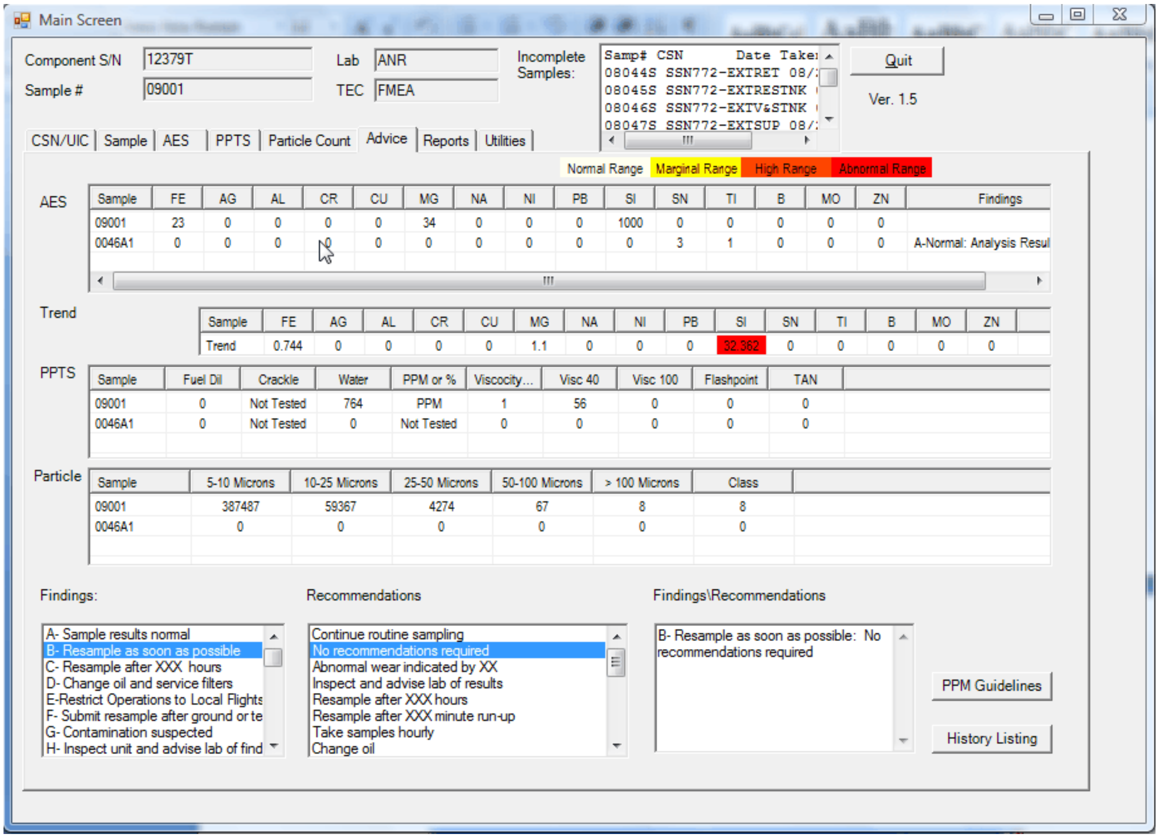


Figure 16. Findings

Note
If you try to choose "normal" and an element failed you get the message indicated below (Figure 17). You must choose a finding other than normal.

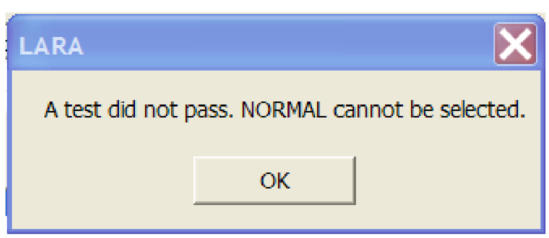


Figure 17. NORMAL Finding Warning

(2) Press "History Listing" to complete the record. By pressing history listing you are committing the record to the database. Not pressing history listing will leave the sample still open and it will appear in the incomplete samples box at the top of the screen. After pressing "History Listing" the following screen appears asking if you wish to print a full history listing (Figure 18).

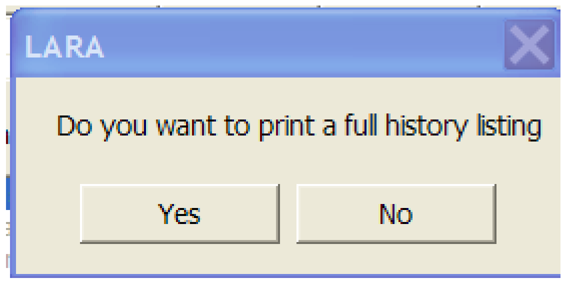


Figure 18. Print History Listing

(3) Choose to print the full history with or without physical property.

(4) To print the history listing on a printer, press file then print. This is set to print five samples per history listing (Figure 19).

Component Model:	F402-RR406B	Command:	VMA-211	Sampling Intervals	LAB NAME:	NSY Pearl Harbor
Component S/N:	12379T	UIC:	M01211	10 hours	LAB ADDRESS:	Code 134.5 Pearl Harbor, HI 96860-5023
End-Item Model:	AV-8B	DET:	053	.	LAB E-MAIL:	
End Item S/N:	165568	.	.	.	LAB PHONE:	808-474-3067

SampleNum	CustomerNum	DateTaken	DateReceived	DateAnalyzed	SinceOVHL	SinceOilChg	OilAdded	Reason	TEC	FindingsRecommendations
09001	1-002	9/13/2010	9/13/2010	9/13/2010	1740	0	0	Routine	FMEA	B- Resample as soon as possible: No recommendations required
0046A1		1/5/2009	1/5/2009	1/5/2009	1431	0	11	Routine	FMEA	A-Normal: Analysis Results Supplied to Customer

Sample No.	FE	AG	AL	CR	CU	MG	NA	NI	PB	SI	SN	TI	B	MO	ZN
09001	23	0	0	0	0	34	0	0	0	1000	0	0	0	0	0
0046A1	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0
Trend	0.74	0	0	0	0	1.1	0	0	0	32.36	0	0	0	0	0

PPM Guidelines	SI	ZN	B
NormalRange	1000	1000	1000
MarginalRange	1000	1000	1000
HighRange	1000	1000	1000
AbnormalRange	1000	1000	1000
AbnormalTrend	10	10	10

Sample No.	Fuel Dil	Crackle	Water	PPM or %	Viscocity Measurement	Visc 40	Visc 100	Flashpoint	TAN
09001	0	Not Tested	764	PPM	1	56	0	0	0
0046A1	0	Not Tested	0	Not Tested	0	0	0	0	0

Sample No.	5-10 Microns	10-25 Microns	25-50 Microns	50-100 Microns	> 100 Microns	Class
09001	387487	59367	4274	67	8	8
0046A1	0	0	0	0	0	0

Sample No.	Remarks
09001	

Figure 19. History Listing Report

g. Adding a component, engine, gearbox or other piece of equipment. If a component is not available, a component may be added in LARA. A component is referenced by is Component Serial Number, or CSN.

(1) From the main sample screen press the “CSN/UIC” tab and the following screen will appear (Figure 20). Adding a component is done when you have searched and can’t find the component serial number and have asked for a transfer disk with no response.

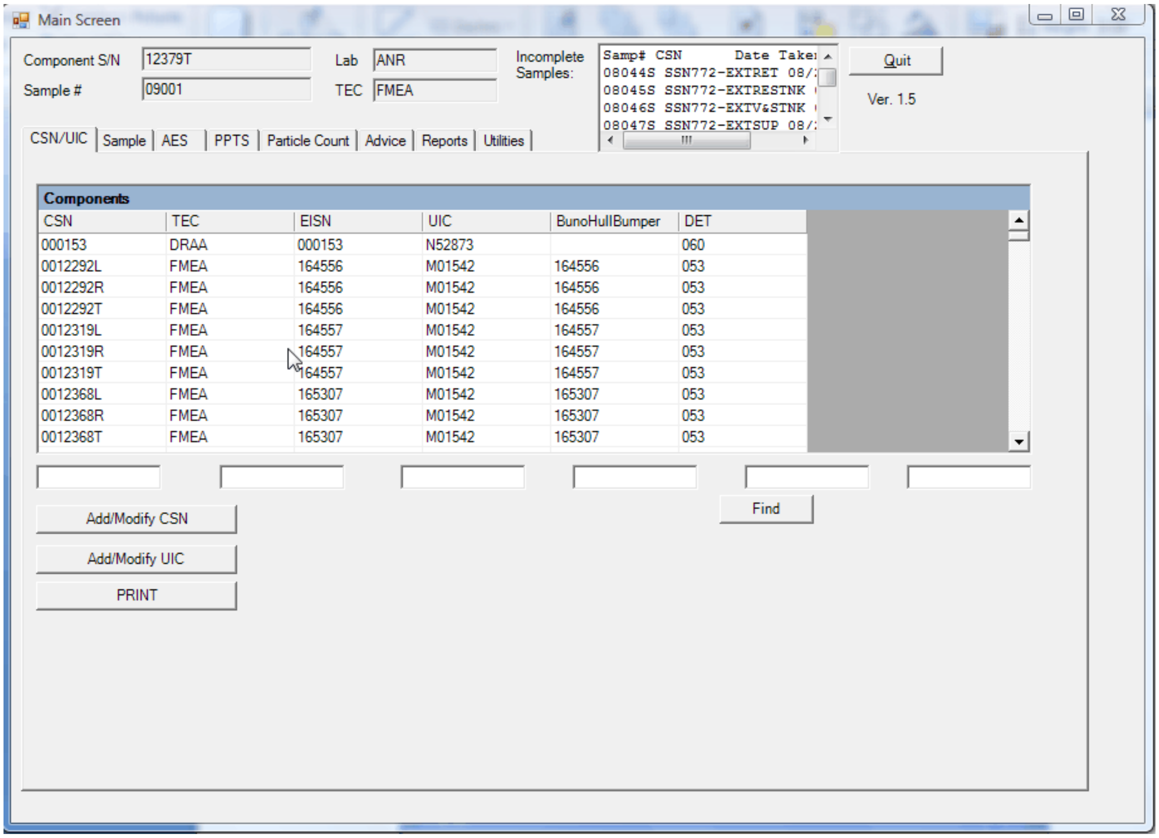


Figure 20. CSN/UIC Tab

(2) Select the Add/Modify CSN button. The CSN Screen displays (Figure 21).

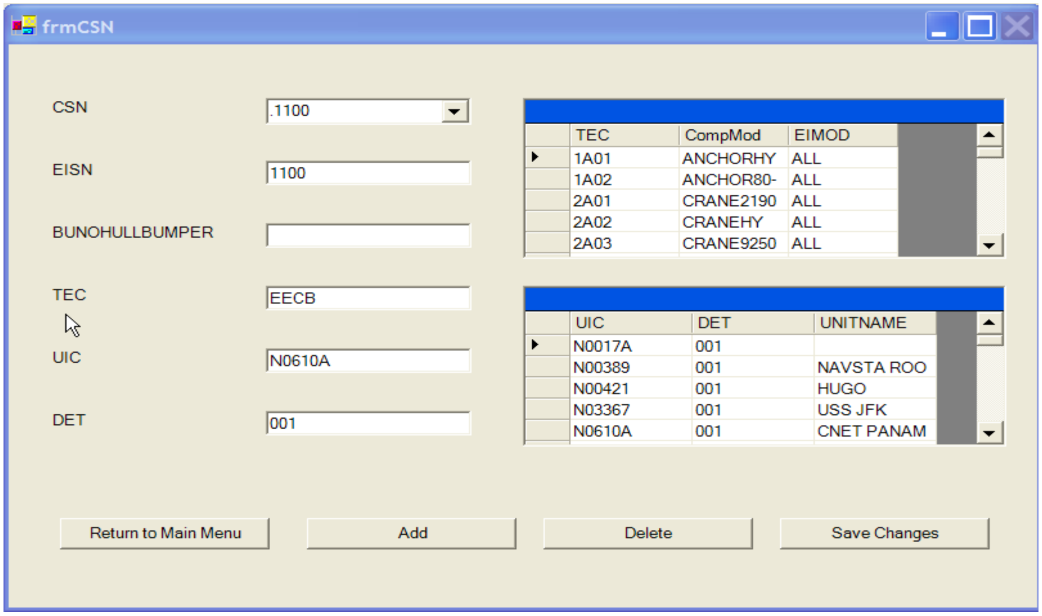


Figure 21. Add/Modify CSN

(3) To add a record press the add button to see the following screen (Figure 22).

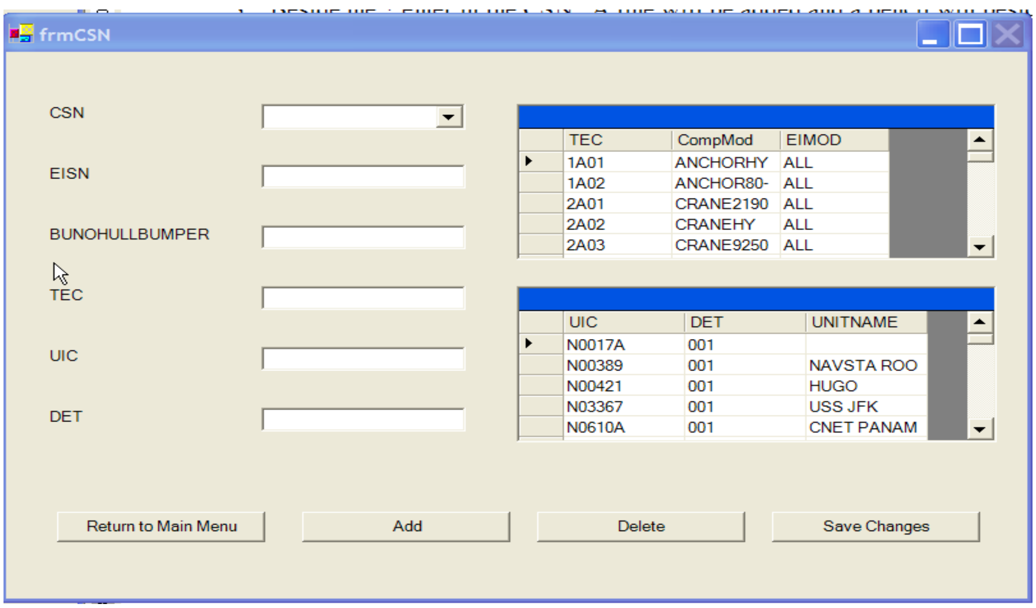


Figure 22.CSN Screen

(4) Enter CSN, EISN, BUNO, HULL or BUMPER, TEC, UIC and DET using the tables for TEC and UIC to the right.

(5) TEC, UIC and DET must exist in the pull downs to the right for record to be added.

(6) Press save changes for the record to be saved (Figure 23).

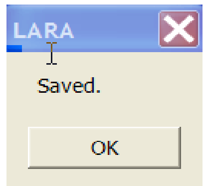


Figure 23. Saved

(7) Press OK.

h. <u>Deleting a component</u>. If a component was added in error, deletion of a component is available in LARA.

(1) From the main screen press the CSN/UIC tab and the following screen will appear (Figure 24). Deleting a component is done only if the component has been taken out of service. Deleting the component will not delete the samples. They will stay in your database until they are purged.

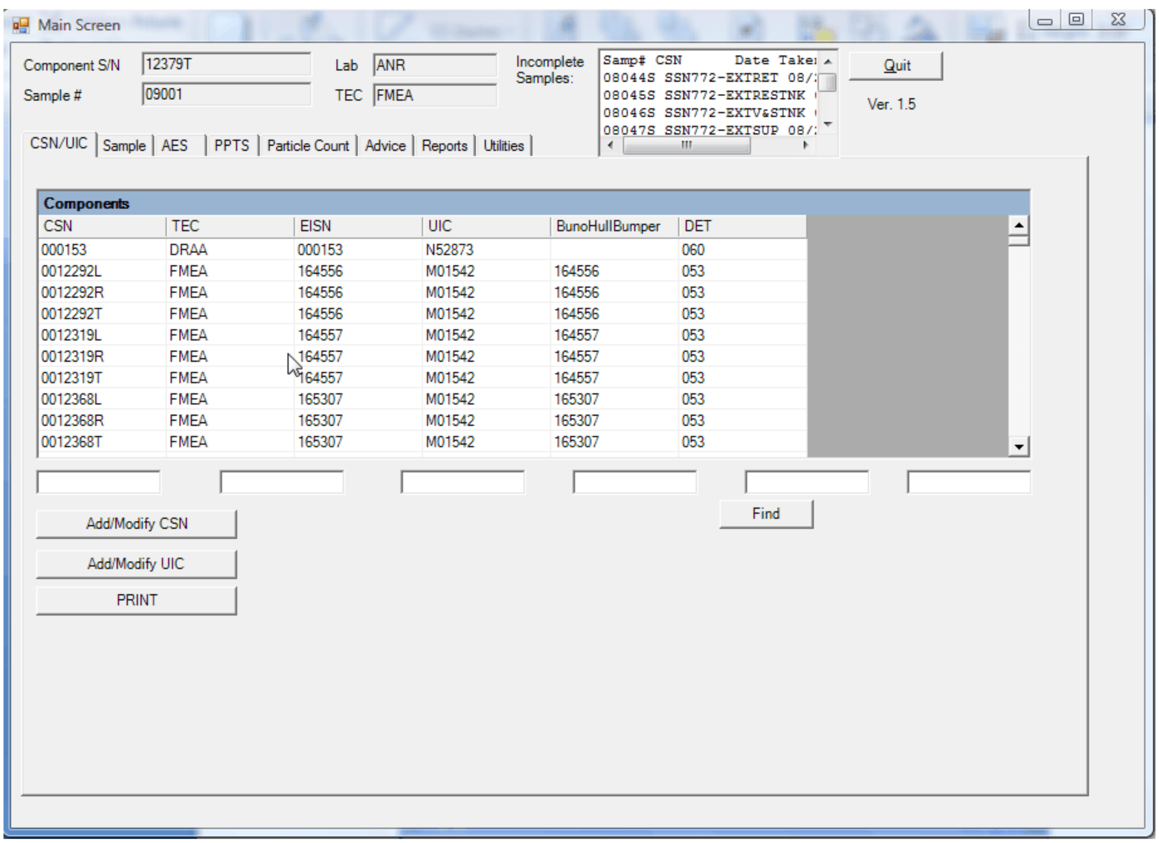


Figure 24. CSN/UIC Tab

(2) Select the Add/Modify CSN button.
(3) Use the pull down to select the CSN to be deleted (Figure 25).

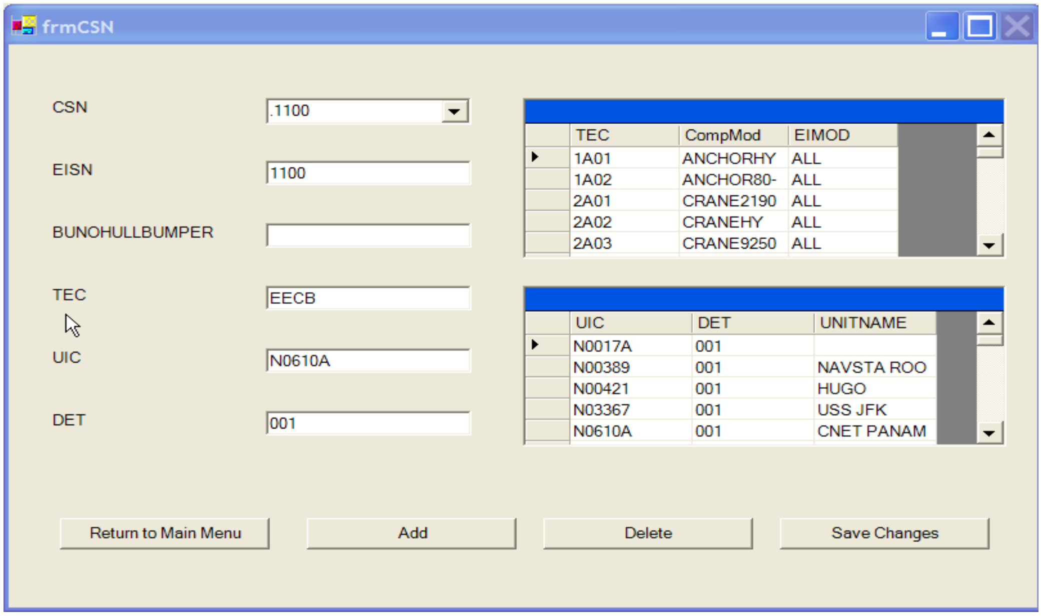


Figure 25. CSN Screen

(4) Press Delete.

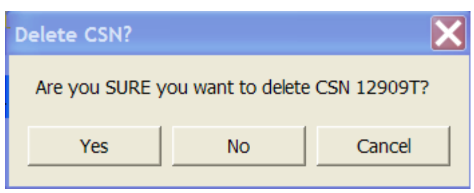


Figure 26. Confirmation

(5) Press Yes (Figure 26).

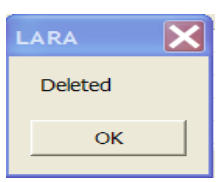


Figure 27. Notification

(6) Press OK (Figure 27).

i. Modify a Component. If a component or CSN required modification, this capability exists in LARA.

(1) From the main screen press the CSN/UIC tab and the following screen will appear (Figure 28).

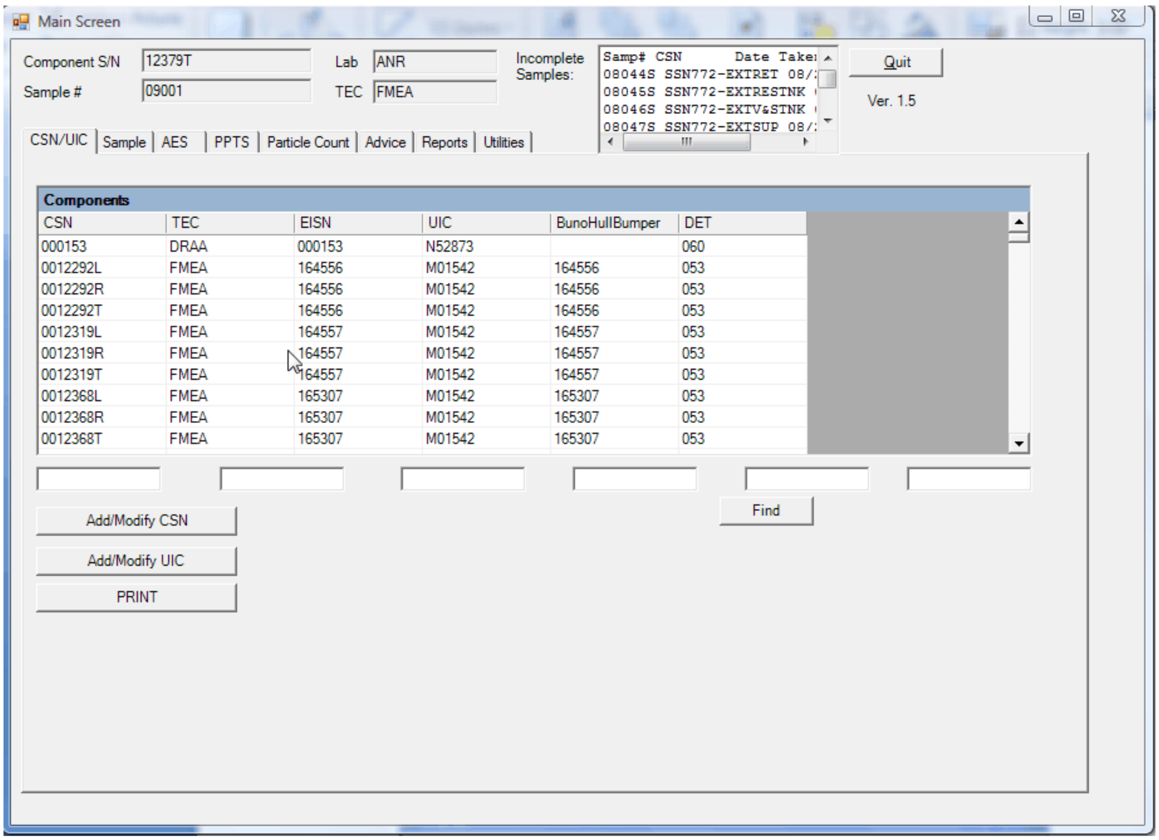


Figure 28. CSN/UIC Tab

(2) Select the Add/Modify CSN button (Figure 29).

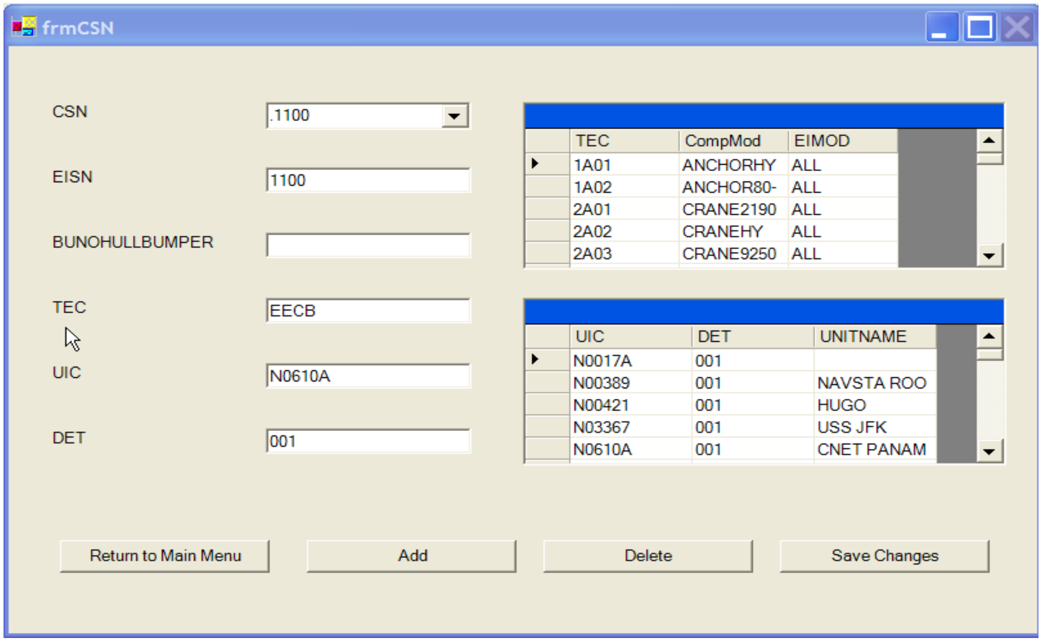


Figure 29. CSN Screen

(3) Use the pull down to select the csn to be changed.
(4) Make any changes and press save changes.

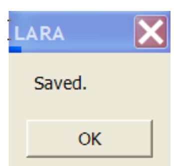


Figure 30. Confirmation

(5) Press OK (Figure 30).

j. Adding a new Unit Identification Code. A Unit is defined within LARA to assist tracking components and equipment with the personnel assigned. The unit is identified by the Unit Identification Code, or UIC.

(1) From the main screen press the CSN/UIC tab and the following screen will appear (Figure 31). Adding a UIC is done when you have searched and can't find the UIC and have asked for a transfer disk with no response.

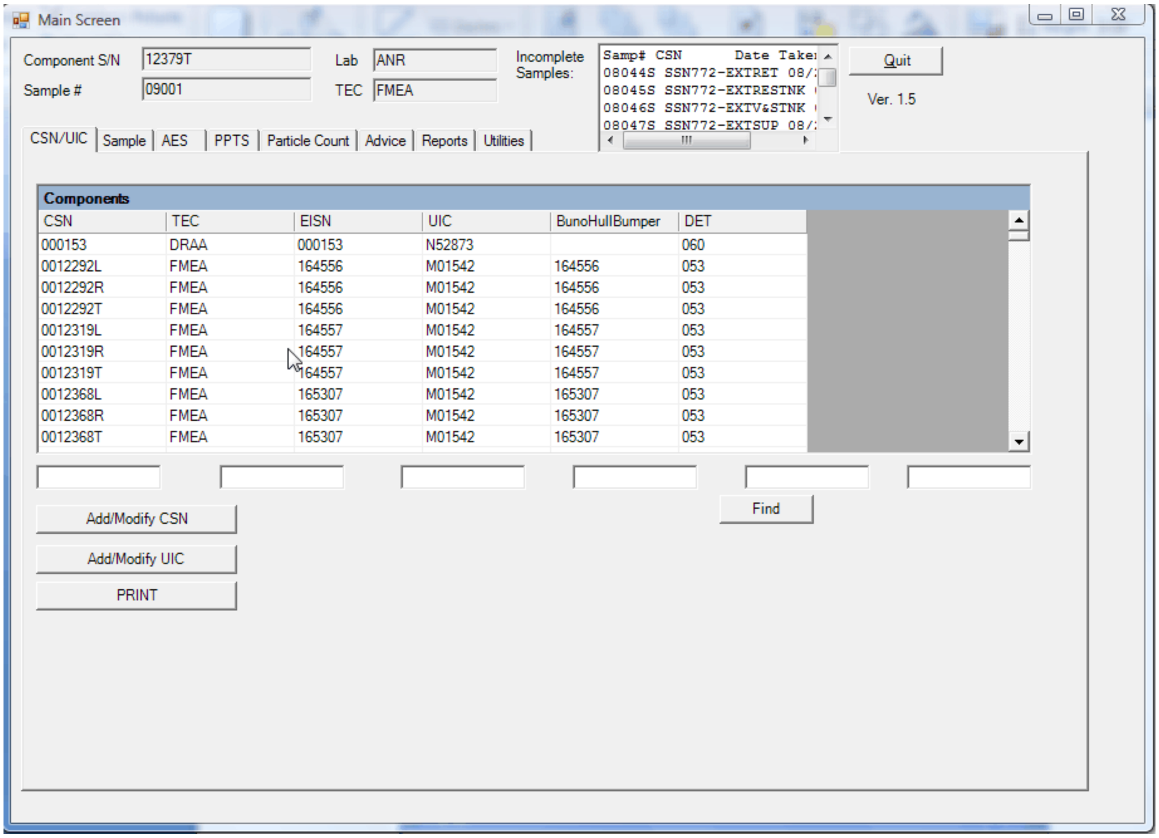


Figure 31. CSN/UIC Tab

(2) Press Add/Modify UIC button (Figure 32).

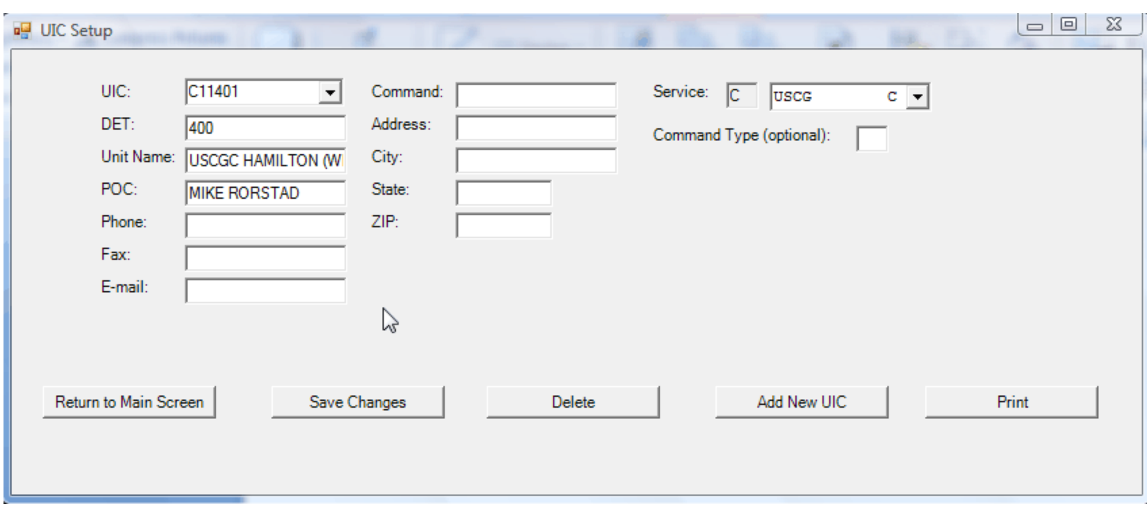


Figure 32. UIC Setup

(3) Press Add New UIC and the following screen will appear (Figure 33).

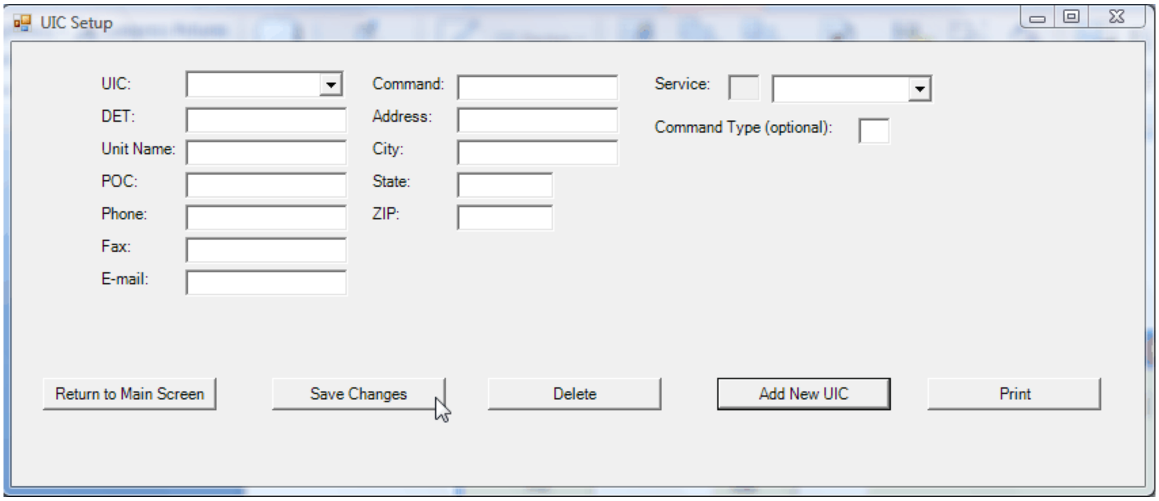


Figure 33. Add UIC

(4) Enter unit identification code, detachment which uniquely identifies multiple commands under one UIC, unit name, point of contact, phone, fax, e-mail address, command, address, city, state, zip, use the pull down to select service (service is hooked to UIC. If you choose Navy then your UIC needs to start with N, Army starts with a W, Marines start with a M, forestry starts with G, Air Force starts with F, contractors start with K and other start with O), enter command type which is used to distinguish ship from air from ground equipment or any way you would like to sort the Monthly status report. Sort is service, Command type, UIC, DET order for Monthly status report and Components enrolled report.

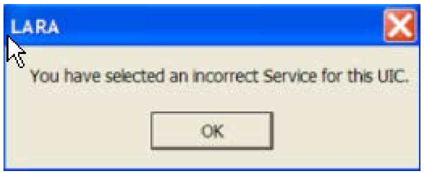


Figure 34. Warning

(5) Press the save changes button. If UIC is not corresponding with the service the above error will appear (Figure 34). Fix the service or UIC and press save changes again.

Figure 35. Confirmation

(6) Press OK (Figure 35).

k. Modify unit identification code. If modification is required, the UIC may be modified.

(1) From the main screen press the CSN/UIC tab and the following screen will appear (Figure 36).

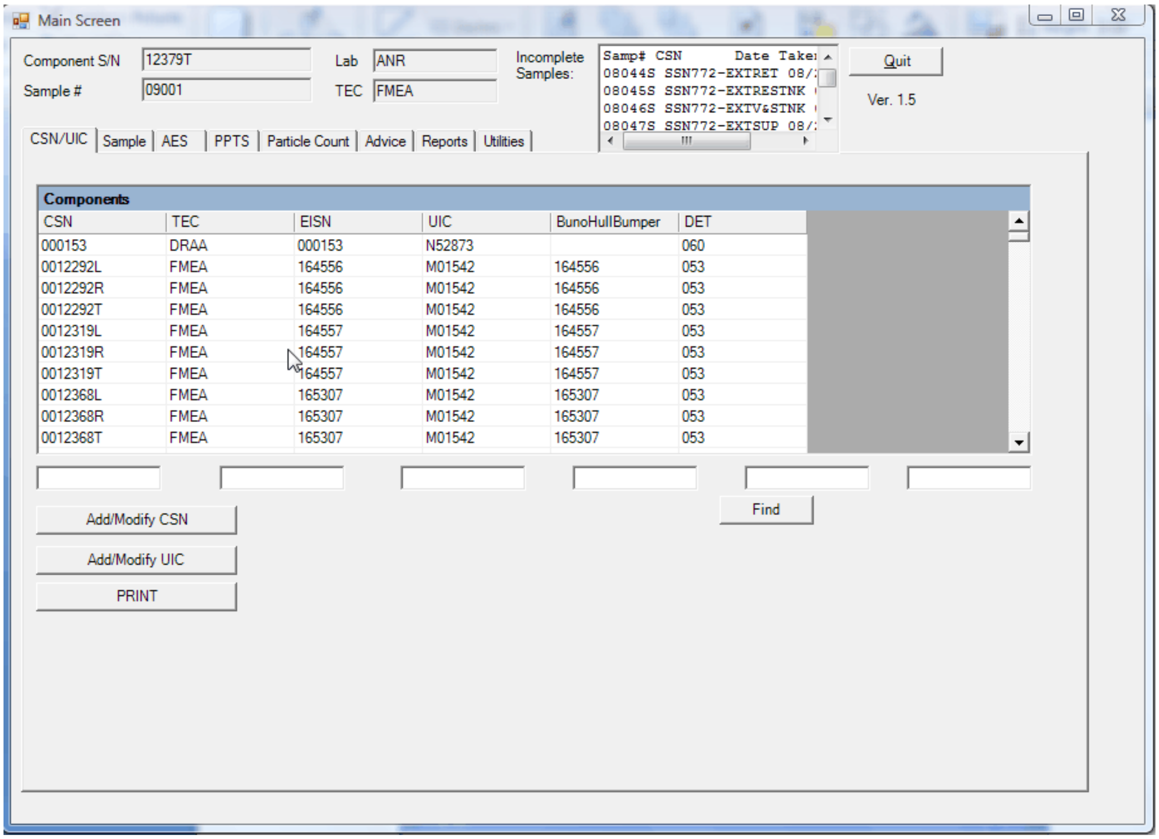


Figure 36. CSN/UIC Tab

(2) Press Add/Modify UIC and the following screen will appear (Figure 37).

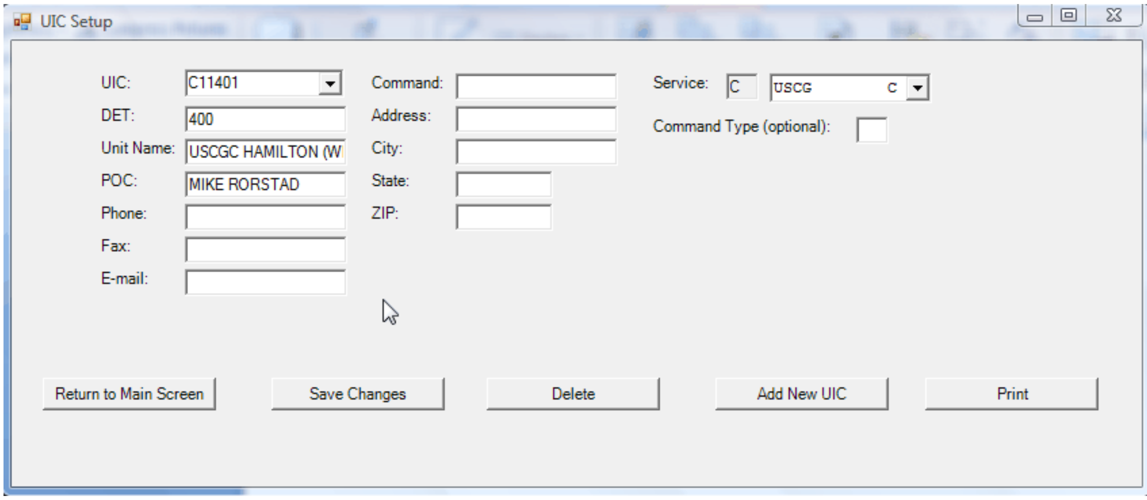


Figure 37. UIC Setup

(3) Use the pull down beside the first UIC to find the UIC to modify.
(4) Make the changes and press save changes and the following screen will appear (Figure 38).

Figure 38. Confirmation

(5) Press OK.

l. Completing/reviewing an existing sample. Samples must be Completed in order to be removed from the Incomplete list.

(1) Use the down arrow to select the CSN or select the csn in the incomplete window at the upper right had corner of the screen (Figure 39). Use the right (<<) and left (>>) arrows to select a sample to complete or review. Not completing samples in the incomplete samples box will stop you from transferring data to another lab.

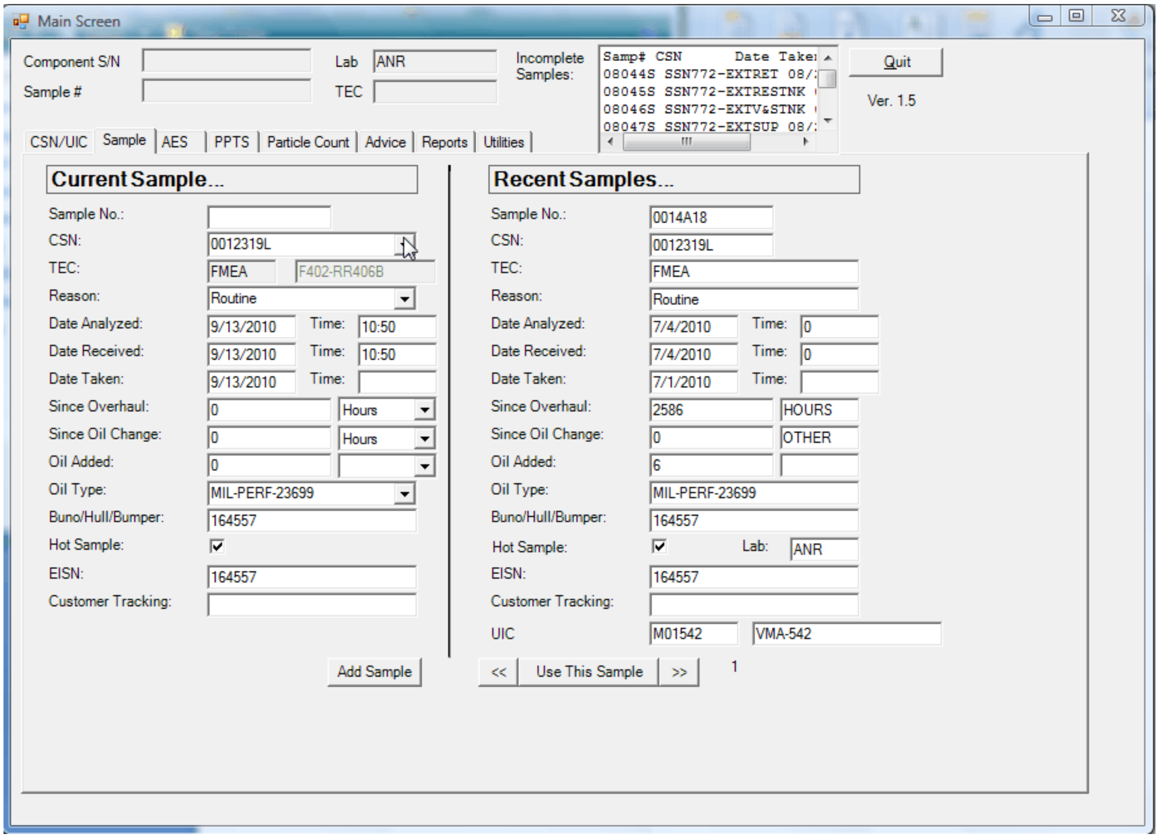


Figure 39. Sample Tab

(2) Press use this sample and the following screen will appear (Figure 40).

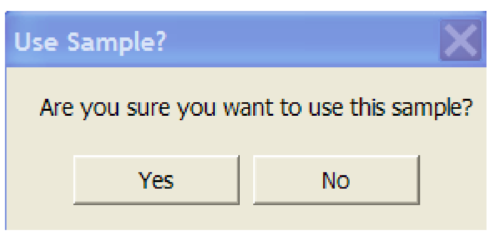


Figure 40. Use Sample?

(3) Press yes and follow steps 17-40 under Entering a Sample above. If the sample is completed you will not be able to change any data but will be able to view the history listing report.

4. REPORTS

All reports within the LARA Software depend on the data available, and how data was identified and/or captured during Equipment Identification, Sample Identification and Testing. Since all reports depend on this source data, it is important for lab operators to properly identify all aspects of the data they are entering into LARA. If the software does not produce a report according to the information entered, it is possible that a data condition or misidentification of data causes a report to not function properly.

Immediately contact the NOAP Office (noap@navy.mil) if a report does not appear as expected, or if information presented on the report is insufficient to provide to a lab customer.

a. Components Enrolled Report. From the main screen press the Reports tab and the following screen will appear (Figure 41).

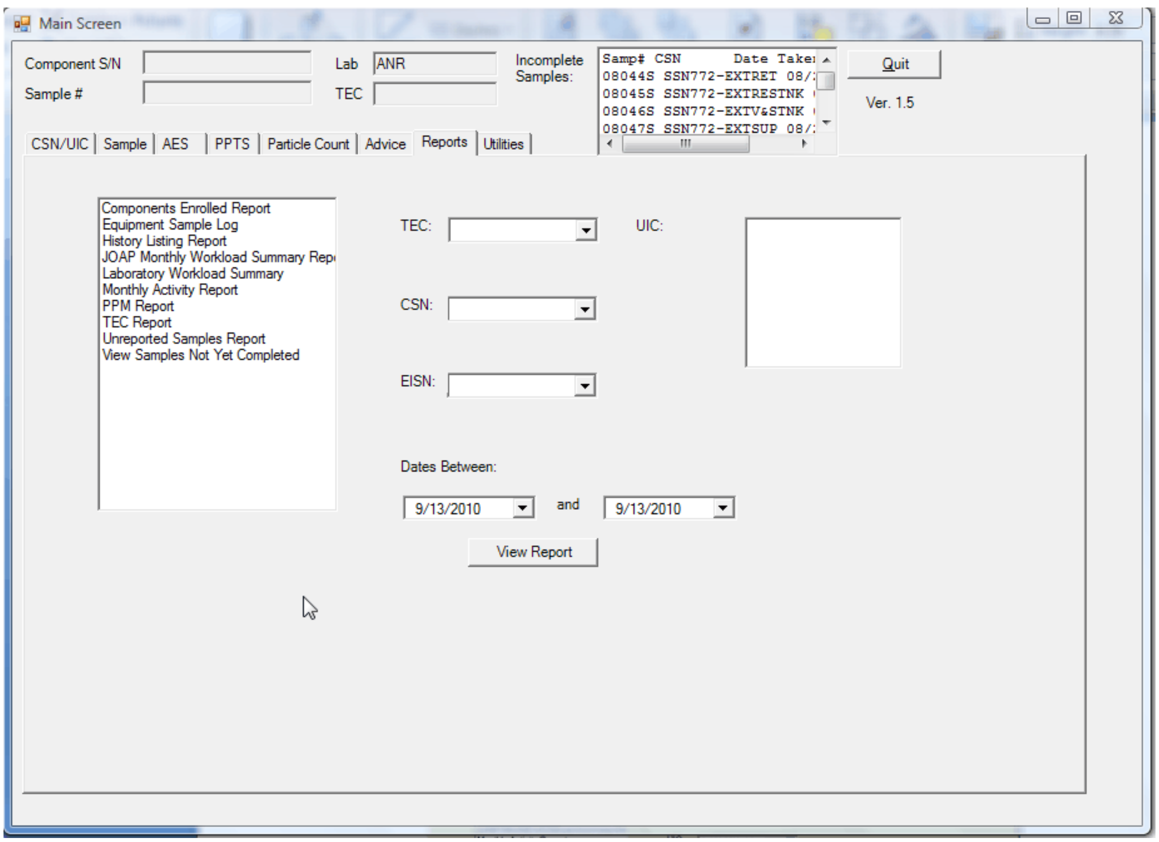


Figure 41. Reports Tab

(1) Click on components enrolled report and the following screen will appear (Figure 42). Components enrolled is done at the end of every month to show the command what components are in the oil program, when they were last sampled, and if they are delinquent.

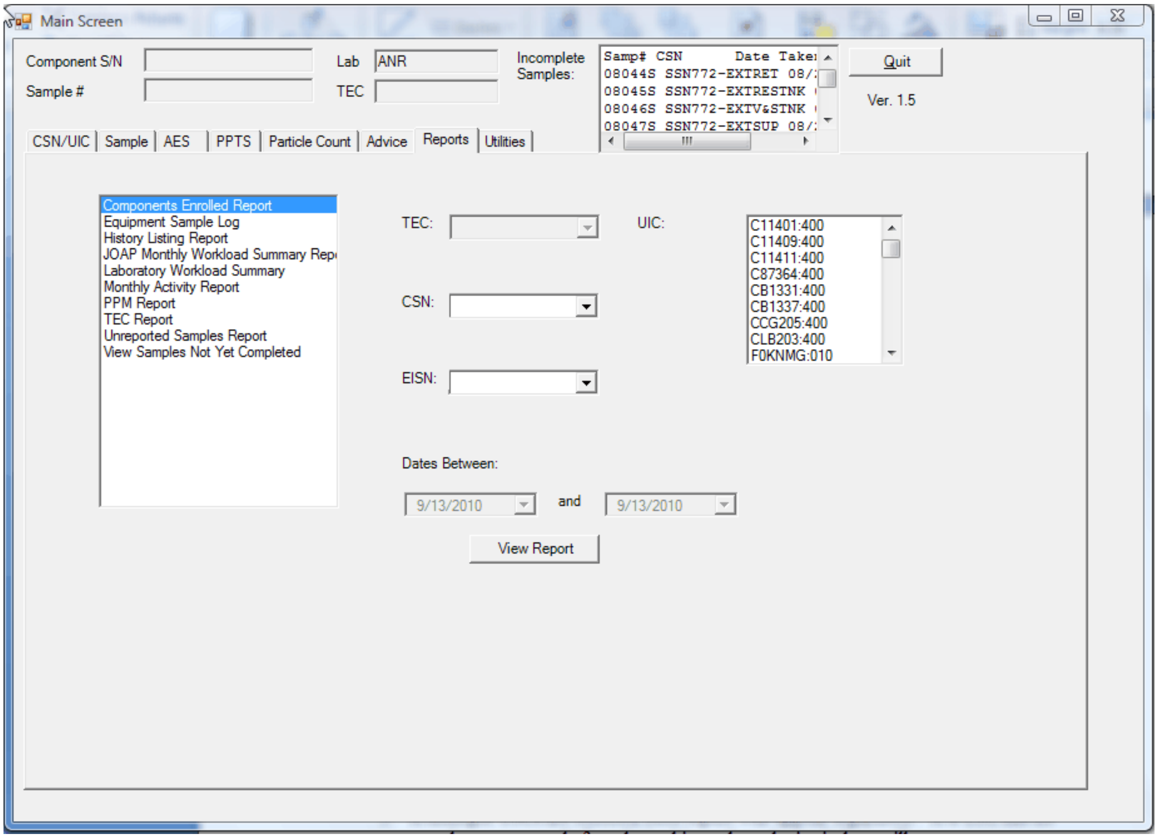
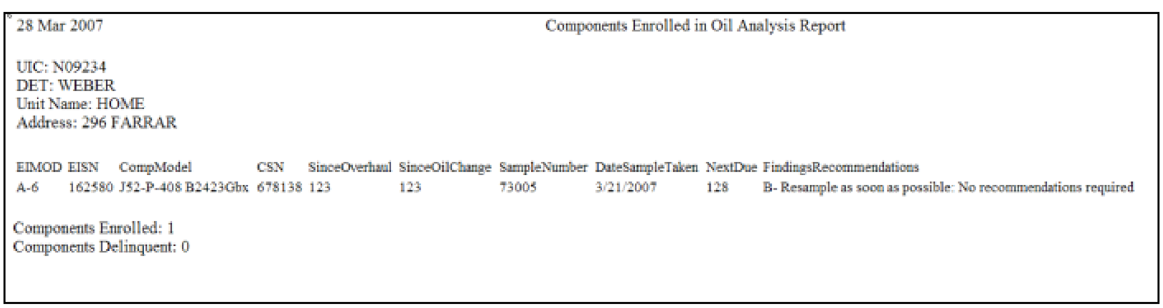


Figure 42. Components Enrolled Report

(2) Use the scroll down to select one or more UIC/DETs or no selection will print all UICs. Sort is service, Command type, UIC, DET order. Page break at each change.

(3) Press view report and the following screen will appear (Figure 43).

(4) If multiple UICs are selected each report will appear separately. If a UIC has no samples a no records found matching selected criteria box will appear.


28 Mar 2007 Components Enrolled in Oil Analysis Report

UIC: N09234
DET: WEBER
Unit Name: HOME
Address: 296 FARRAR

EIMOD	EISN	CompModel	CSN	SinceOverhaul	SinceOilChange	SampleNumber	DateSampleTaken	NextDue	FindingsRecommendations
A-6	162580	J52-P-408 B2423Gbx	678138	123	123	73005	3/21/2007	128	B- Resample as soon as possible: No recommendations required

Components Enrolled: 1
Components Delinquent: 0

Figure 43. Report

b. Equipment Samples Log. Click on equipment sample log and the following screen will appear (Figure 44).

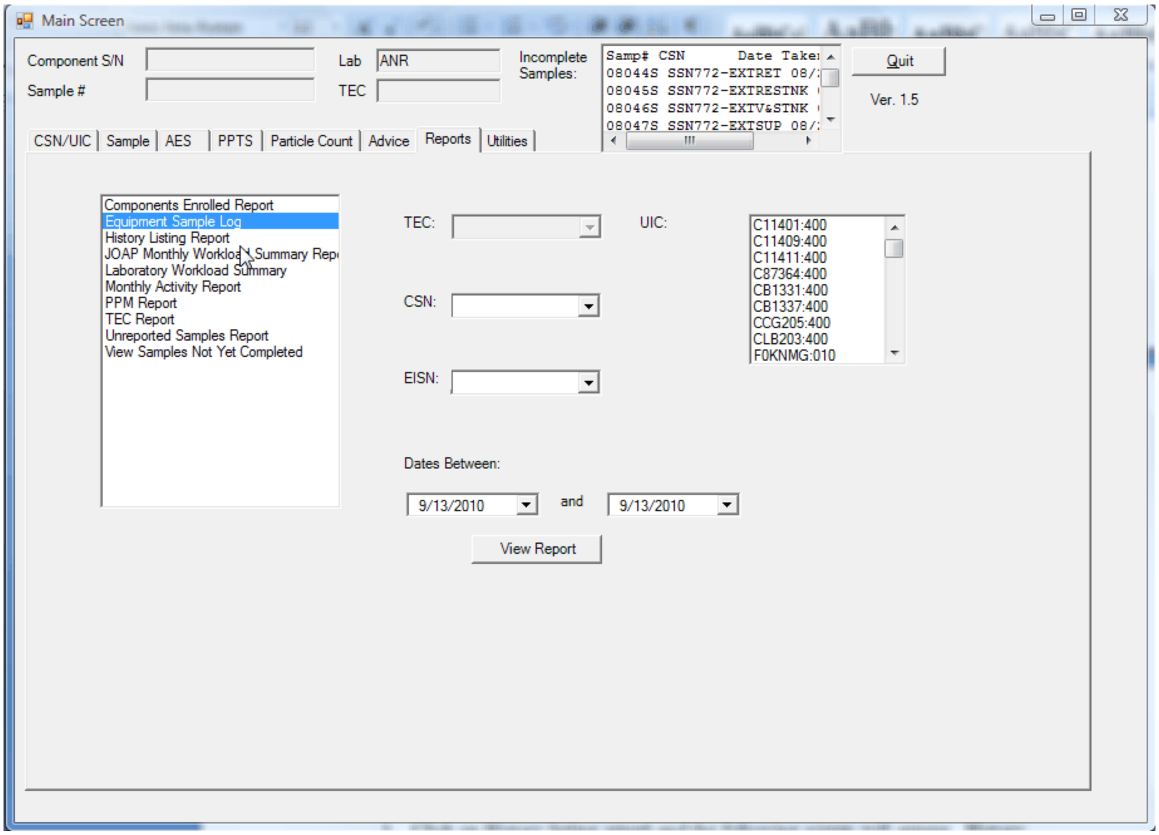


Figure 44. Equipment Sample Log

(1) Use the pull down to select one or more UIC/DETs or no selection will print all UIC/DETs. Sort is service, Command type, UIC, DET order. Page break at each change. Date is required and the pull down will display a calendar.

(2) Press view report and the following screen will appear (Figure 45). If a UIC has no samples a no records found matching selected criteria box will appear.

28 Mar 2007 Equipment Sample Log

SampleNumber	DateSampleReceived	DateSampleAnalyzed	UIC	CSN	CompModel	EISN	EndItemModel
73004	3/27/2007	3/27/2007	N09995	678138	J52-P-408 B2423Gbx	163849	A-6
73005	3/27/2007	3/27/2007	N09995	678138	J52-P-408 B2423Gbx	163849	A-6

Figure 45. Report

c. History Listing Report. Click on History listing report and the following screen will appear (Figure 46). History listing would be run if a one is lost or a squadron has called for one.

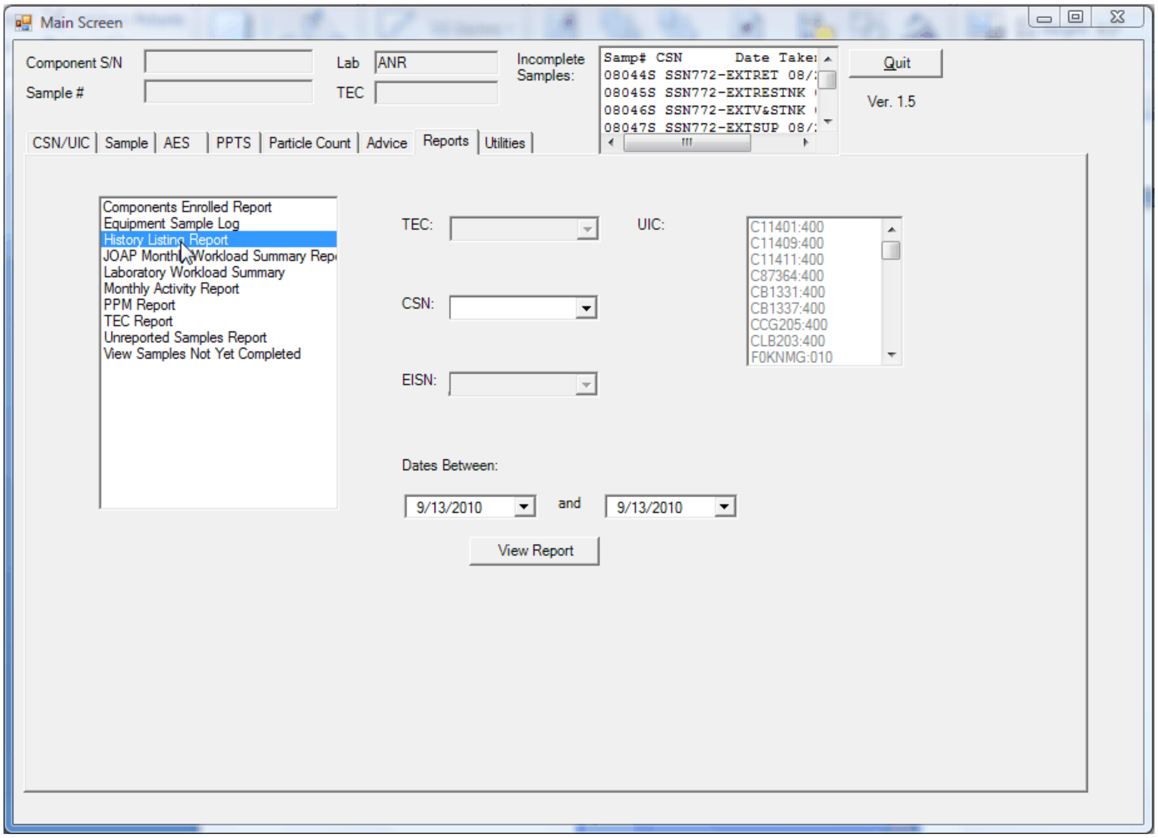


Figure 46. History Listing Report

(1) Use the pull downs to select CSN or EISN in the white boxes. Date is required and the pull down will display a calendar.

(2) Press view report and the following screen will appear (Figure 47).

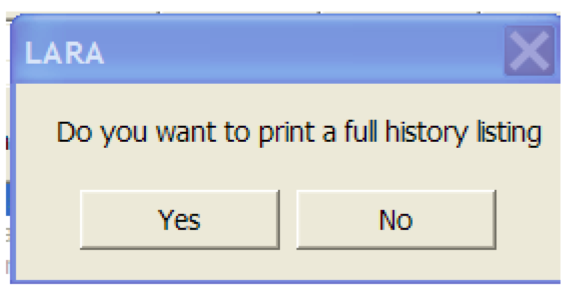


Figure 47. Confirmation

(3) Press “yes” and the following will appear (Figure 48).

Component Model:	T58-GE-402	Command:		Sampling Intervals		LAB NAME:	Cherry Point
Component S/N:	A232-54-7843	UIC:	N09234	30 hours		LAB ADDRESS:	Cherry Point
End-Item Model:	H-46	DET:	WEBER	.		LAB E-MAIL:	jennifer.sanderson@navy.mil
End Item S/N:	45	.	.	.		LAB PHONE:	DSN 555-5555

SampleNum	CustomerNum	DateTaken	DateReceived	DateAnalyzed	SinceOVHL	SinceOilChg	OilAdded	Reason	TEC	FindingsRecommendations
73090		3/11/2007	3/29/2007	3/29/2007	12	12	0	Routine	SEJB	A- Sample results normal: Continue routine sampling

Sample No.	FE	AG	AL	CR	CU	MG	NA	NI	PB	SI	SN	TI	B	MO	ZN
73090	0	0	7	0	0	0	0	0	7	0	0	0	0	0	0

PPM Guidelines	AL	FE	CU	CR	AG
NormalRange	10	30	10	3	6
MarginalRange	12	36	12	3	7
HighRange	14	47	14	4	9
AbnormalRange	15	48	15	5	10
AbnormalTrend	4	10	4	2	3

Sample No.	Fuel Dil	Crackle	Water	PPM or %	Viscocity Measurement	Visc 40	Visc 100	Flashpoint	TAN
73090	0	Not Tested	0	Not Tested	0	0	0	0	0

Sample No.	5-10 Microns	10-25 Microns	25-50 Microns	50-100 Microns	> 100 Microns	Class
73090	0	0	0	0	0	0

Sample No.	Remarks
73090	

Figure 48. Report

(4) Press “no” and the following will appear (Figure 49).

Component Model:	WINCHHYDRAUL	Command:	CG69	Sampling Intervals		LAB NAME:	Cherry Point
Component S/N:	CG69-2/RSD	UIC:	N21684	0		LAB ADDRESS:	Cherry Point
End-Item Model:	ALL	DET:	001	.		LAB E-MAIL:	jennifer.sanderson@navy.mil
End Item S/N:	2 RSD	.	.	.		LAB PHONE:	DSN 555-5555

SampleNum	CustomerNum	DateTaken	DateReceived	DateAnalyzed	SinceOVHL	SinceOilChg	OilAdded	Reason	TEC	FindingsRecommendations
87043		7/9/2008	7/9/2008	7/9/2008	0	0	0	Routine	W001	AA- Oil condition normal: Continue routine sampling
87033		7/2/2008	7/7/2008	7/7/2008	0	0	0	Routine	W001	PC- Particle count excessive: RB- Resample as soon as possible:
83167		12/28/2007	3/27/2008	3/27/2008	0	0	0	Routine	W001	AA- Oil condition normal: Continue routine sampling
0015H5		3/12/2007	3/12/2007	3/12/2007	0	0	0	Routine	W001	A-Normal: Continue Routine Sample

Sample No.	FE	AG	AL	CR	CU	MG	NA	NI	PB	SI	SN	TI	B	MO	ZN
87043	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87033	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0015H5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trend	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Sample No.	Remarks
87043	
87033	
83167	
0015H5	ADVICE CODE AA

Figure 49. Report

d. <u>JOAP Monthly Workload Summary Report</u>. Click on JOAP Monthly Workload Summary Report and the following screen will appear (Figure 50). JOAP Monthly Workload Summary Report is done at the end of every month to show the lab what samples were done that month by UIC.

Report Date: 19 Mar 2009 JOAP Monthly Workload Summary Report

UIC	DET	COMMAND NAME	DESIGNATION	SAMPLES RECEIVED	AVIATION	HYDRAULIC	NON HYDRAULIC
N21032	001	USS McINERNEY	FFG8	1	0	1	0
N21053	001	USS BOONE	FFG28	1	0	1	0
N21103	001	USS UNDERWOOD FFG36	USS UNDERWOOD FFG36	1	0	1	0
N21106	001	USS DOYLE	FFG 39	5	0	3	2
N21107	001	USS HALYBURTON	FFG40	7	0	5	2
N21109	001	USS KLAKRING	FFG 42	7	0	5	2
N21139	001		FFG45	2	0	2	0
N21197	001	USS DEWERT	FFG45	18	0	14	4
N21201	001	USS ROBERT G BRADLEY(FFG49)	FFG49	18	0	10	8
N21231	001	USS TAYLOR	FFG50	11	0	6	5
N21314	001		USS AVENGER MCM-1	19	0	2	17
N21350	001	USS SIMPSON	FFG 56	3	0	3	0
N21352	001	USS SAMUEL B ROBERTS (FFG58)	FFG58	6	0	6	0
N21403	001	USS DEFENDER		1	0	0	1
N21404	001	USS SENTRY	MCM 3	47	0	6	41
N21405	001	USS CHAMPION(MCM-4)	COMMANDING OFFICER	5	0	1	4
N21454	001	USS GLADIATOR	MCM 11	1	0	0	1
N21457	001	USS WARRIOR	USS WARRIOR MCM-10	1	0	0	1
N21624	001	USS GETTYSBURG	CG 64	18	0	17	1
N21684	001	USS VICKSBURG	CG69	36	0	36	0
N21900	001	USS ARDENT MCM-12	COMMANDING OFFICER	1	0	1	0
N21923	001	USS CARNEY	DDG 64	18	0	16	2
N21942	001	USS THE SULLIVANS	DDG 68	5	0	0	5
N21954	001	USS ROOSEVELTS	DDG 80	19	0	17	2
N42L01	001	HSL42 DET-01	OIC	2	0	0	2
N53912	001	HELANTISUBRONLT 40	HSL-40	242	0	0	242
N53913	001	HSL 42	HSL 42	170	0	0	170
N53915	001	HSL-45	COMMANDING OFFICER	5	0	0	5
N53916	001	HELANTISUBRONLT 46	HSL 46	194	0	0	194
N53918	001	HELANTISUBRONLT 48	HSL 48	165	0	0	165
N53975	001	HELANTISUBRONLT 44	HSL 44	180	0	0	180
N84055	001	HSL-60	COMNAVAIRES	48	0	0	48
TOTALS:	:	:	:	1257	0	153	1104

My Computer 100%

Figure 50. Report

e. Monthly Activity Report. Click on Monthly activity report and the following screen will appear (Figure 51). Monthly activity is done at the end of every month to show the command what samples were run in that month.

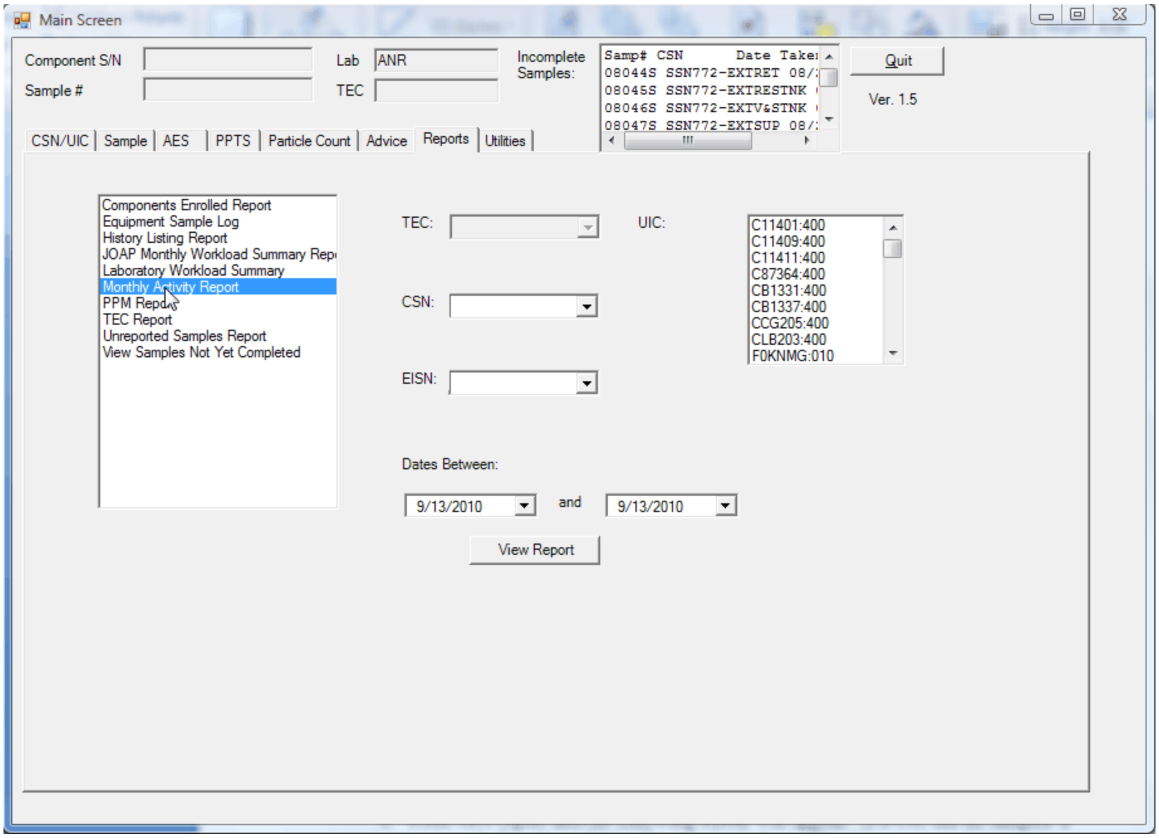


Figure 51. Monthly Activity Report

(1) Use the pull down to select one or more UIC/DETs or no selection will print all UIC/DETs. Sort is service, Command type, UIC, DET order. Page break at each change. Date is required and the pull down will display a calendar.

(2) Press view report and the following screen will appear (Figure 52). If a UIC has no samples a no records found matching selected criteria box will appear.

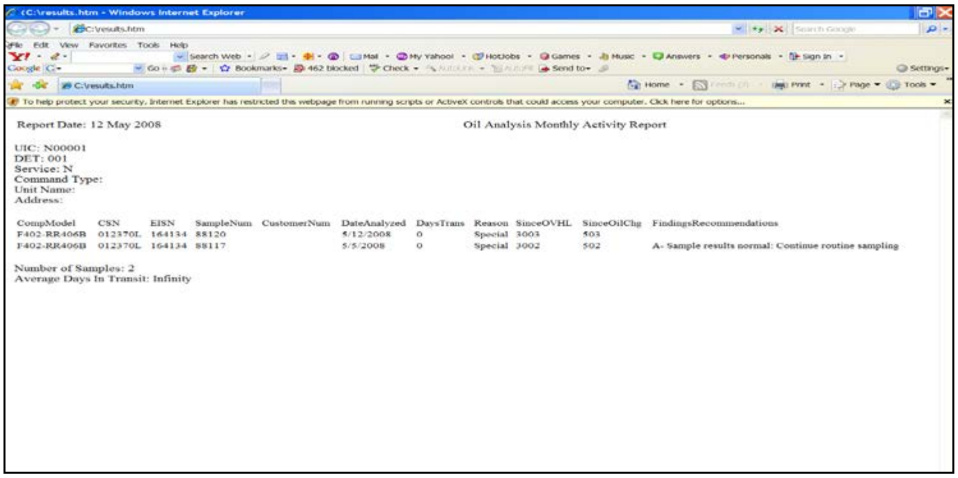


Figure 52. Report

f. PPM Report. Click on PPM report and the following screen will appear (Figure 53). Use the pull downs to select options in any of the white boxes

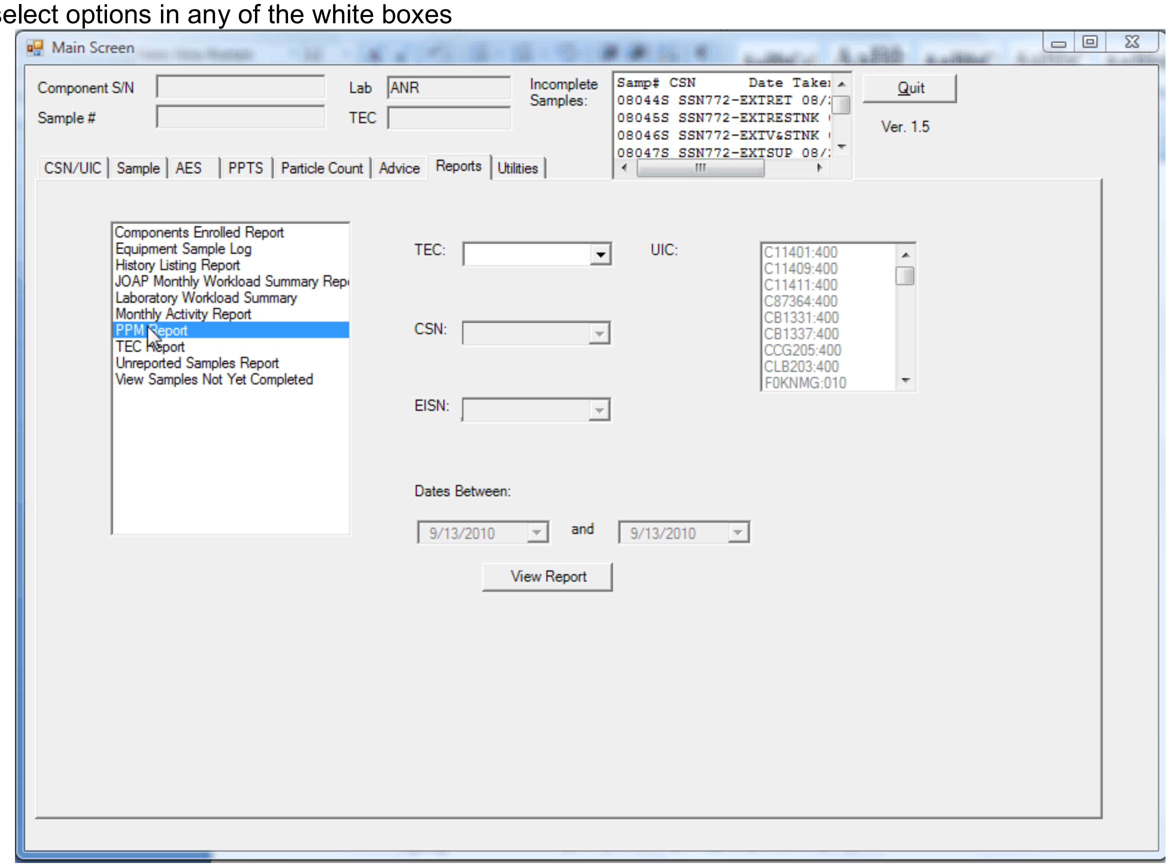


Figure 53. PPM Report

(1) To print all the PPM tables leave the white boxes blank. If all the white boxes are left blank the file will go directly to the printer.

(2) Press view report and the following screen will appear (Figure 54).

PPM Range Table PPM Ranges

TEC

3E7G

	FE	AG	AL	CR	CU	NI	PB	SI	SN	MO
PPM Guidelines										
NormalRange	212	24	20	15	208	13	124	55	17	4
MarginalRange	261	30	24	18	256	16	152	68	21	5
HighRange	326	31	31	23	320	20	190	85	26	6
AbnormalRange	327	32	32	24	321	21	191	86	27	7
AbnormalTrend	16	3	2	2	23	2	11	4	2	2

Figure 54. Report

g. <u>TEC Report</u>. Click on TEC report and the following screen will appear (Figure 55).

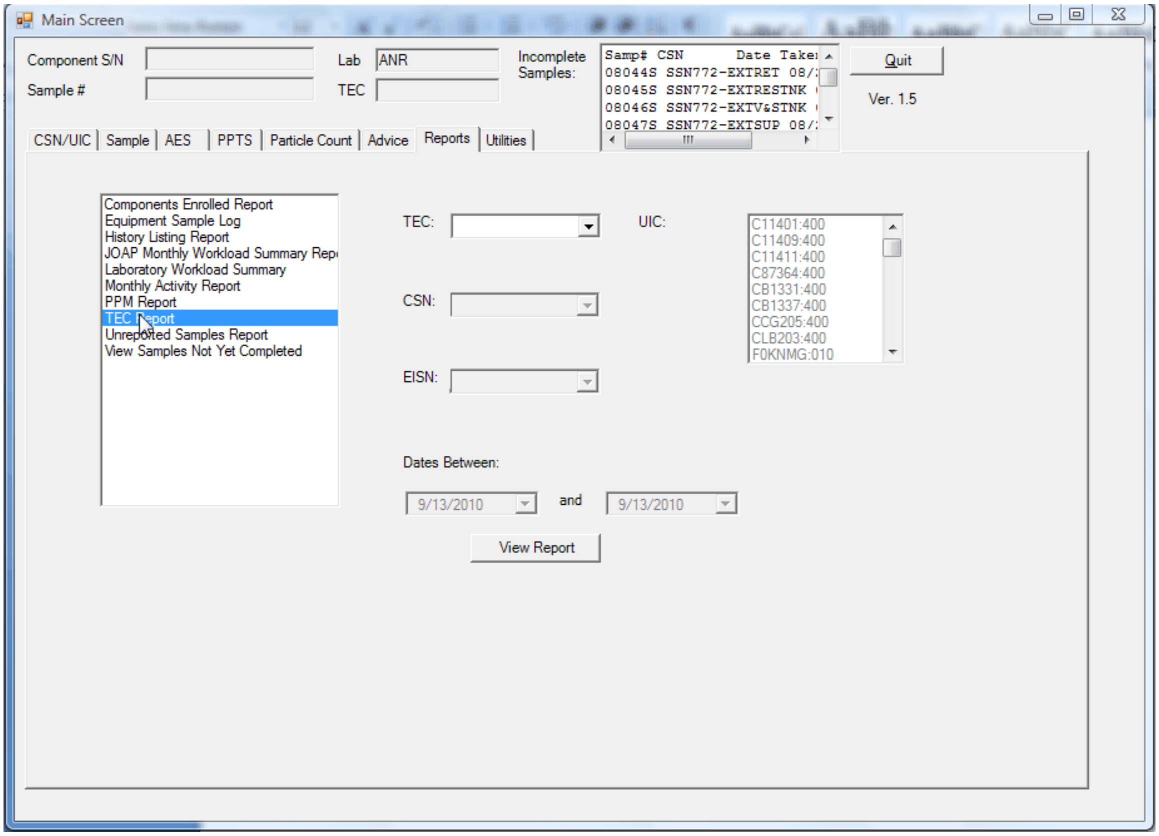


Figure 55. TEC Report

(1) Use the pull downs to select options in any of the white boxes. To print all the TEC tables leave the white boxes blank. If all the white boxes are left blank the file will go directly to the printer. If all the white boxes are left blank the file will go directly to the printer.

(2) Press view report and the following screen will appear (Figure 56).

28 Mar 2007 — Type Equipment Code (TEC) Sorted By TEC

TEC	EIMOD	CompMod	SampleInterval
3E7G	M109A5	XTG-411-2A	60 days

Figure 56. Report

h. Unreported Samples Report. Click on Unreported samples report and the following screen will appear (Figure 57).

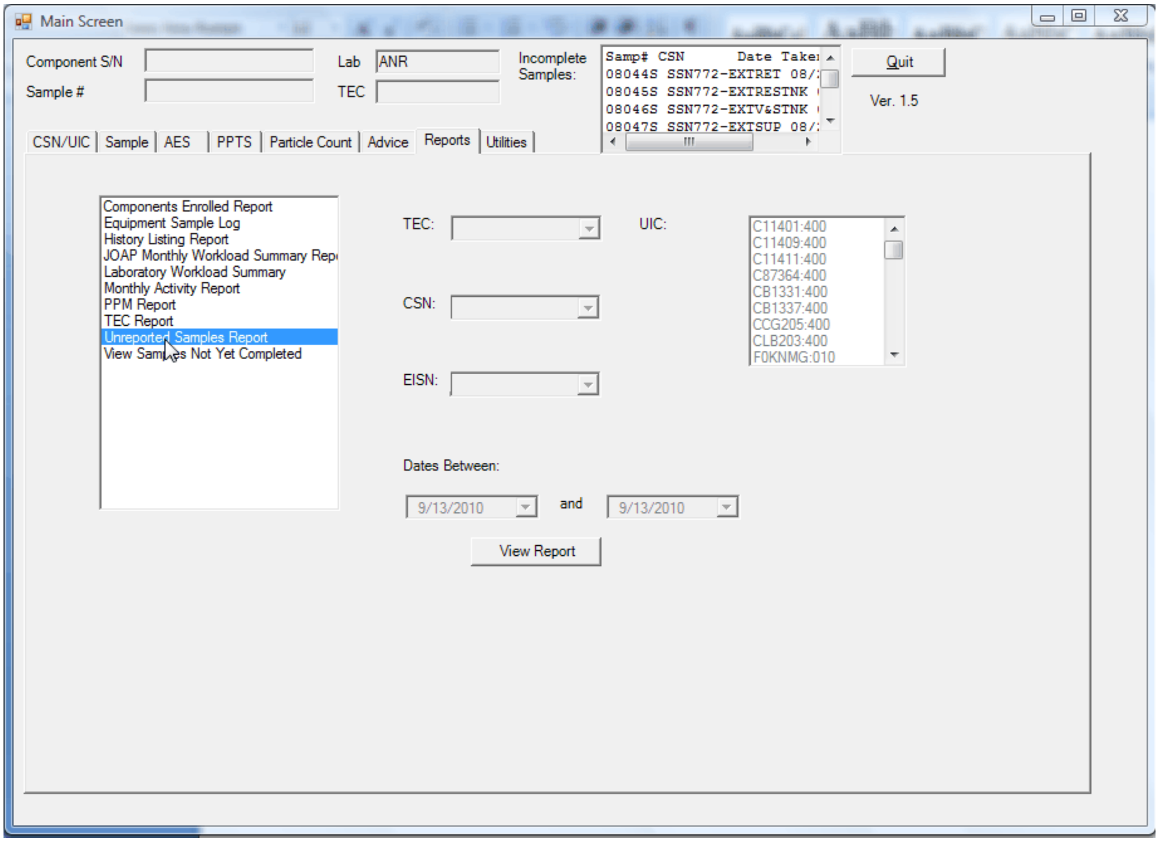
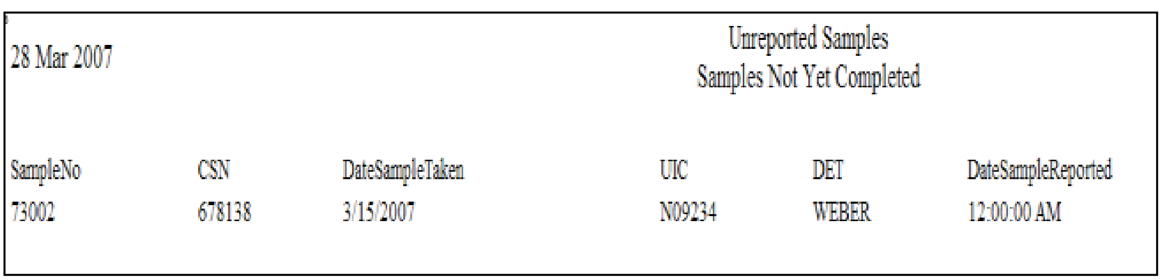


Figure 57. Unreported Samples Report

(1) Use the pull downs to select options in any of the white boxes.
(2) Press view report and the following screen will appear (Figure 58).


28 Mar 2007

Unreported Samples
Samples Not Yet Completed

SampleNo	CSN	DateSampleTaken	UIC	DET	DateSampleReported
73002	678138	3/15/2007	N09234	WEBER	12:00:00 AM

Figure 58. Report

5. TRANSFER FILES

a. Create NOAP export data. NOAP data is required to be transferred to the NOAP Office regularly. This procedure is required by WP 003 01 and also under NAMP 4790. NOAP Labs provide vital fleet and squadron data to Navy personnel, and also to NAVSEA and NAVAIR data analysts and managers who in turn offer recommendations to various programs across the Department of Defense. On more than one occasion, NOAP data has saved the lives of Navy personnel, and avoided additional hardship, costs and workload to Navy personnel. NOAP Labs provide a tremendous service to many levels throughout the Navy, by accurately assessing equipment health, and reducing the risk of equipment failures.

(1). The NOAP Export File must be created using LARA Toolbox. Instructions for creating the Export File can be found in Volume II WP 003 04.

b. Transfer by UIC/Component. If a squadron or UIC requests their data, it can be provided by creating a series of transfer files.

(1). From the main sample screen press the Utilities tab and the following screen will appear (Figure 61).

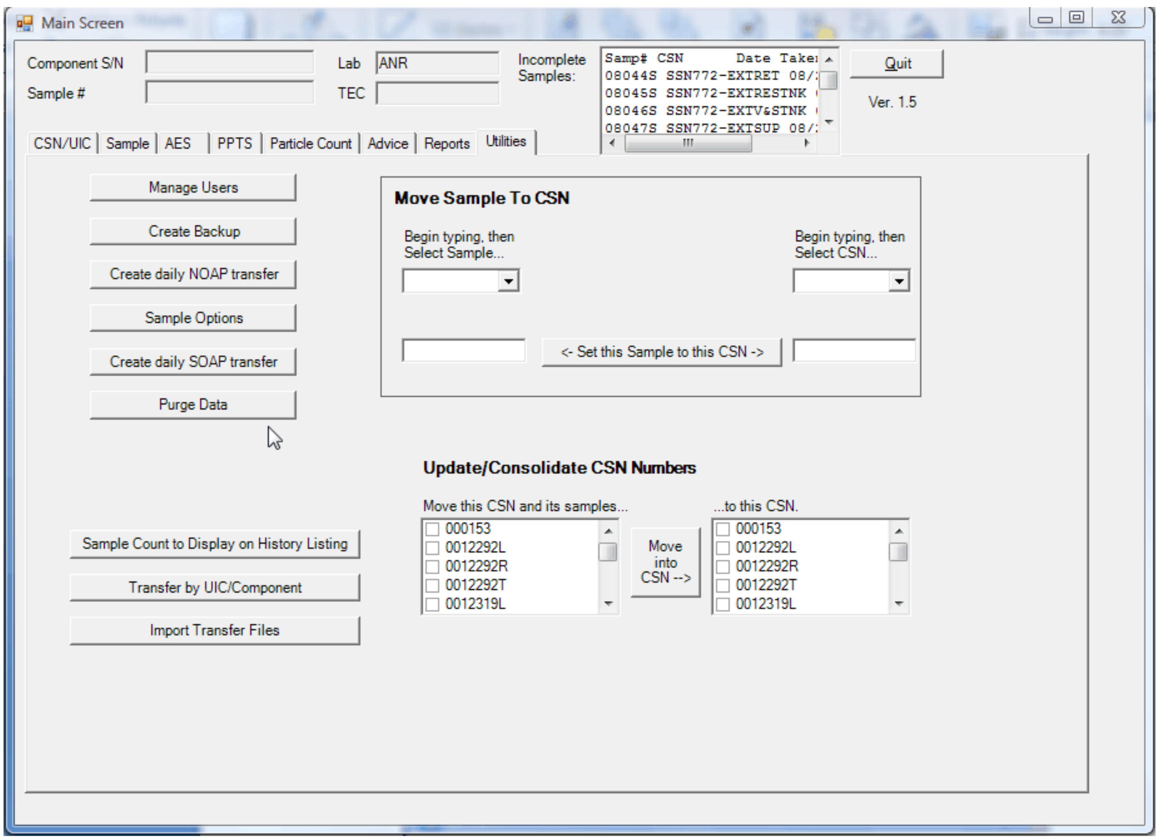


Figure 61. Utilities Tab

(2). Press transfer by UIC/Component and the following screen will appear (Figure 62).

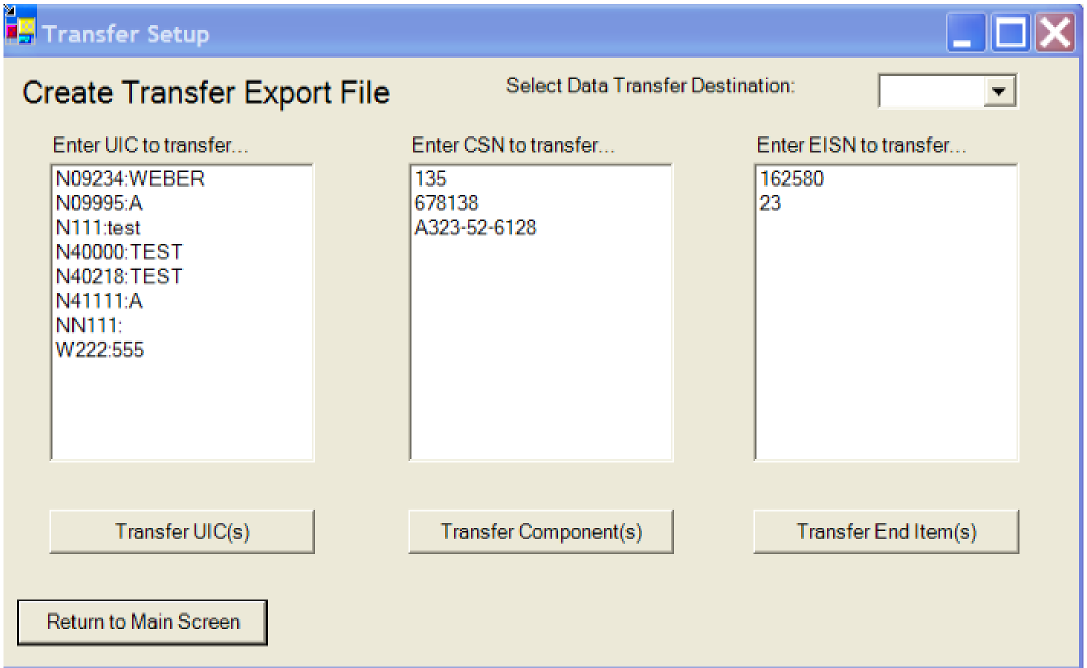


Figure 62. Transfer Setup

(3). Use the pull down to select the drive the file is to be copied to, highlight the UIC(s), CSN(s), or EISN(s) to be transferred and press transfer UIC, transfer Components, or transfer end item.

(4). If you forget to select a drive the following will appear (Figure 63).

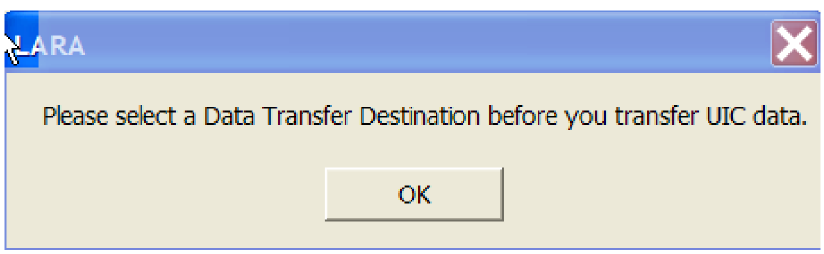


Figure 63. Confirmation

(5). Press OK.

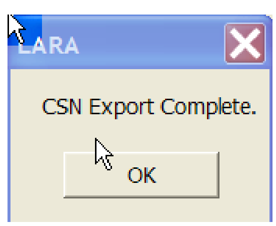


Figure 64. Confirmation

(6). Press OK (Figure 64).

c. Import transfer files. When a squadron or UIC arrives and wishes their history to be available in LARA, they will provide you with the appropriate transfer files to import.

(1). From the main sample screen press the Utilities tab and the following screen will appear (Figure 65).

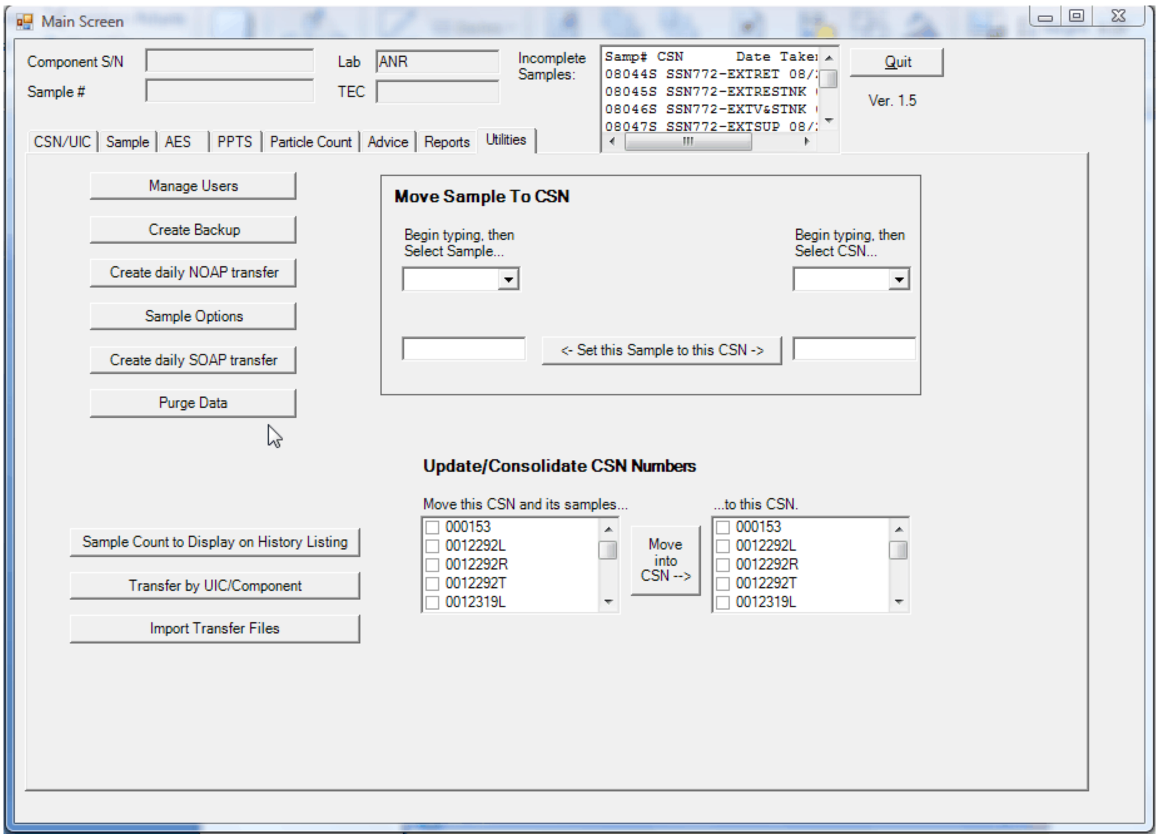


Figure 65. Utilities Tab

(2). Press import transfer files and the following screen will appear (Figure 66).

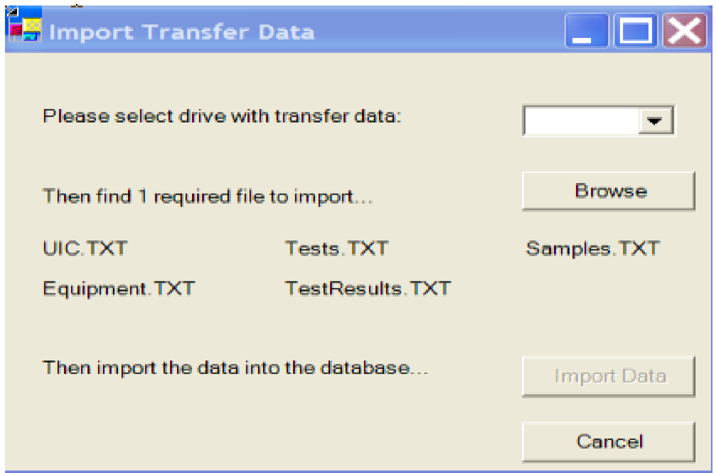


Figure 66. Import Transfer Data

(3). Use the pull down to select the drive the file will go to, press browse and the following screen will appear (Figure 67).

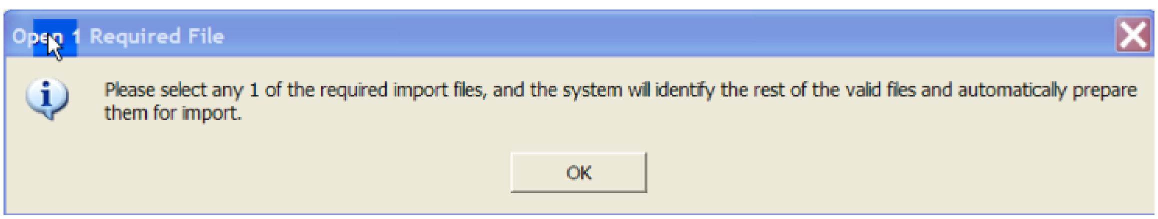


Figure 67. Required File

(4). Press OK.

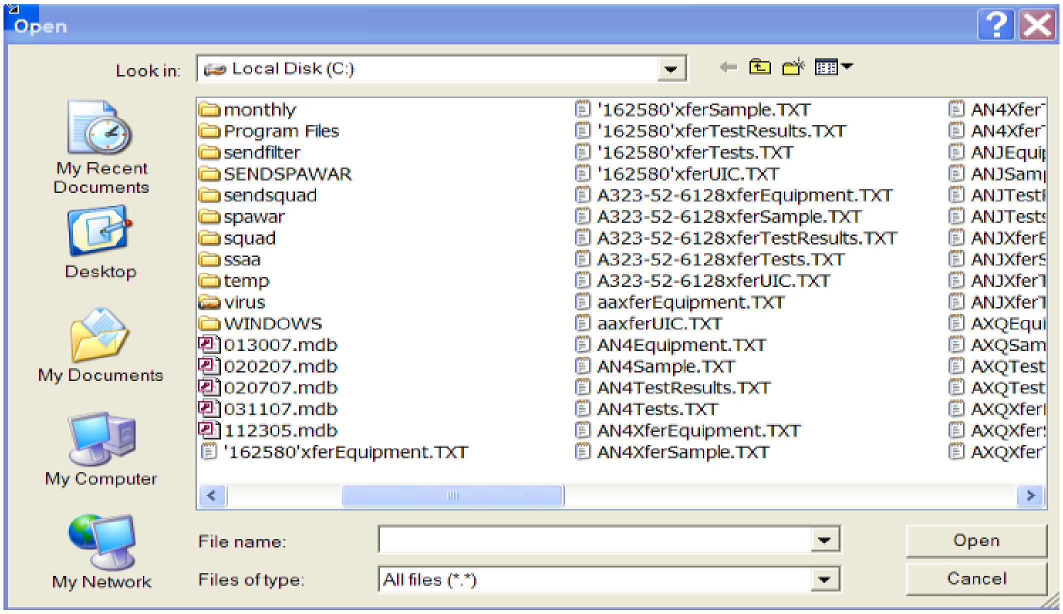


Figure 68. Open Screen

(5). Select one of the files to be imported and press open (Figure 68). In the above screen I know I am importing CSN A323-52-6128 so I will select one of the five files starting with that CSN number.

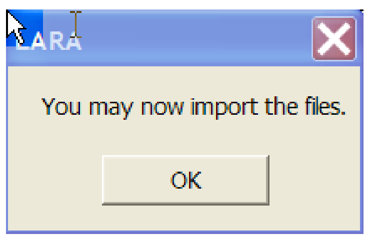


Figure 69. Confirmation

(6). Press OK (Figure 69).

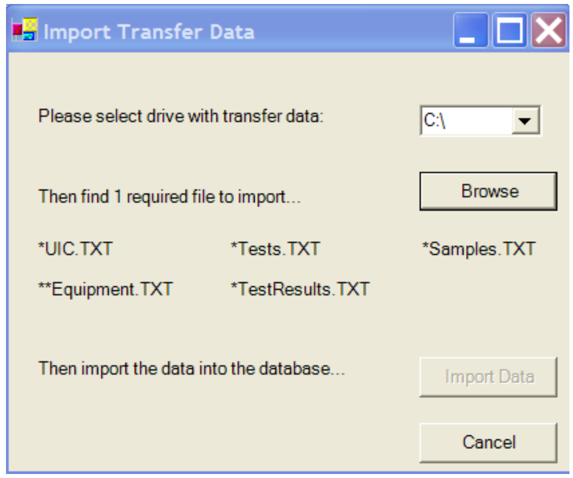


Figure 70. Import Transfer File

(7). Press import data (Figure 70).

Figure 71. Confirmation

(8). Press OK (Figure 71).

6. EQUIPMENT REQUIRED

a. Spectrometer
b. Computer Workstation / Lara Software Installed
c. Spectrometer Printer
d. Lara Printer
e. Printer Cables
f. Spectrometer-To-Workstation Null-Modem Cable

7. SOFTWARE / COMPUTER MAINTENANCE

a. Manage users (adding/deleting/modifying users). From the main sample screen press the Utilities tab and the following screen will appear (Figure 72). If your user account is not authorized you will not see the utilities tab.

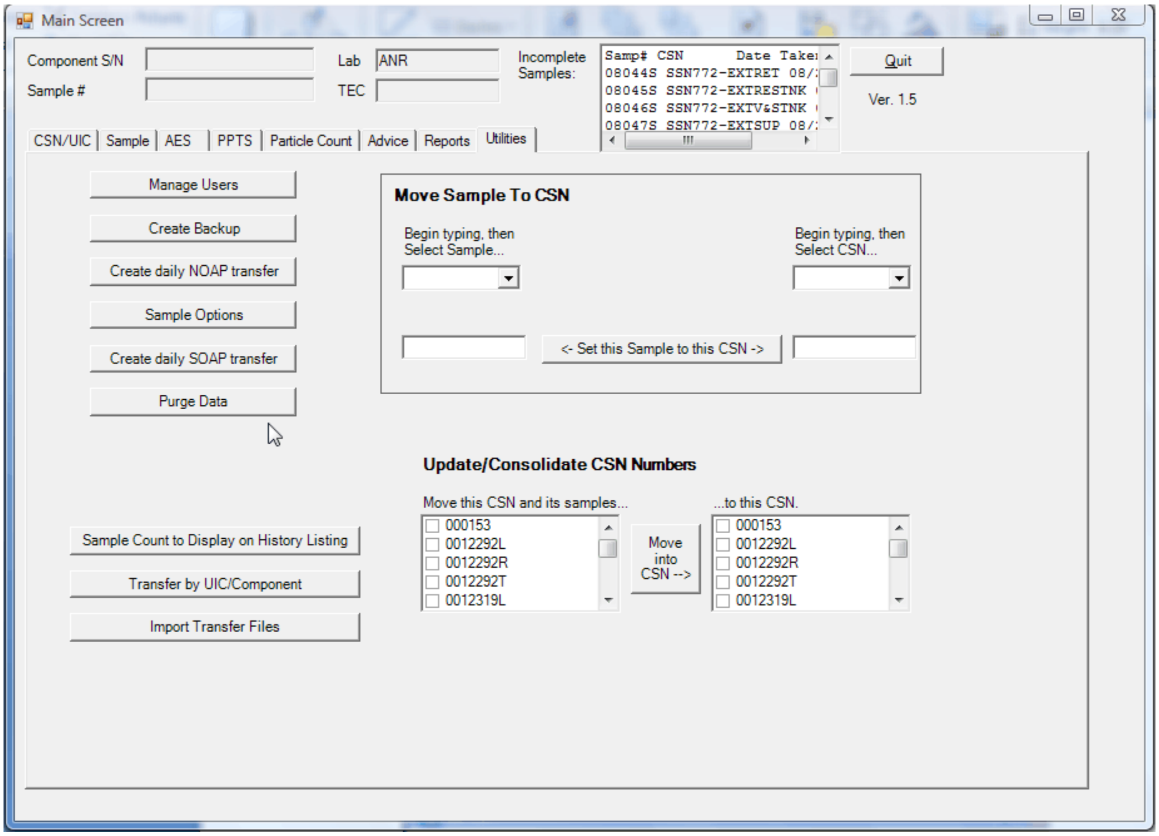


Figure 72. Utilities Tab

(1). Press Manage users and the following screen will appear (Figure 73).

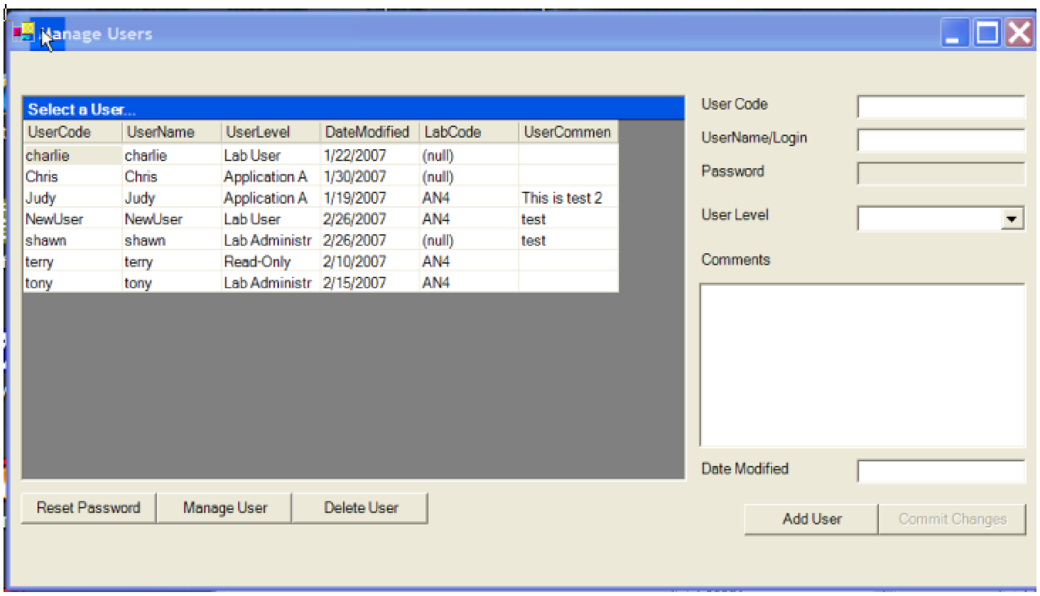


Figure 73. Manage Users

(2). To reset a password highlight the users to be reset and press the reset button, the following screen will appear (Figure 74).

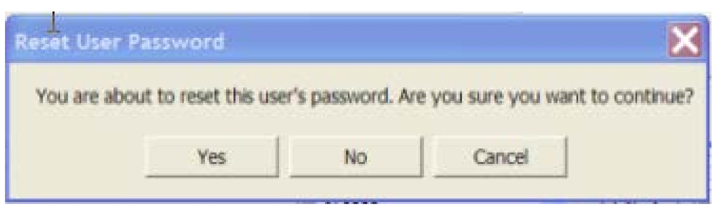


Figure 74. Reset User Password

(3). Press Yes.

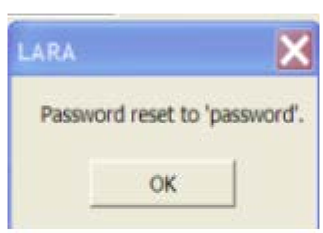


Figure 75. Change Password

(4). Press OK and the password will be changed to password (Figure 75).

(5). To modify a user's information highlight the user to be modified and press manage user. The information for that user will be filled in to the right.

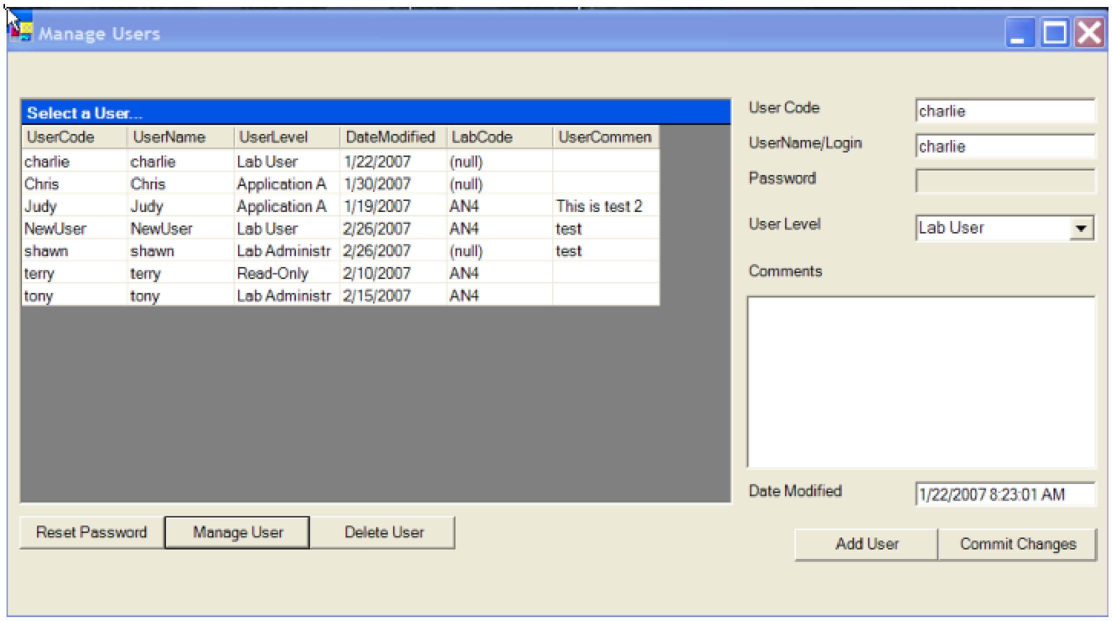


Figure 76. Manage Users

(6). Make the changes needed and press commit changes (Figure 76).

Figure 77. Confirmation

(7). Press OK (Figure 77).
(8). To delete a users highlight the user to be deleted and press delete user.

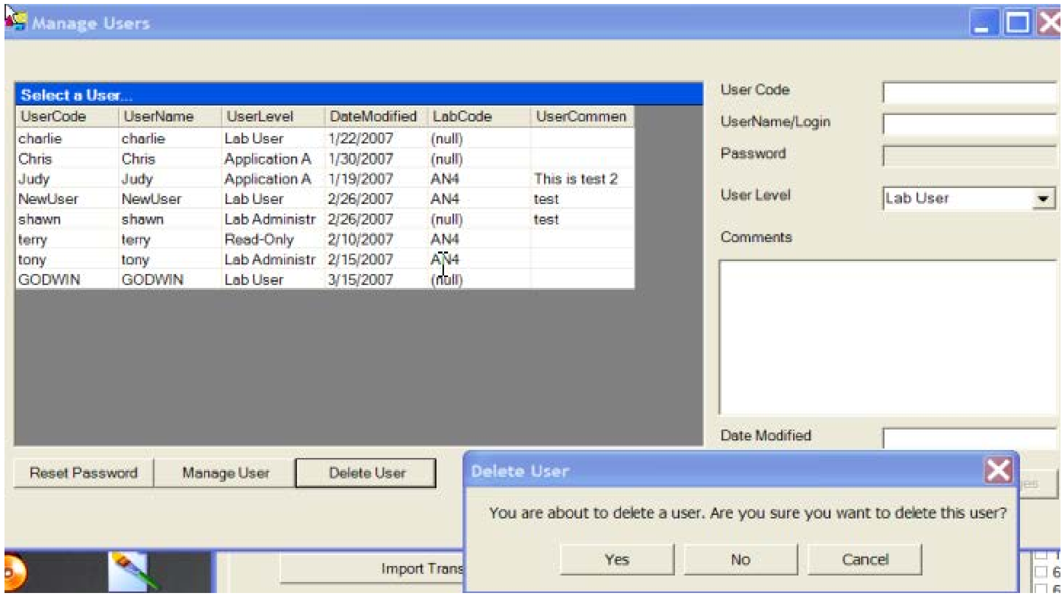


Figure 78. Manage Users

(9). Press Yes (Figure 78).

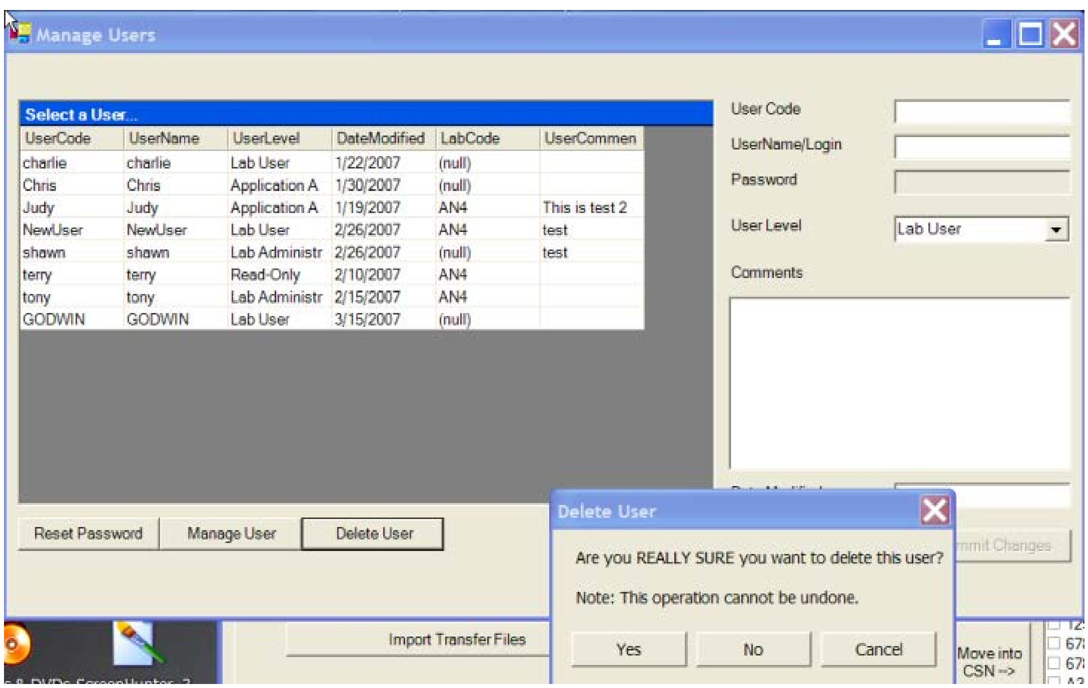


Figure 79. Delete Users

(10). Press Yes (Figure 79).

(11). To add a users Enter user code, username/login user level comments and date modified to the right (Figure 80). User levels are:

Application admin – programmer only
Lab user – access to all except utilities
Read only - access to reports only
Lab Administrator – all

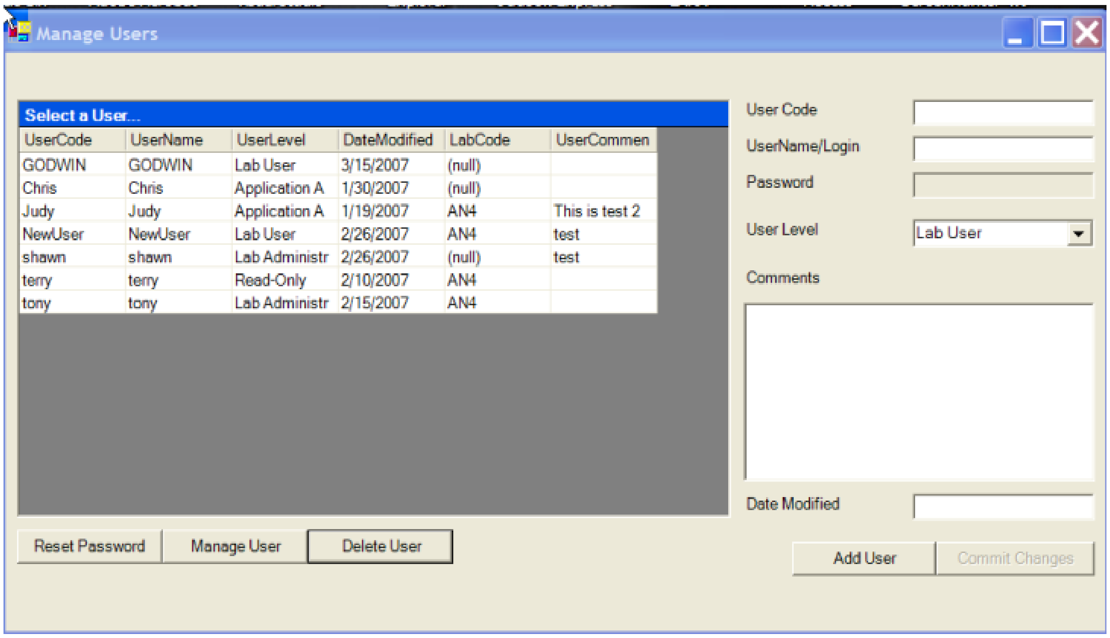


Figure 80. Manage Users

(12). Press add user and the following screen will appear.

Figure 81. Confirmation

(13). Press OK (Figure 81).

b. Create Backup. Procedures for creating a Backup File can be found in Volume II WP 003 04.

c. Purge data. From the main sample screen press the Utilities tab and the following screen will appear (Figure 86).

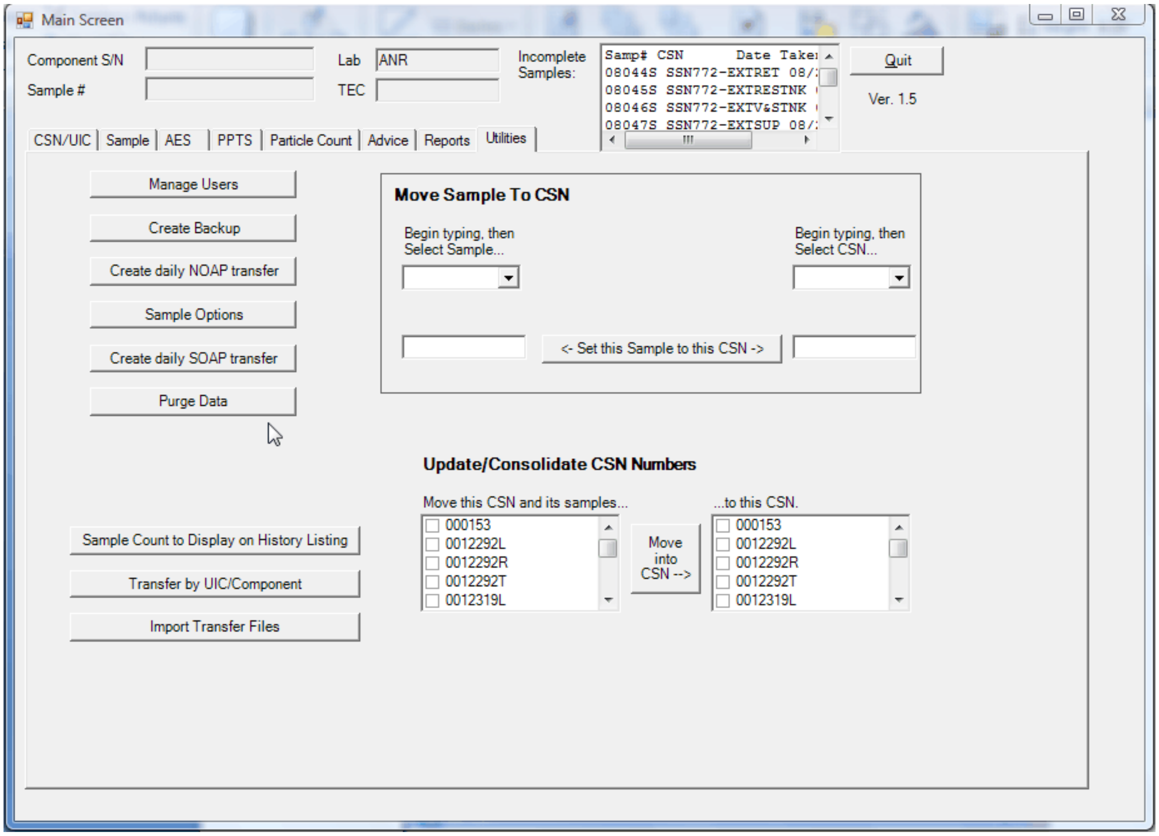


Figure 86. Utilities

Note
Purge data should be done once a month.

(1). Press purge data (Figure 87).

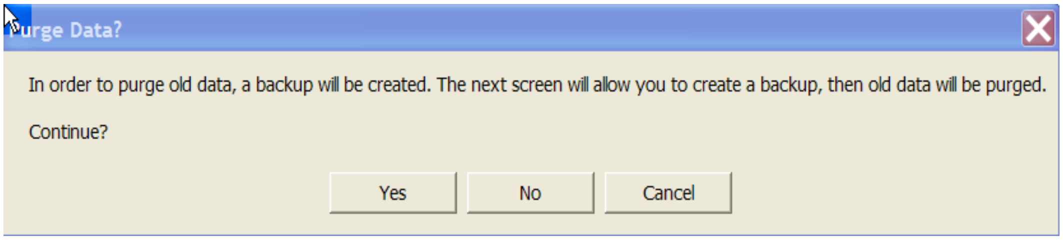


Figure 87. Purge Data

(2). Press yes.

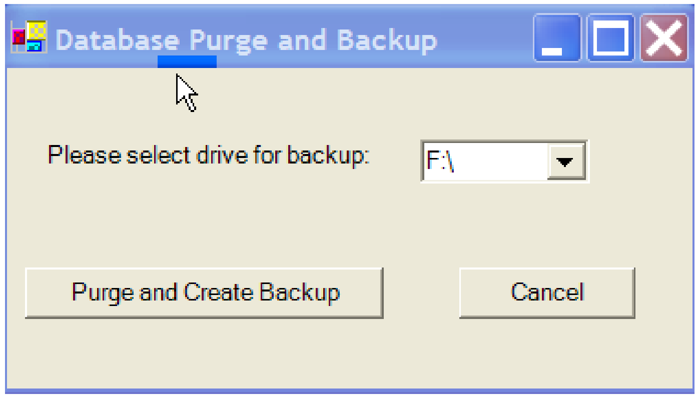


Figure 88. Database Backup

(3). Use the pull down to select the drive the backup is to be copied to.
(4). Press purge and create backup (Figure 88).

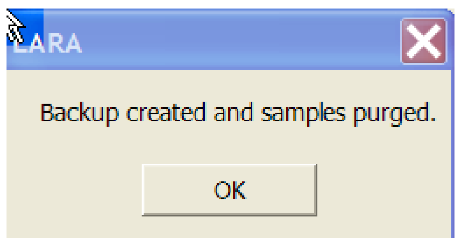


Figure 89. Confirmation

(5). Press OK (Figure 89).

d. Sample options. From the main sample screen press the Utilities tab and the following screen will appear (Figure 90). Sample options gives you the ability to change sample information for a given sample.

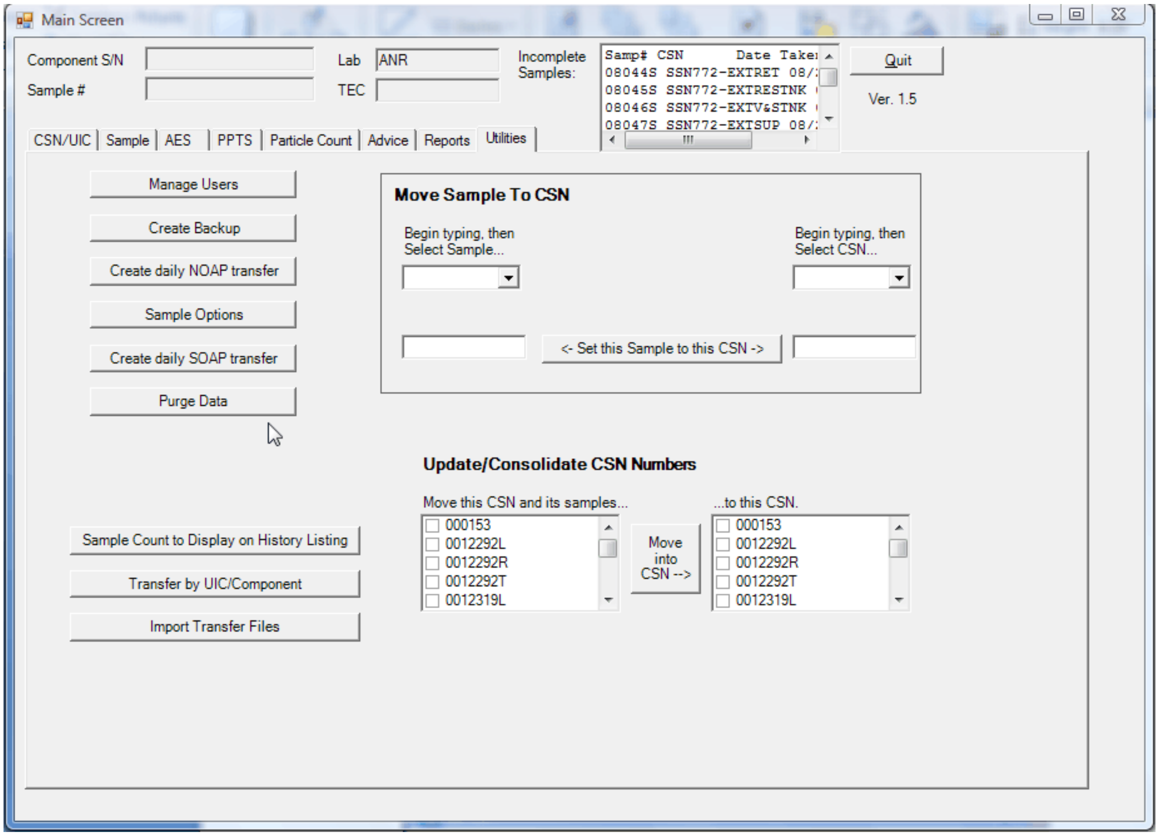


Figure 90. Utilities Tab

(1). Press sample options and the following screen will appear (Figure 91).

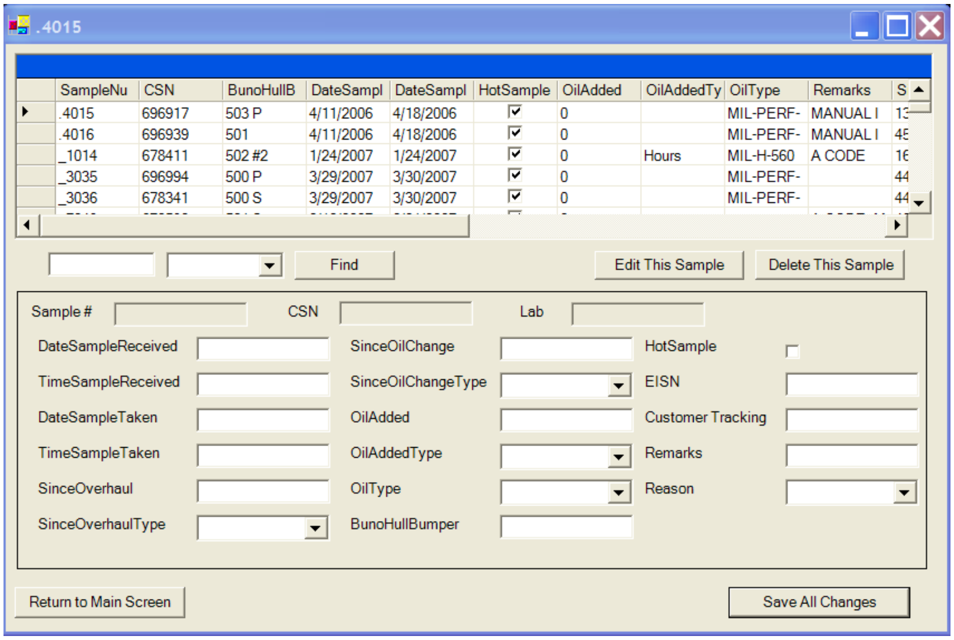


Figure 91. Sample Options

(2). Enter a sample number or select a CSN using the pull down then press find to retrieve the sample you need to change (Figure 92).

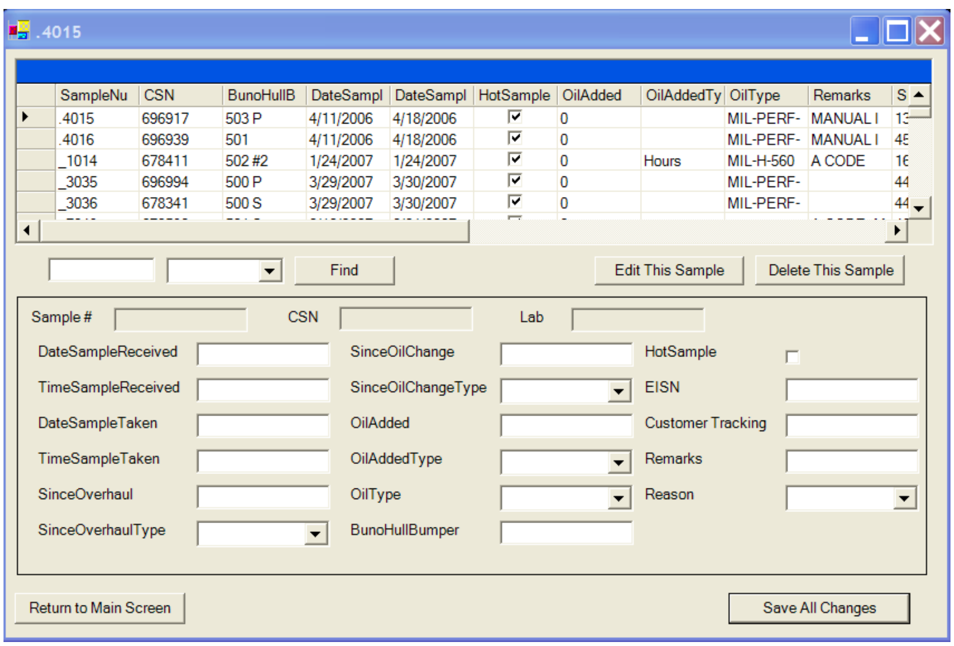


Figure 92. Sample Options

(3). Highlight the sample and press edit this sample and the following screen will appear (Figure 93).

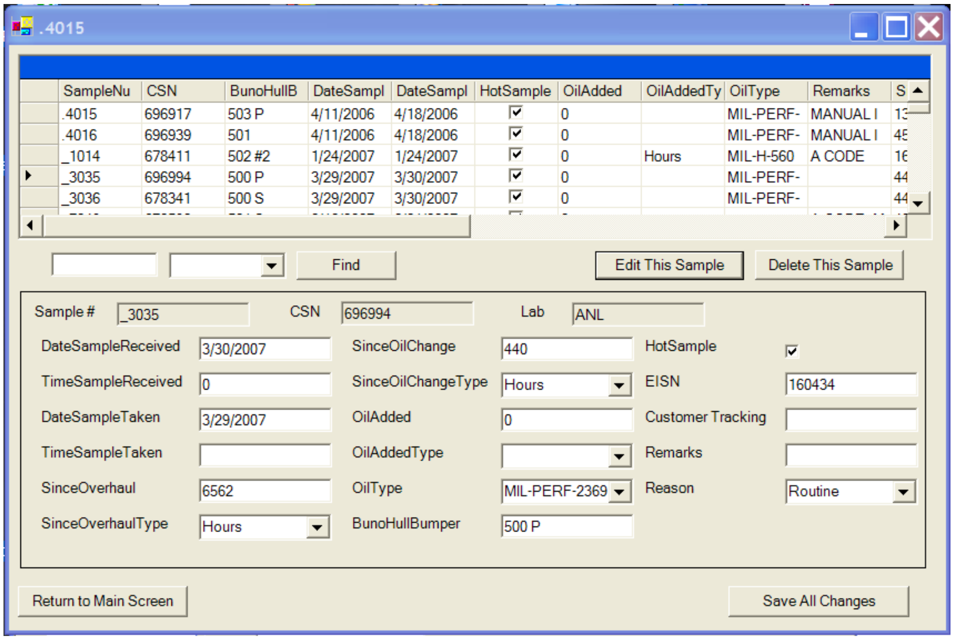


Figure 93. Sample Options

(4). Make the needed changes to the bottom half and press save all changes. The following screen will appear (Figure 94).

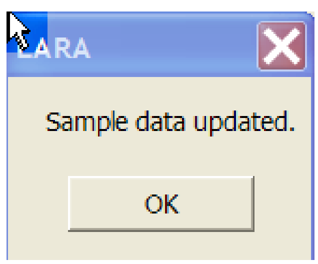


Figure 94. Confirmation

(5). Press OK.
(6). To delete a sample highlight the sample (Figure 95).

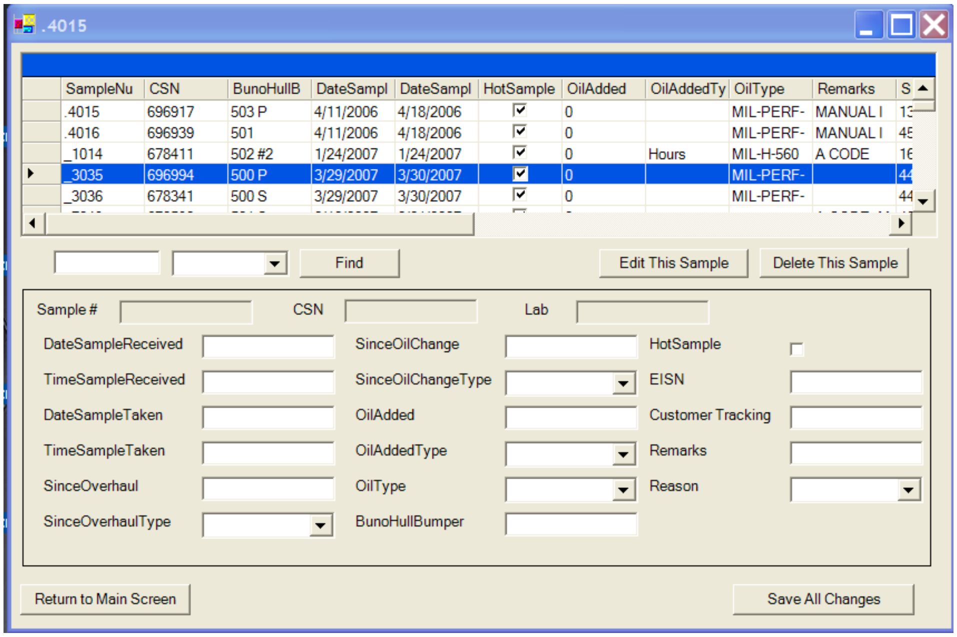


Figure 95. Sample Options

(7). Press delete this sample.

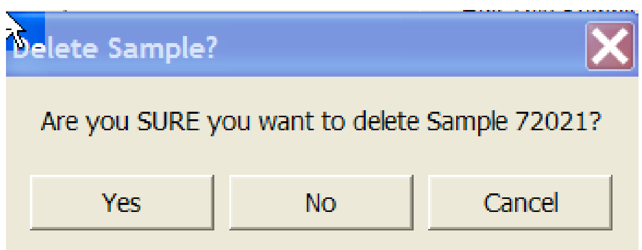


Figure 96. Confirmation

(8). Press Yes (Figure 96).

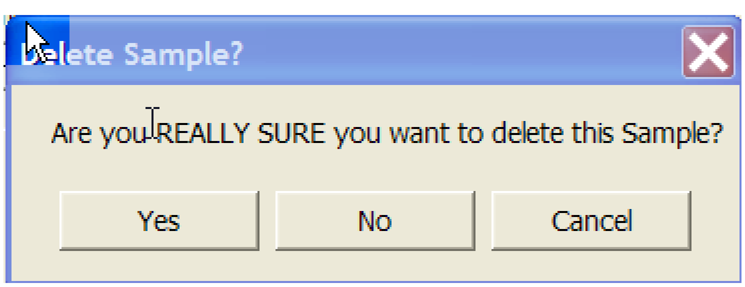


Figure 97. Confirmation

(9). Press Yes (Figure 97).

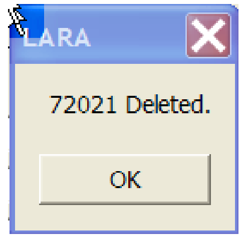


Figure 98. Notification

(10). Press OK (Figure 98).

e. Sample count to display on history listing. From the main sample screen press the Utilities tab and the following screen will appear (Figure 99). Sample count to display on history listing determines how many samples will appear on the history listing report.

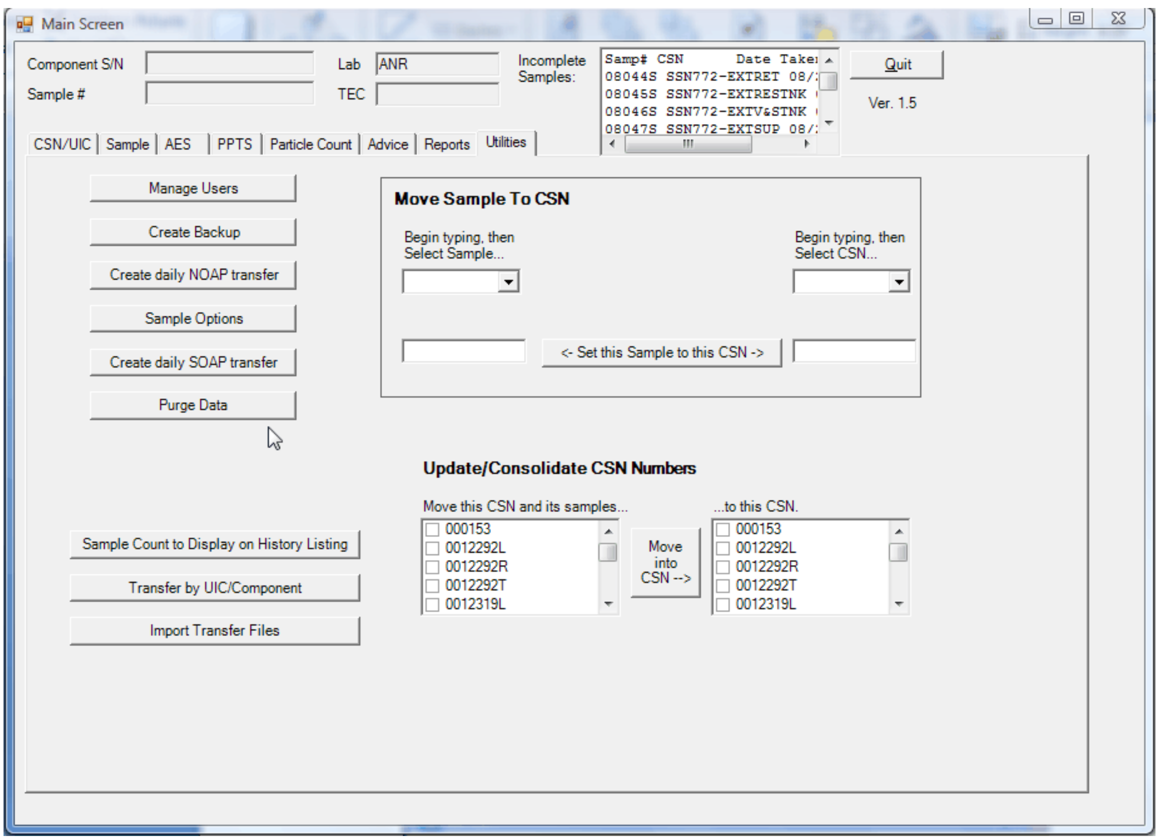


Figure 99. Utilities

(1). Press sample count to display on history listing (Figure 100).

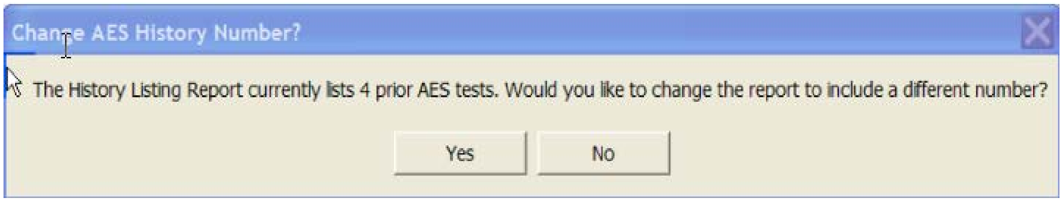


Figure 100. AES History

(2). Press yes.

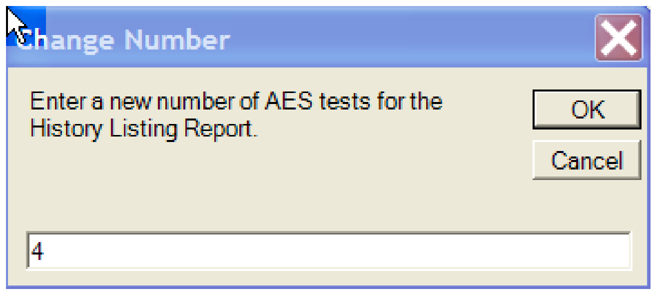


Figure 101. Change Number

(3). Enter the number of samples to appear on the history listing report. Press OK (Figure 102).

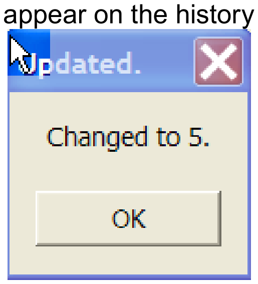


Figure 102. Notification

(4). Press OK.

f. Move sample to CSN. From the main sample screen press the Utilities tab and the following screen will appear (Figure 103). Move sample to CSN takes a sample entered under the wrong CSN and moves it to the correct CSN. If the TEC's are different the sample needs to be deleted then reentered.

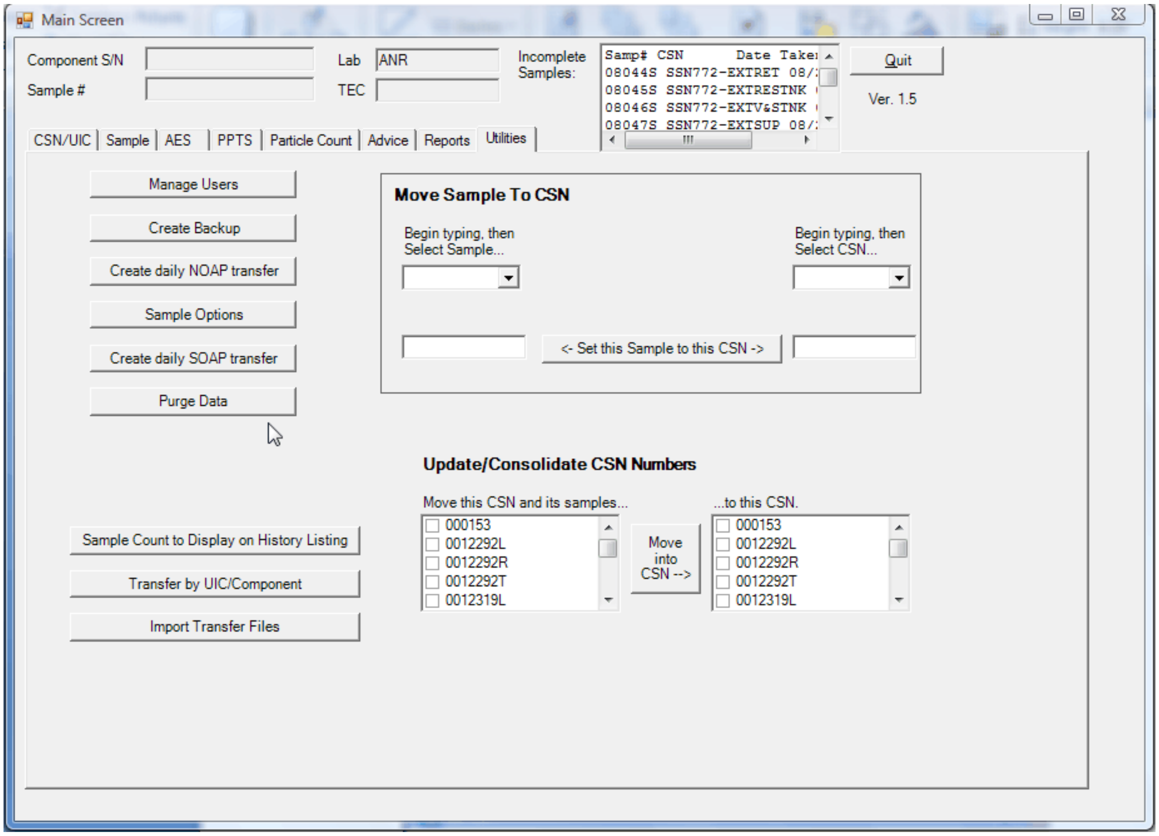


Figure 103. Utilities Tab

(1). Use the pull down on the left to select the sample number to be moved. Use the pull down to right to select the CSN to receive the sample.

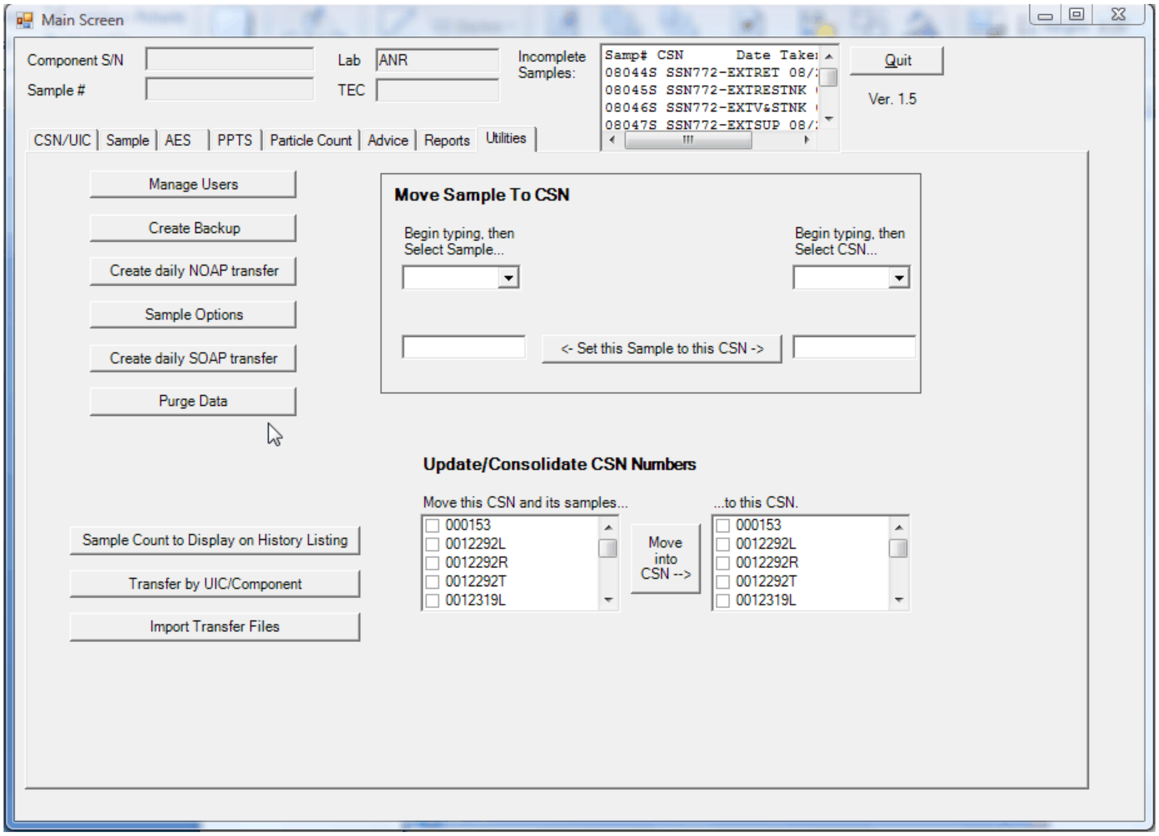


Figure 104. Utilities Tab

(2). Press set the sample to this CSN (Figure 104).

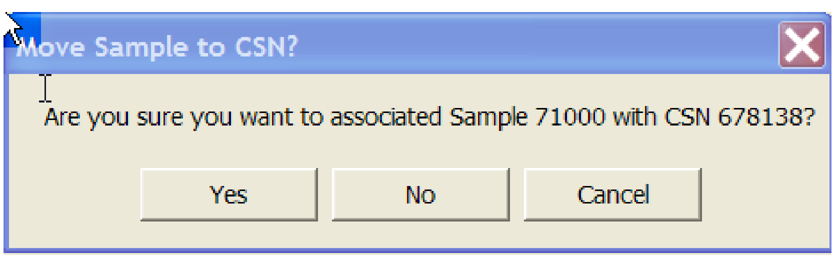


Figure 105. Move Sample to CSN

(3). Press Yes (Figure 105).

(4). If the two CSNs have different TECs this message will appear. The sample can not be moved to that component. You must delete the sample and redo it.

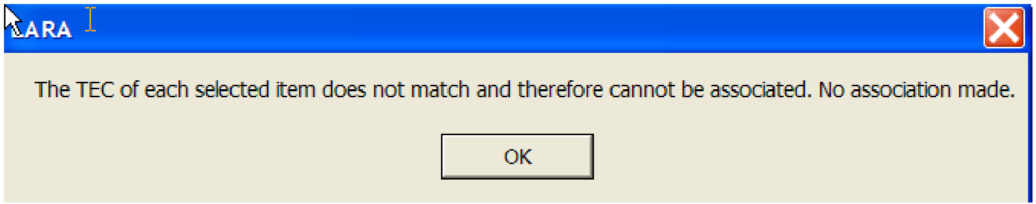


Figure 106. Notification

(5). Press OK (Figure 106).

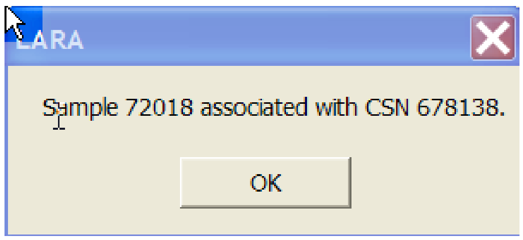


Figure 107. Confirmation

(6). Press OK (Figure 107).

g. Update/consolidate CSN numbers. From the main sample screen press the Utilities tab and the following screen will appear (Figure 108). Update/consolidate CSN numbers takes all the samples entered under the wrong CSN and moves it to the correct CSN. Update/consolidate CSN numbers takes all of the samples associated with a CSN and moves them to another existing CSN. An example of why this would be used is a transfer disk brought CSN A232521653 into your system. You have that CSN but under the correct CSN of A232-52-1653. Update/consolidate CSN numbers would merge the A232521653 samples under A232-52-1653 with the correct CSN. If the TEC's are different the TEC needs to be changed to the accepting TEC.

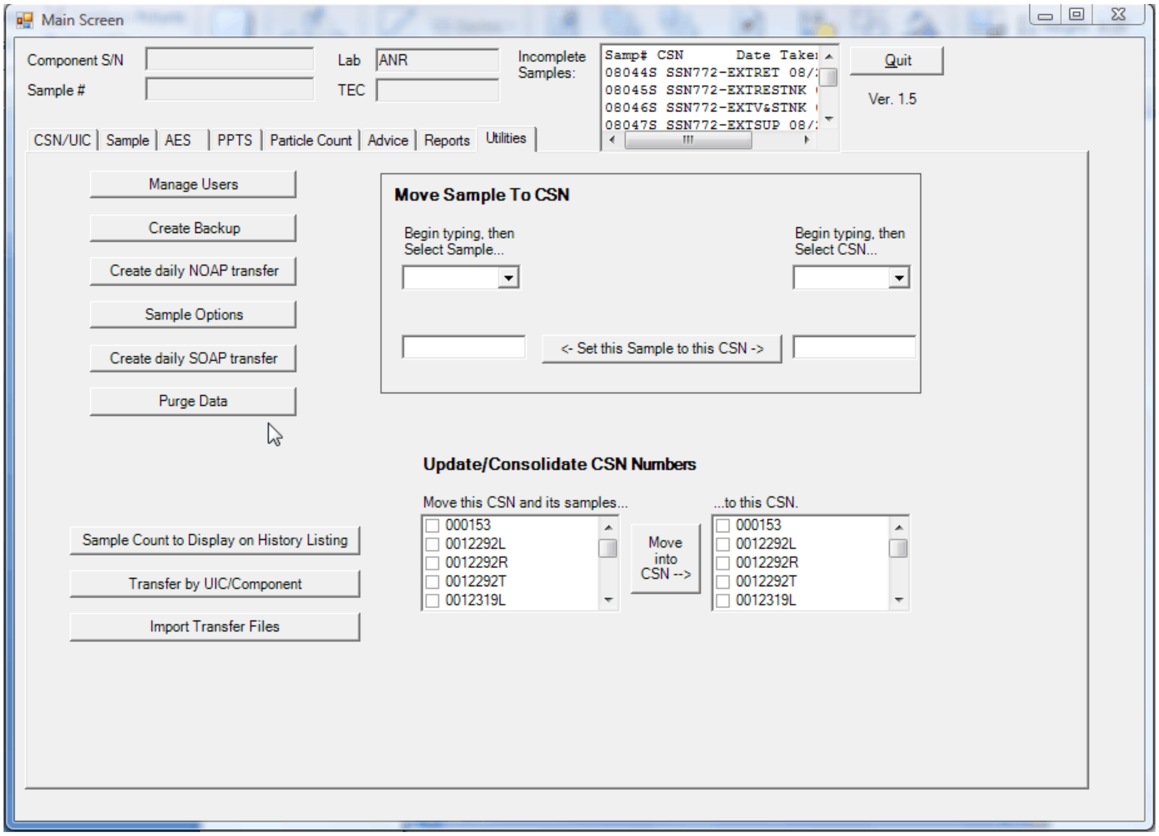


Figure 108. Utilities Tab

(1). Select the CSN on the right (the wrong one) and the one on the left (the correct one) and press move into CSN (Figure 109).

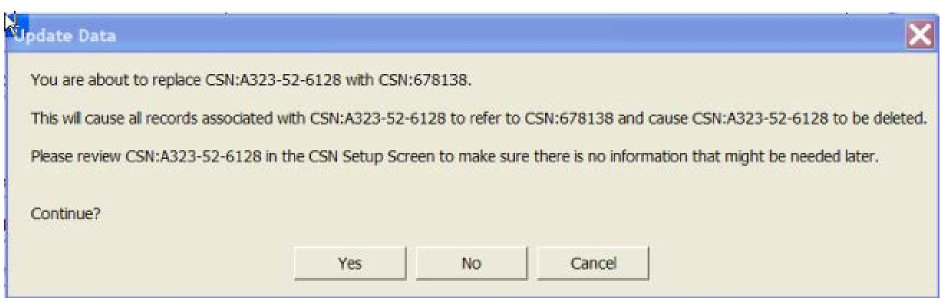


Figure 109. Update Data

(2). Press Yes.

Figure 110. Confirmation

(3). Press OK (Figure 110).

h. Problems with LARA database. When there are problems with your LARA database the lab operator needs to immediately contact the NOAP Office via phone and/or email (noap@navy.mil). The NOAP Office may ask that your Backup File be posted to SharePoint.

Procedures for creating a Backup File can be found in Volume II WP 003 04.

8. DEFINITIONS

5-10 microns – Displayed on the Particle count screen and History Listing report. Numeric field entered from data generated from the particle counter machine.
10-25 microns – Displayed on the Particle count screen and History Listing report. Numeric field entered from data generated from the particle counter machine.
25-50 microns – Displayed on the Particle count screen and History Listing report. Numeric field entered from data generated from the particle counter machine.
50-100 microns – Displayed on the Particle count screen and History Listing report. Numeric field entered from data generated from the particle counter machine.
(>) 100 microns – Displayed on the Particle count screen and History Listing report. Numeric field entered from data generated from the particle counter machine.
Abnormal Range – Displayed on the History Listing report and PPM range report. Numeric field from the JOAP manual corresponding to the range of numbers unacceptable for a specific TEC. Used to determine if a sample failed.
Abnormal Trend – Displayed on the History Listing report and PPM range report. Numeric field from the JOAP manual corresponding to unacceptable trend for a specific TEC. Used to determine if a sample failed.
Address – Displayed on the UIC setup screen, Monthly Activity report, and Components Enrolled report. Address is the street or PO box of the unit.
Advice – Displayed on the main screen. Tab, when pressed allows findings and recommendations to be selected and by pressing history listing the record is saved and completed.
AES - Displayed on the main screen. Tab, when pressed allows spectrometer data to be entered or transferred into the sample.
Automatic – Displayed on the AES screen. When pressed allows spectrometer data to be transferred into the sample.
Average Days in Transit – Displayed on the Monthly Activity report.
BunoHullBumper - Displayed on the CSN setup screen. Bunohullbumper is the buno number, hull number or bumper number depending on if the component comes from a plane, ship or truck. Entered from DD2026.
Buno/Hull/Bumper - Displayed on the sample screen. Buno/hull/bumper is the buno number, hull number or bumper number depending on if the component comes from a plane, ship or truck.
City - Displayed on the UIC setup screen. City is the city of the unit.
Class – Displayed on the Particle count screen and History Listing report. Numeric field entered from data generated from the particle counter machine.
Command - Displayed on the UIC setup screen and History listing report. Usually filled in by commanding officer of the unit.
Command Type - Displayed on the UIC setup screen. Used for a sort to cause a page break. Sort is service, Command type, UIC, DET order.

CompMod - Displayed on the TEC report. CompMod is the component model for the component that corresponds to the TEC and end item model number.

Comp Model - Displayed on the History listing report, Monthly Activity report, Components Enrolled report, and Equipment Sample Log. Comp Model is the component model for the component that corresponds to the TEC and end item model number.

Component S/N - Displayed on the History listing report and main screen. Components S/N is the component serial number for the component.

Components Delinquent - Displayed on the Components Enrolled report. Displays the number of samples past due.

Components Enrolled - Displayed on the Components Enrolled report. Displays the number of samples in the JOAP program.

Crackle – Displayed on PPTS screen, Advice screen, and History Listing report. Displays the results of the crackle test. Pass/Fail

CSN - Displayed on the Components Enrolled report, Monthly Activity report, Unreported report, and Equipment Sample Log, Utilities screen, sample setup screen, CSN setup screen and transfer setup screen. CSN is the component serial number for the component. Entered from DD2026.

CSN/UIC - Displayed on the main screen. Tab, when pressed allows UIC and CSN maintenance to be performed.

Customer Tracking – Displayed on the sample screen. The sample number found on the DD2026.

Date Analyzed – Displayed on the sample screen. The date the sample was analyzed. Entered from DD2026.

Date Modified – Displayed on the select a user screen. The date the user data was modified.

Date Received - Displayed on the sample screen. The date the sample was received in the lab. Entered from DD2026.

Dates Between – Displayed on NOAP Export and Reports screen. A date range to narrow down the results of a request for data.

DateSampleAnalyzed - Displayed on the Monthly Activity report, Equipment Sample Log and History Listing report. Date the sample was analyzed by the lab.

DateSampleReceived - Displayed on the Equipment Sample Log and History Listing report. Date the sample was received by the lab.

DateSampleReported - Displayed on the Unreported Sample report and Sample Setup screen. Date the sample was reported by the lab.

DateSampleTaken - Displayed on the Components Enrolled report and Sample Setup screen. Date the sample taken.

Date Taken - Displayed on the History Listing report and Sample screen. Date the sample taken.

Days Trans - Displayed on the Monthly Activity report. Displays the number of days between the date the sample was taken and when the sample was analyzed.

DD2026 – Form filled out by the customer and delivered with the oil sample with data specific to a component.

DET - Displayed on the UIC setup screen, History listing report, Monthly Activity report, and Components Enrolled report. Used for a sort to cause a page break. Sort is service, Command type, UIC, DET order.

E-Mail - Displayed on the UIC setup screen. Filled in by e-mail address of the POC.

EIMOD - Displayed on the Components Enrolled report, and TEC report. EIMOD is the model number for the end item the component is attached to that corresponds to the TEC and component model.

EISN - Displayed on the Components Enrolled report, Monthly Activity report, Equipment Sample Log, and sample screen, and CSN setup screen. EISN is the serial number for the component end item the component is attached to. Entered from DD2026.

EnditemModel - Displayed on the History Listing report. EndItemModel is the model number for the end item the component is attached to that corresponds to the TEC and component model.

EndItemS/N - Displayed on the History Listing report. EndItemS/N is the serial number for the component end item the component is attached to. Entered from DD2026.

FAX - Displayed on the UIC setup screen. FAX is the fax number of the unit.
Findings/Recommendations - Displayed on the History Listing report, Components Enrolled report, Monthly Activity report, and Advice screen. Chosen from a list tells the status of the oil sampled.
Flash Point - Displayed on PPTS screen, Advice screen, and History Listing report. Displays the results of the flash point test.
Fuel Dil % - Displayed on PPTS screen, Advice screen, and History Listing report. Displays the results of the fuel test. Percent of fuel in the oil.
High Range - Displayed on the History Listing report and PPM range report. Numeric field from the JOAP manual corresponding to the range of numbers unacceptable for a specific TEC. Used to determine if a sample failed.
Hot Sample - Displayed on the sample screen and sample setup screen. Hot Sample is pass/fail. Entered from DD2026.
Incomplete Samples - Displayed on the main screen. Lists all the samples that have not been completed by pressing the history listing button off advice screen.
JOAP Manual – NAVAIR 17-15-30 1 through 4. Used to determine pass or fail of samples.
Lab Code – Displayed on the Manage users screen. Code given to a lab.
LARA - Lubricants Analysis and Research Application
Manual - Displayed on the AES screen. When pressed allows spectrometer data to be typed into the sample.
Marginal Range - Displayed on the History Listing report and PPM range report. Numeric field from the JOAP manual corresponding to the range of numbers unacceptable for a specific TEC. Used to determine if a sample failed.
NAPOL – NAPOL Internet, NAVAIR’s version of a secure Internet. It is required to have a login to access.
Next Due - Displayed on the Components Enrolled report. Date or hour when next sample is due.
NMCI – Navy Marine Corp Internet
Normal Range - Displayed on the History Listing report and PPM range report. Numeric field from the JOAP manual corresponding to the range of numbers unacceptable for a specific TEC. Used to determine if a sample failed.
Number of Samples - Displayed on the Monthly Activity report. Reports the number of samples done for a specific UIC.
Oil Added - Displayed on the sample screen, History Listing report and sample setup screen. Entered from DD2026.
Oil Added Type - Displayed on the sample setup screen. Oil added type is either hours, miles, ect. Entered from DD2026.
Oil Type - Displayed on the sample screen and sample setup screen. Oil type is the type of oil. Entered from DD2026.
Particle Count – Displayed on the main screen. Tab, when pressed allows particle count data to be added.
Password – Displayed on the login screen.
Phone - Displayed on the UIC setup screen. Phone is the phone number of the unit.
POC - Displayed on the UIC setup screen. POC is the Point of Contact of the unit.
PPTS – Displayed on the main screen. Tab, when pressed allows physical property tests data to be added.
Reason - Displayed on the sample screen and History Listing report. Why the sample was taken. Entered from DD2026.
Remarks - Displayed on the sample setup screen, PPTS, and particle count screens. Any information that needs to be passed on to the customer.
Reports – Displayed on the main screen. Tab, when pressed allows access to reports.
Sample – Displayed on the main screen. Tab, when pressed allows a sample to be added.
Sample # – Displayed on the main screen. Sample # is created by the last number of the year, followed by the month number (October = O, November = N and December = D) then a sequential number. Example 73001 first sample for the month of March in the year 2007.
Sample Interval - Displayed on the TEC report and History Listing report. How long is acceptable between samples.

Sample No - Displayed on the sample screen, Unreported Samples report and sample setup screen. Sample no is created by the last number of the year, followed by the month number (October = O, November = N and December = D) then a sequential number. Example 73001 first sample for the month of March in the year 2007.

Sample Number - Displayed on the Components Enrolled report, Monthly Activity report, Equipment Sample Log, and History Listing report. Sample number is created by the last number of the year, followed by the month number (October = O, November = N and December = D) then a sequential number. Example 73001 first sample for the month of March in the year 2007.

Service

Since Oil Change - Displayed on the sample screen, Components Enrolled report, Monthly Activity report, and sample setup screen. Entered from DD2026.

Since Oil Change Type - Displayed on the sample setup screen. Entered from DD2026.

Since Overhaul - Displayed on the sample screen, Components Enrolled report, Monthly Activity report, and sample setup screen. Entered from DD2026.

Since Overhaul Type - Displayed on the sample setup screen. Entered from DD2026.

SOAP – Squadron Oil Access Program. Used to create DD2026 and keep track of sample results.

Standard - Displayed on the Particle Count screen. What standard was used to determine the class?

State - Displayed on the UIC setup screen. State is the state of the unit.

TAN - Displayed on the History Listing report, Advice screen and PPTS screen. Total Acid number for the sample.

TEC - Displayed on the History Listing report, UIC setup screen, CSN/UIC screen, CSN setup screen, PPM report and PPM report. Technical equipment code is created to connect specific equipment with their limits.

Trend - Displayed on the History Listing report and Advice screen. Trend is calculated by taking the last two samples and dividing the change in PPM for a specific element over the change in hours times ten.

UIC - Displayed on the History Listing report, Sample screen, Main screen, CSN/UIC screen, CSN setup screen, Components Enrolled report, Monthly Activity report, Equipment Sample Log, Unreported Sample Log, and Transfer Setup screen. UIC is the Unit of Identification. The first character distinguishes the service and 5 digits represent the command.

Unit Name - Displayed on the UIC setup screen, Components Enrolled report, and Monthly Activity report. Unit Name is the name of the unit.

Unit of VISC Measurement – Displayed on the Advice screen and the PPTS screen. Either CP or CS.

User Code – Displayed on the Manage Users screen. User Code is entered by the user creating the account.

User Comments – Displayed on the Manage Users screen. User Code is entered by the user creating the account.

User Level – Displayed on the Manage Users screen. The user levels are Application admin – programmer only, Lab user – access to all except utilities, Read only - access to reports only, Lab Administrator – all

User Name – Displayed on the Manage Users screen and Login screen. User Code is entered by the user creating the account and used in the login process.

Utilities – Displayed on the main screen. Tab, when pressed allows access to user accounts, transfer data, import data, combine samples, backup, purge, sample changes, and move samples.

VISC40 C - Displayed on the History Listing report, PPTS screen and Advice screen. VISC40 is the viscosity at around 40 degrees C.

VISC100 C - Displayed on the History Listing report, PPTS screen and Advice screen. VISC100 is the viscosity at around 100 degrees C.

Water - Displayed on the History Listing report, PPTS screen and Advice screen. Water is the amount of water in the oil.

ZIP - Displayed on the UIC setup screen. ZIP is the zip code of the unit.

Change 1 - 1 June 2015

NAVY OIL ANALYSIS PROGRAM - LARA TOOLBOX OPERATIONS GUIDE

Table of Contents

1. Introduction.

a. LARA Toolbox is a new program that works with any existing LARA installation to produce database backup files and better transfer files. LARA Toolbox will also facilitate auditing the list of TECs and Equipment Test limits. Currently LARA Toolbox will not run on NMCI.

b. At the time of publication, the current version of LARA Toolbox is 6.3. The instructions below are for LARA Toolbox Version 6.3. This work package will be updated when a new version of LARA Toolbox is released. For additional guidance and/or assistance contact noap@navy.mil.

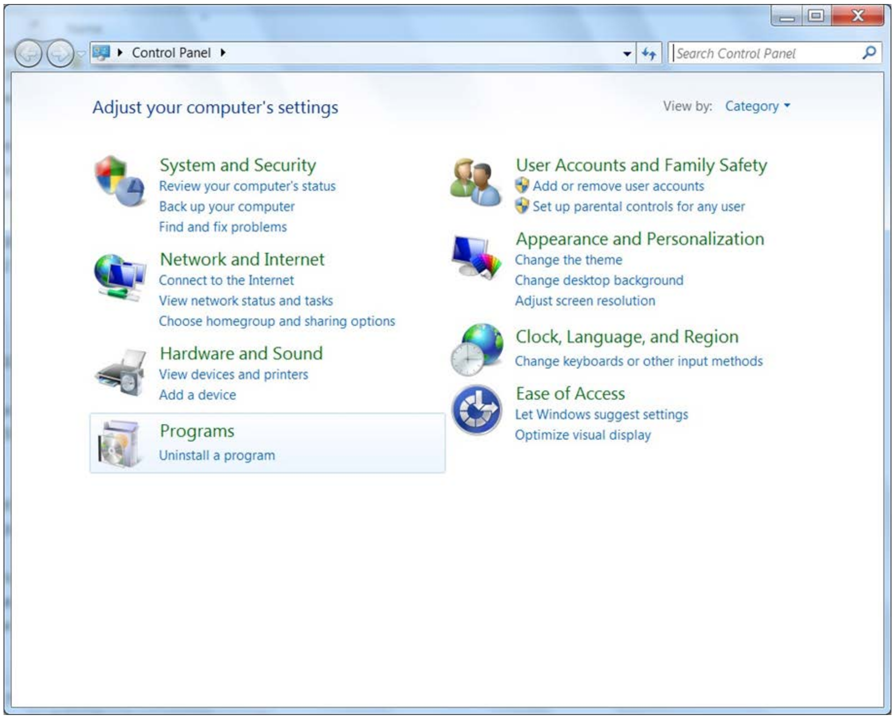
c. Contact the NOAP Office (noap@navy.mil) with any questions or concerns regarding LARA Toolbox.

2. Installation.

a. LARA Toolbox v6.3. The instructions below are for LARA Toolbox Version 6.3. If you are trying to install a different version of LARA Toolbox then contact the NOAP Office (noap@navy.mil) to see if these instructions are applicable.

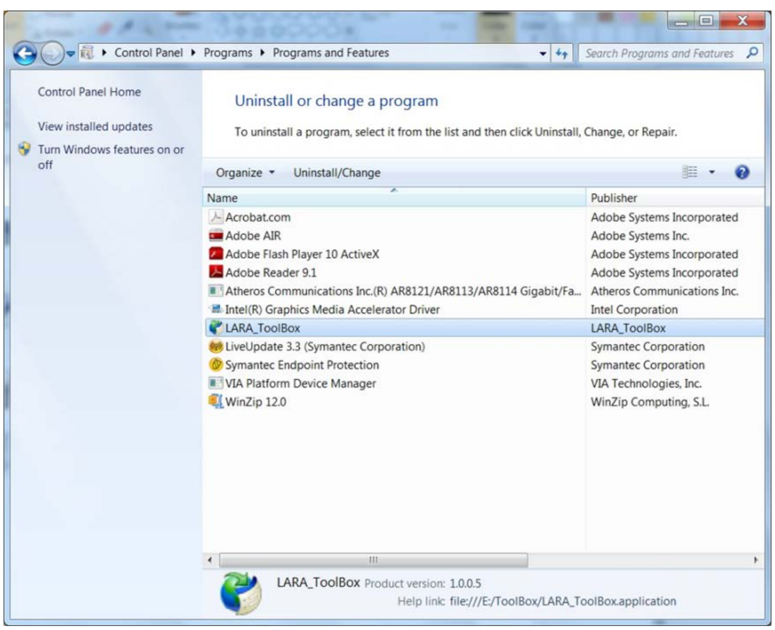
1. Click the Windows “START” button in the bottom left-corner of the screen and select “Control Panel” on the right side of the start menu.

2. Under the “Programs” option and the bottom-right of the screen, select “Uninstall a program”

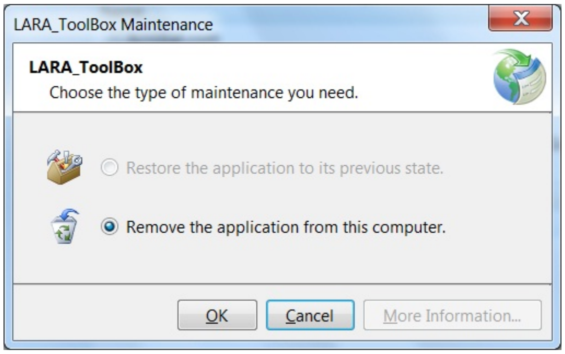


3. From the “Uninstall or change a program” screen, select the “LARA_ToolBox” option and click the “Uninstall/Change” button.

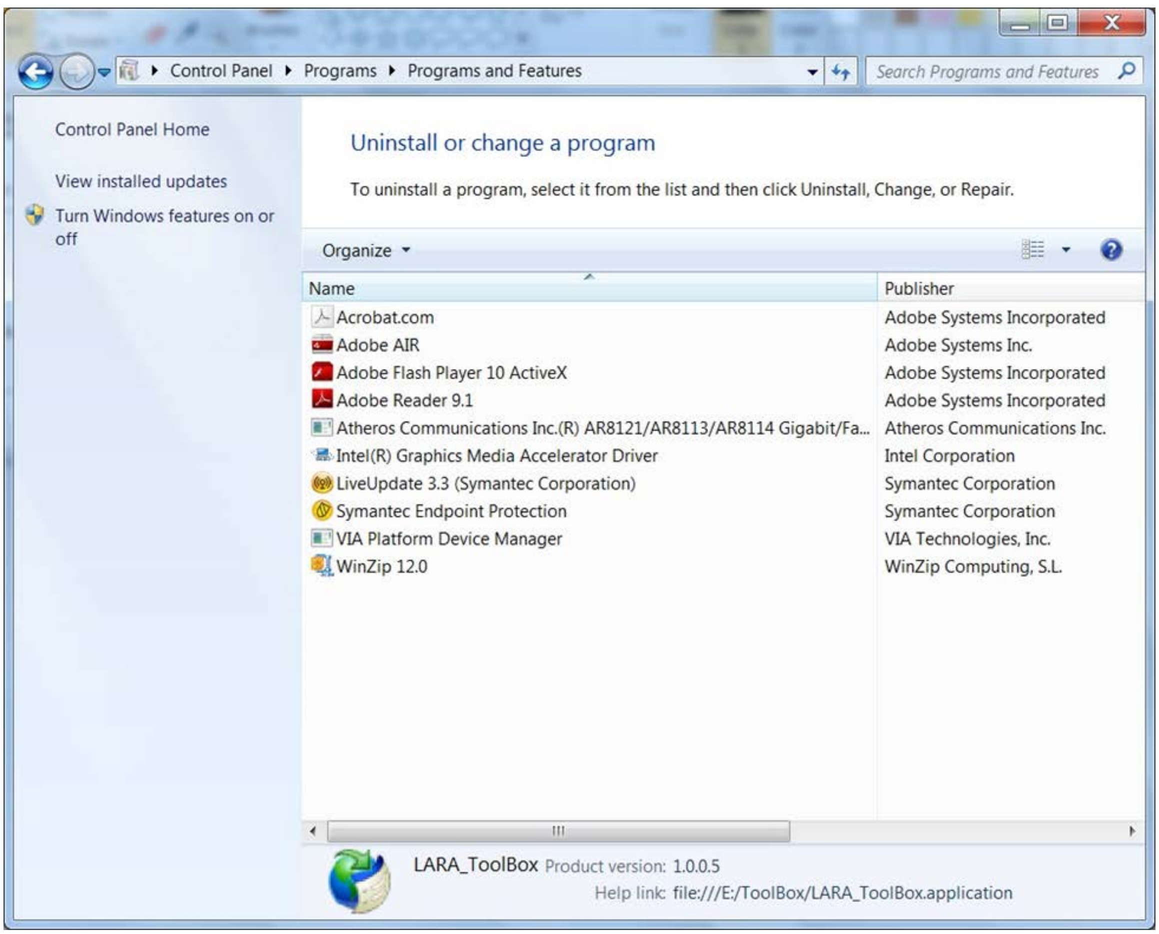
NOTE: If the LARA_ToolBox option is not seen in the list, close this screen and proceed to step 6



4. Make sure the “Remove the application from this computer” option is selected and click “OK”



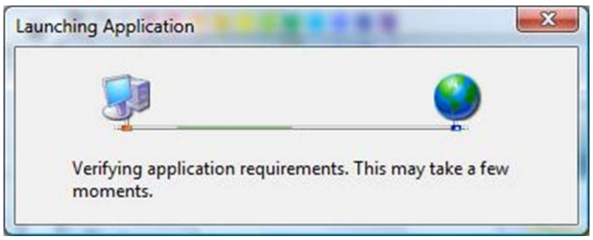
5. Double-check the list to make sure the “LARA_ToolBox” program in uninstalled. Close the window when confirmed.



6. Put the CD labeled “LARA TOOLBOX 6.3 INSTALLTION CD” into the CD Drive. The CD window will open. If the CD window does not open, double-click the CD drive in the My Computer window.

7. Double-click the “Setup” icon

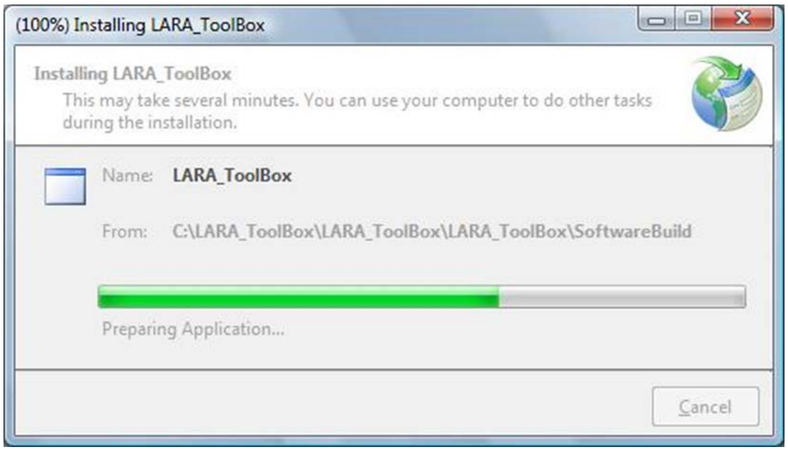
8. The Installation Application will begin to launch.



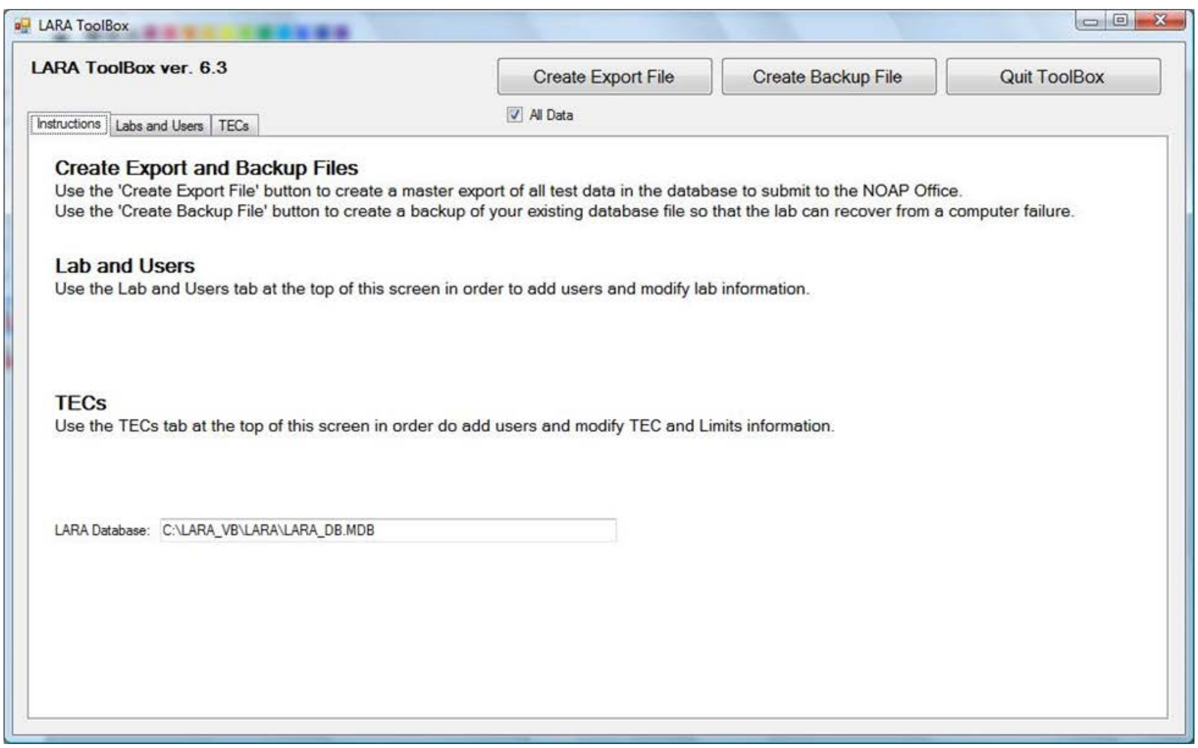
9. The Application Install – Security Warning window will display. Click the “Install” button.

10. The “Installing LARA_ToolBox” window will display. When the screen displays 100%, the installation is complete.

NOTE: If an installation error occurs, it is still possible that the installation was successful.



11. If successful, the LARA ToolBox 6.3 program will display.



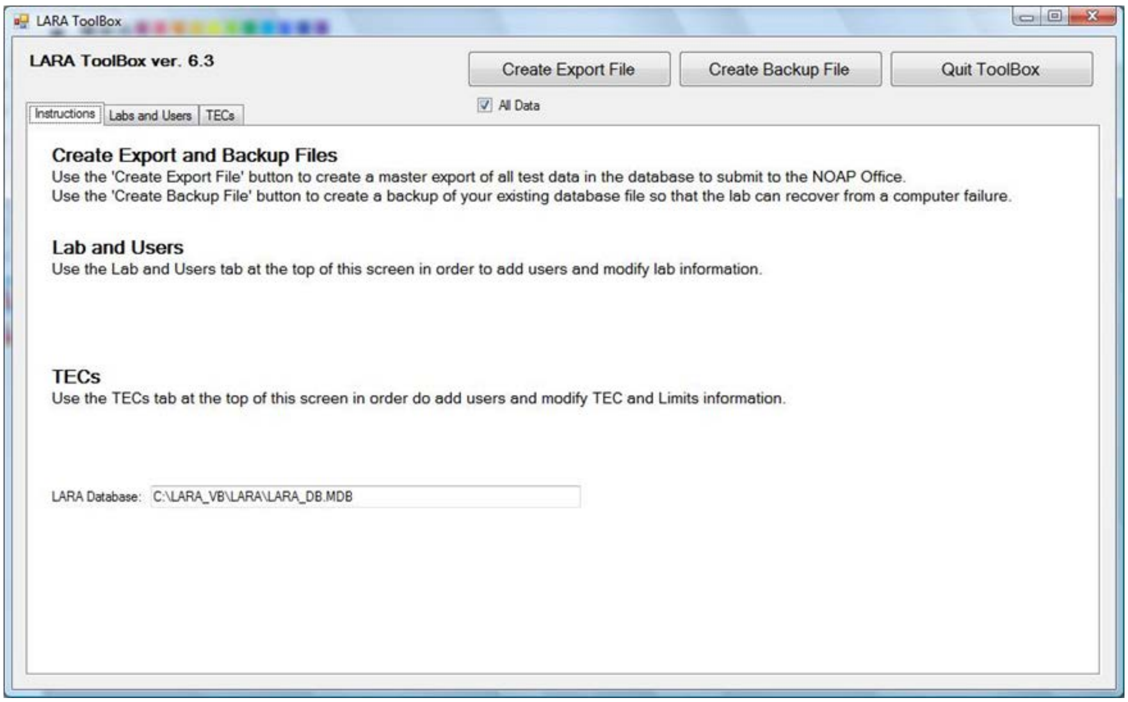
3. Using LARA Toolbox.

a. Launching LARA Toolbox.

1. Login to the LARA workstation using User Name: noap and Pasword: noap.

2. Double-click the LARA_ToolBox Icon on the Desktop. If you do not see it on the Desktop, access it by clicking the Start button in the bottom left corner of your screen and selecting Programs. LARA_ToolBox will be available under the Programs menu.

The LARA ToolBox ver. 6.3 Program will display.



b. Instructions Tab.

1. The instructions tab provides explanations about the current LARA Toolbox features. Procedures for each of the features are presented in the remainder of this work package.

2. Features included in LARA Toolbox v6.3:

Create an Export File

Create a Backup File

Update Lab Code and Information

Create/Modify a User

Modifying the limits associated with a TEC

4. Creating an Export File.

a. Create Export File Button

NOAP data is required to be uploaded to SharePoint regularly (Volume II WP 003 01 and NAMP 4790). NOAP Labs provide vital fleet and squadron data to DoD personnel, and also to NAVSEA and NAVAIR data analysts and managers who in turn offer recommendations to various programs across the Department of Defense.

On more than one occasion, NOAP data has saved the lives of DoD personnel, and avoided additional hardship, costs and workload to DoD personnel. NOAP Labs provide a tremendous service to many levels throughout the DoD, by accurately assessing equipment health, and reducing the risk of equipment failures.

The Export File is used by the NOAP Office to synchronize a lab's data with the Master NOAP Database. This needs to be done on a weekly basis in order to provide all of the engineering support teams timely access to current data which is vital to maintaining a high level of flight safety.

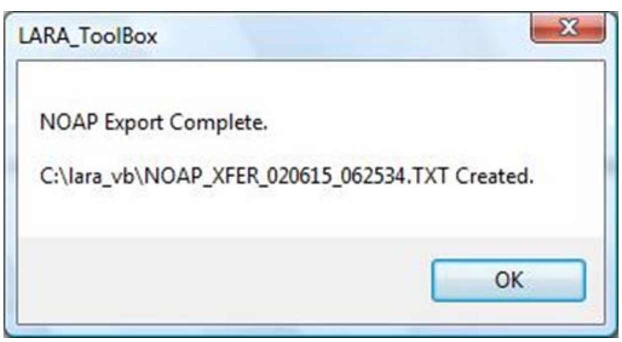
1. Click the "Create Export File" button. This Export File is required weekly from all NOAP labs (see Volume II WP 003 01).

NOTE: If this is the first time you are creating an Export file, make sure the All Data checkbox is checked under the Create Export File button.

If this has been done in the lab before, un-check the All Data button.

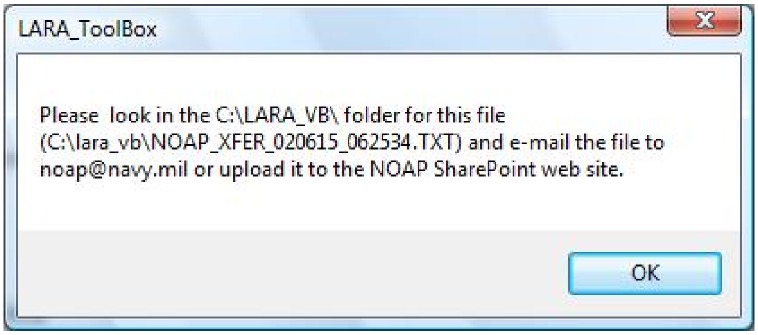
If you receive an error message while creating an Export File, send an email to noap@navy.mil stating an error message was received.

The NOAP Export Complete screen will display indicating the filename and location of the file.



NOTE: The Export File will have a .txt file extension.

Once you click "OK" the following screen will display with the instruction to upload the file to the NOAP SharePoint web site.



2. Use Windows Explorer to navigate to the C:\LARA_VB\ folder on the LARA computer and copy the Export file to a blank CD or an approved NMCI Portable Hard Drive.

3. Follow the instruction in the Volume II WP 003 05 (SharePoint Operations Guide) to upload the Export File to the applicable NOAP SharePoint site.

5. Creating a Backup File.

a. Create Backup File Button

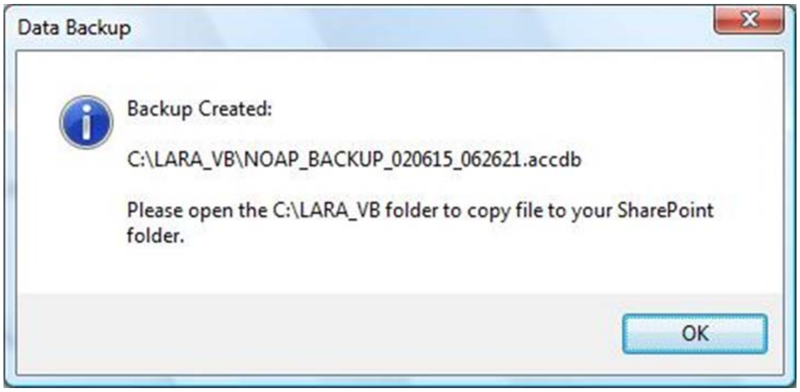
The Backup File is required in order to assist the NOAP Office in recovering a lab's LARA database in the event that a LARA workstation happens to fail. If a LARA workstation's hard drive crashes, the NOAP Office needs to get the lab back up and operational as quickly as possible. If the NOAP Office has access to a recent copy of your database, we can significantly reduce the amount of time required to get a lab back up and operational and minimize the amount of data that would be missing/lost.

NOAP labs are required to submit Backup Files to the applicable NOAP SharePoint site on a monthly basis however they are encouraged to do so a weekly basis if possible.

1. Click the "Create Backup File" button. This Backup File is required monthly from all NOAP labs (see Volume II WP 003 01).

NOTE: The Database Backup is required for all labs to ensure lab continuity if there is a computer failure or loss of historical data.

If you receive an error message while creating a Backup File then send an email to noap@navy.mil stating an error message was received.

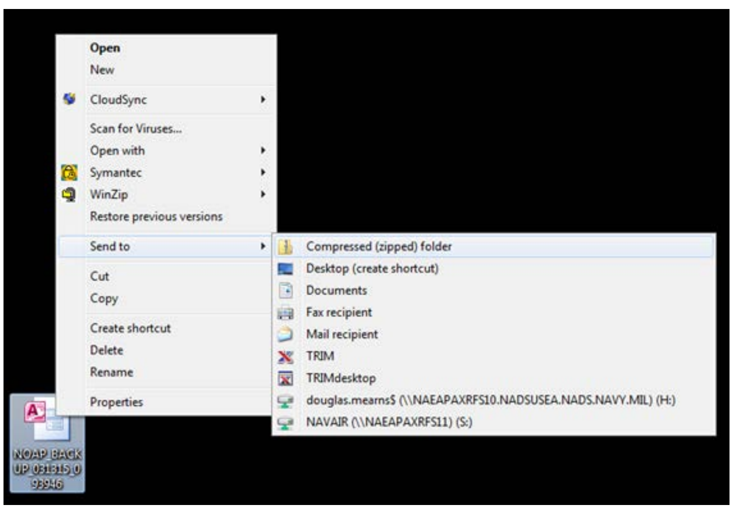


NOTE: The Backup File will have an .accdb file extension.

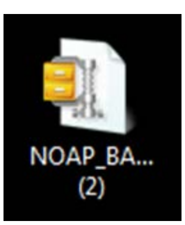
2. Copy the Backup File from the C:\LARA_VB folder to a blank CD or an approved NMCI Portable Hard Drive.

3. Save the Backup File to the desktop of an NMCI computer.

4. Right click on the Backup File and the following menu of options will appear.



5. Select “Send to” and then “Compressed (zipped) folder”. The zipped file should appear on your desktop.



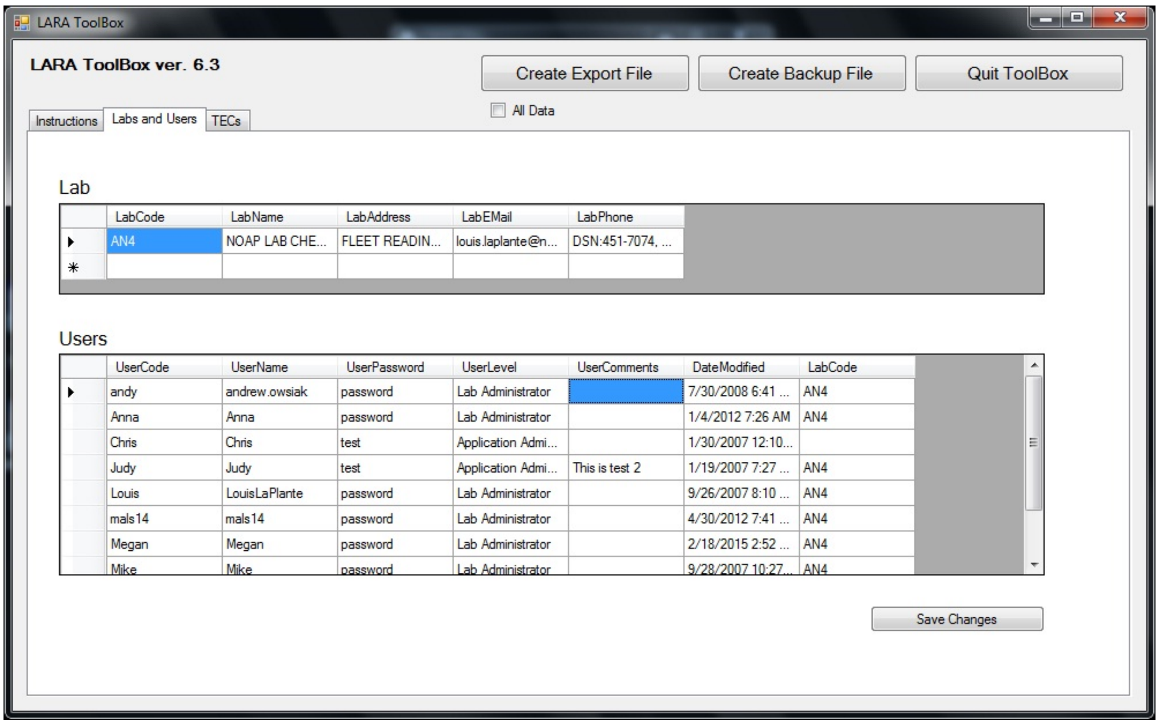
NOTE: The Compressed File will have a .zip file extension.

6. Follow the instruction in Volume II WP 003 05 (SharePoint Operations Guide) to upload the Backup File to applicable NOAP SharePoint site.

6. Updating Lab Code and Lab Information.

   a. Labs and Users Tab.

      1. In the Lab section, enter the updated information into the applicable box (Lab Code, Lab Name, Lab Address, Lab Email, Lab Phone)

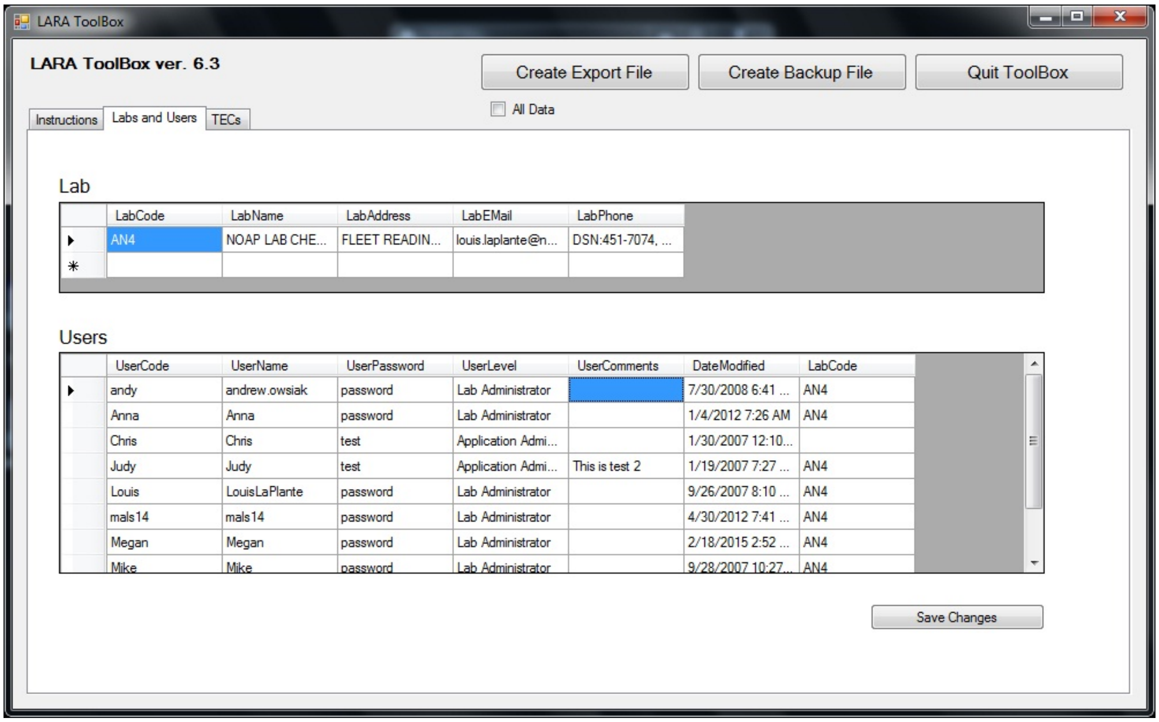


      2. Click the Save Changes button

7. Creating/Modifying LARA User Accounts.

   a. Labs and Users Tab.

      1. In the Users section, enter the updated information into the applicable box (User Code, User Name, User Password, User Level, User Comments, Date Modified, Lab Code)



      2. Click the Save Changes button

8. Auditing TEC limits.

   a. TECs Tab

      1. Lab operators are not authorized to use this feature without first receiving approval from the NOAP Office. Contact the NOAP Office at noap@navy.mil for further guidance and instruction.

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Change 1 - 1 June 2015

NAVY OIL ANALYSIS PROGRAM - SHAREPOINT OPERATIONS GUIDE

Table of Contents

1. Introduction.

   a. The Navy Oil Analysis Program SharePoint websites were designed to encourage collaboration and information sharing throughout the Navy Oil Analysis Program and to serve as the location for important documentation and the central NOAP database.

   NOTE: SharePoint is a NMCI web based information management tool. Access to information on this site can be affected by availability, transfer speeds, location, and file sizes. Please be advised when accessing information on SharePoint that there may be times of significant delay. Therefore individuals are reminded to give sufficient time when uploading and/or downloading files, especially files >100MB.

2. User Registration.

   a. Laboratory Operators must register with the Navy Oil Analysis Program Team Lead for access to the NOAP SharePoint sites.

   To start the registration process, send an email to NOAP@navy.mil stating the names of the individuals needing SharePoint access and the NOAP Lab or activity that will be supported.

   The Navy Oil Analysis Program Team Lead will provide the SharePoint registration form that must be completed in order to complete the registration process.

   Individuals already registered for SharePoint access shall report changes in duty station (including reassignment to a different NOAP Laboratory), email address or phone number(s) by sending an email to NOAP@navy.mil.

   b. SharePoint User Request-blank-NFLCFT-NOAP Excel File

   This section provides an individual assistance with completing the SharePoint registration form.

   1. Column A = Last Name

      Enter the individual’s last name.

   2. Column B = First Name

      Enter the individual’s first name.

   3. Column C = MI

Enter the individual’s middle initial. If the individual does not have a middle initial then enter NMI.

4. Column D = EDIPI (10 digit number when CAC card is pulled)

   The DoD ID (EDIPI) number is essential. This number should appear on the back of the individual’s CAC card or will appear on the computer screen when the CAC card is pulled out of the computer without logging off or shutting down.

5. Column E = Email Address

   Enter the individual’s email address. If a lab operator has multiple email addresses then enter the address is most accessible for lab operator.

6. Column F = Telephone Number

   Enter a telephone number that can be used to reach the individual.

7. Column G = Full Work Address (Incl. Building and Room # if applicable)

   Enter the full work address for the individual.

8. Column H = Base Supported

   Enter the duty station or ship for which the individual is assigned.

9. Column I = PMA

   Do not enter any information in this column. This column should already be populated with NFLCFT.

10. Column J = Job Title

    If the individual works in a NOAP lab then enter the individual’s Lab ID (See Figure 1 in Volume II WP 003 02 for a list of Lab IDs).

    If the individual does not work in a NOAP lab then enter the duty station, ship, or program office for which the individual is assigned.

11. Column K = NFLCFT Relationship: NOAP Lab Operator / NOAP Data Customer / Tri-Service Alt Fuels

    Enter NOAP Lab Operator if the individual works in a NOAP Lab.

    Enter NOAP Data Customer if the individual is part of an engineering support team and/or does not work in a NOAP Lab.

12. Column L = Competency Code

    Do not enter any information in this column. This column should already be populated with AIR-4.4.1.

13. Column M = CIV, MIL, or Contractor Name

    Enter CIV if the individual is a member of the civilian federal workforce.

    Enter MIL if the individual is a member of the military.

    Enter the company’s name if the individual is a contractor.

14. Column N = PM or IPT Sponsor

    Do not enter any information in this column. This column should already be populated with Douglas Mearns.

15. Column O = NMCI Seat – Yes/No

    Enter Yes if the individual has an NMCI/DoD-network computer. Otherwise, enter No.

16. Column P = Foreign National Y or N

    Enter Y if the individual is a foreign national. Otherwise, enter N.

17. Column Q = If yes, please list your country code

    If the individual is a foreign national then enter the country.

18. Column R = Permissions Group (selected by NF&LCFT Admin)

    Do not enter any information in this column. This column will be populated by the NOAP Office.

19. Column S = NOAP Lists (selected by NF&LCFT Admin)

    Do not enter any information in this column. This column will be populated by the NOAP Office.

2. <u>NOAP SharePoint Sites</u>.

   a. The NOAP SharePoint sites are only accessible using an NMCI computer.

   b. NOAP Laboratory Operators' Workspace

   The NOAP Laboratory Operators' WorkSpace website is the primary repository for NOAP data and information and is used by both laboratory operators and customers.

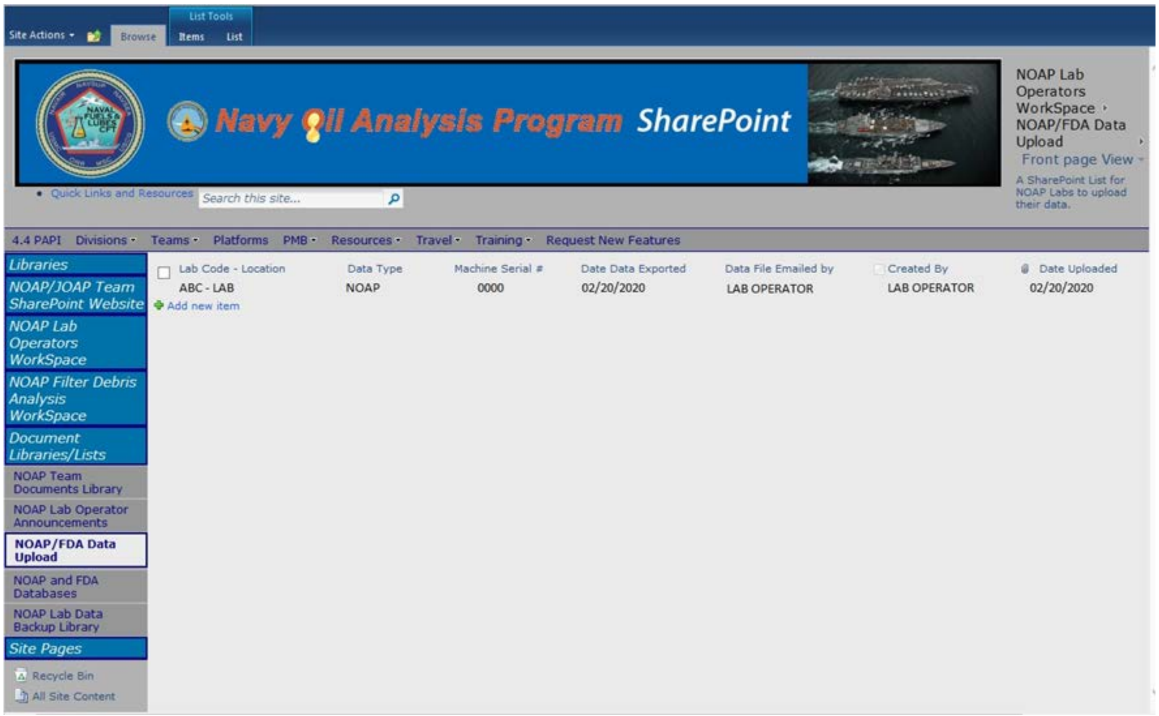
   The URL for the NOAP Laboratory Operators' WorkSpace website:

   https://myteam.navair.navy.mil/air/44/nflcft/NOAP/NOAPLABS/SitePages/Home.aspx

c. NOAP and FDA Data Upload Site

The NOAP and FDA Data Uploads website is the primary repository for LARA Toolbox Export Files (NOAP data) and FILTER Transfer Files (FDA data).

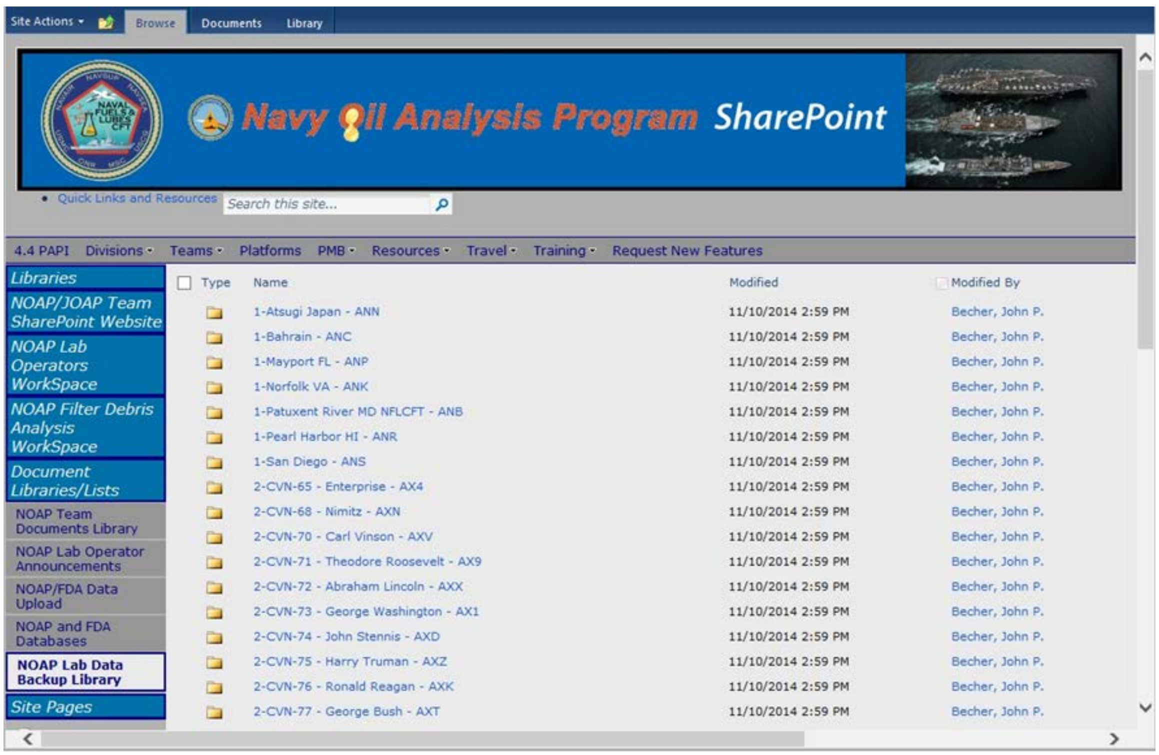
Click the "NOAP/FDA Data Upload" link under the "Document Library/Lists" category at the right of the screen



d. NOAP Lab Data Backup Library Site

The NOAP Lab Data Backup Library website is the primary repository for LARA Toolbox Backup Files.

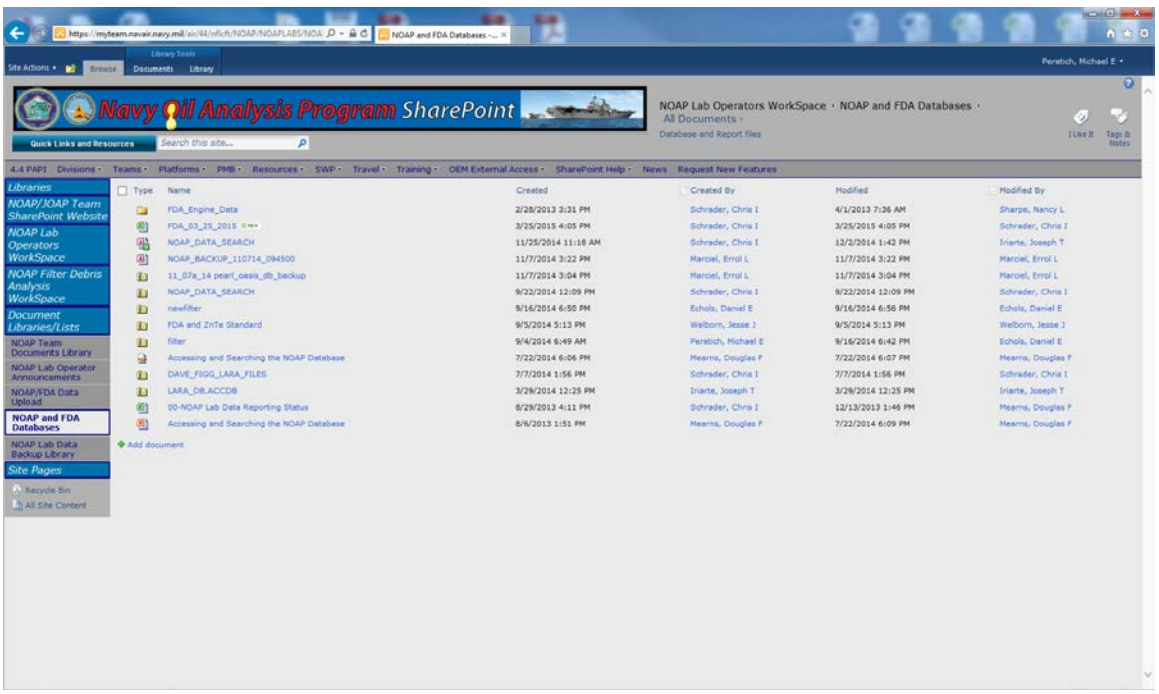
Click the “NOAP Lab Data Backup Library” link under the “Document Library/Lists” category at the right of the screen



e. NOAP and FDA Databases Site

The NOAP and FDA Databases website is the primary repository for the central NOAP database, Instructions for accessing the central NOAP database, J52 Rotrode Database, J52 FDA Database, and Historical J52 Engine Data.

Click the "NOAP and FDA Databases" link under the "Document Library/Lists" category at the right of the screen

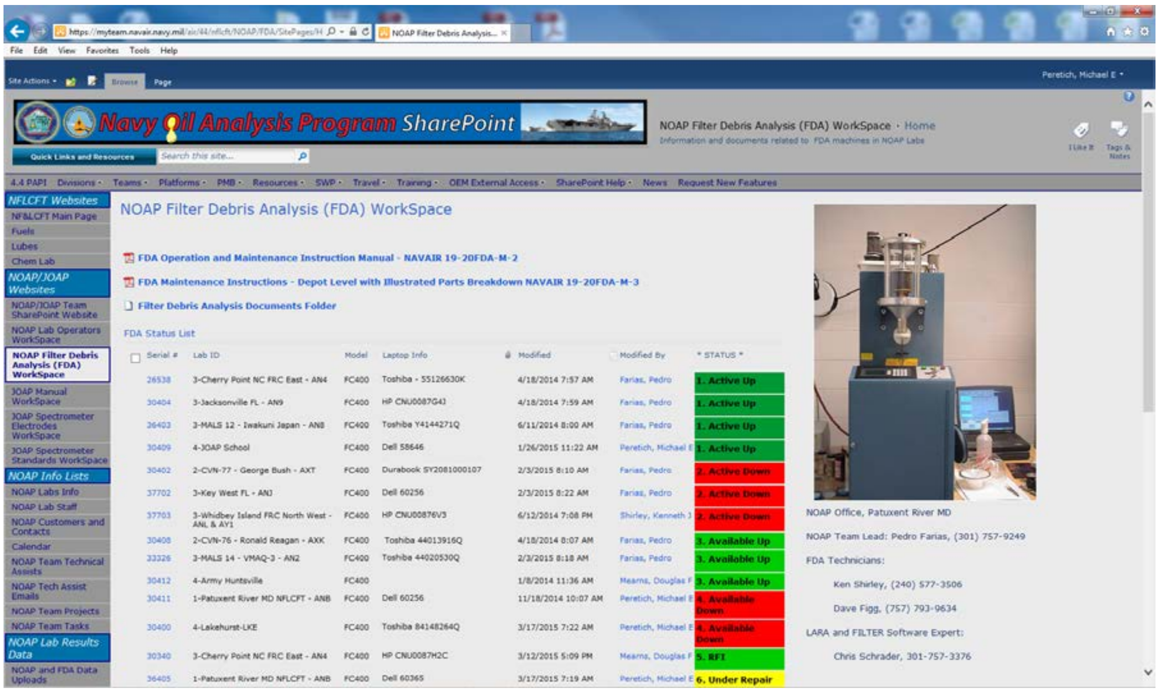


f. NOAP Filter Debris Analysis Workspace

The NOAP Filter Debris Analysis website is the primary repository for FDA related information.

The URL for the NOAP Filter Debris Analysis WorkSpace website:

https://myteam.navair.navy.mil/air/44/nflcft/NOAP/FDA/SitePages/Home.aspx



3. Uploading an Export File.

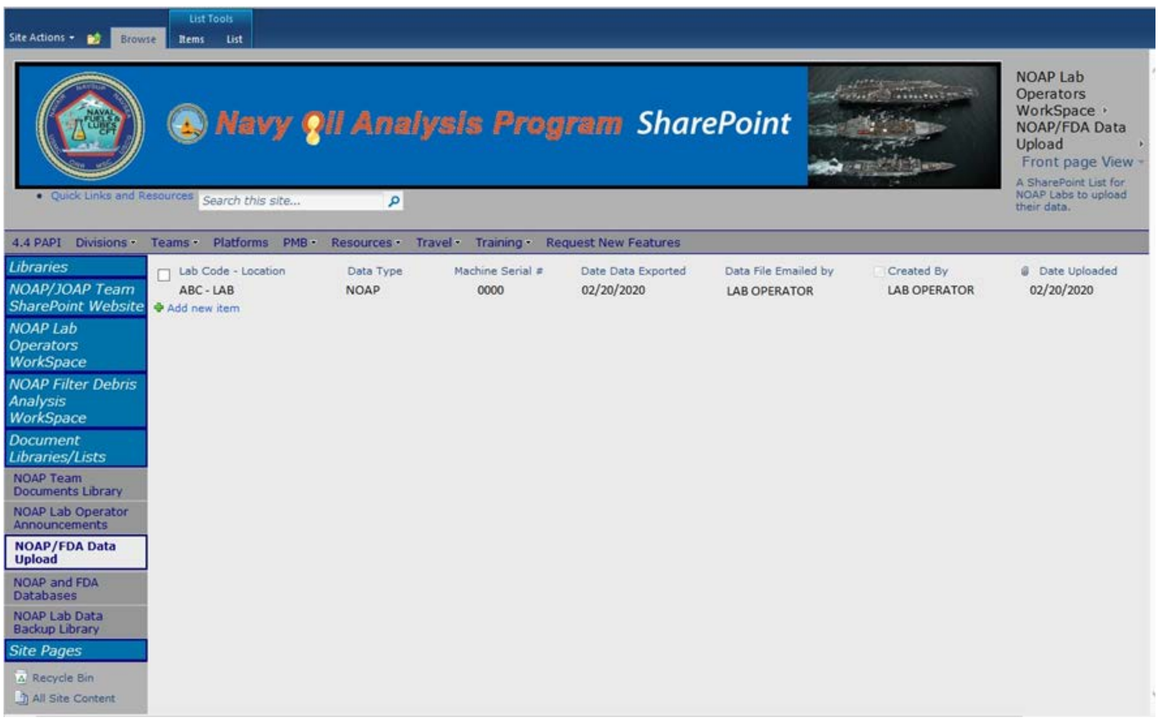
NOTE: Large files take longer to upload to the SharePoint. Please be patient and allow for a sufficient amount of time.

If you receive an error message during the upload of an export file or are unable to upload an export file then contact the NOAP Office at noap@navy.mil for further assistance.

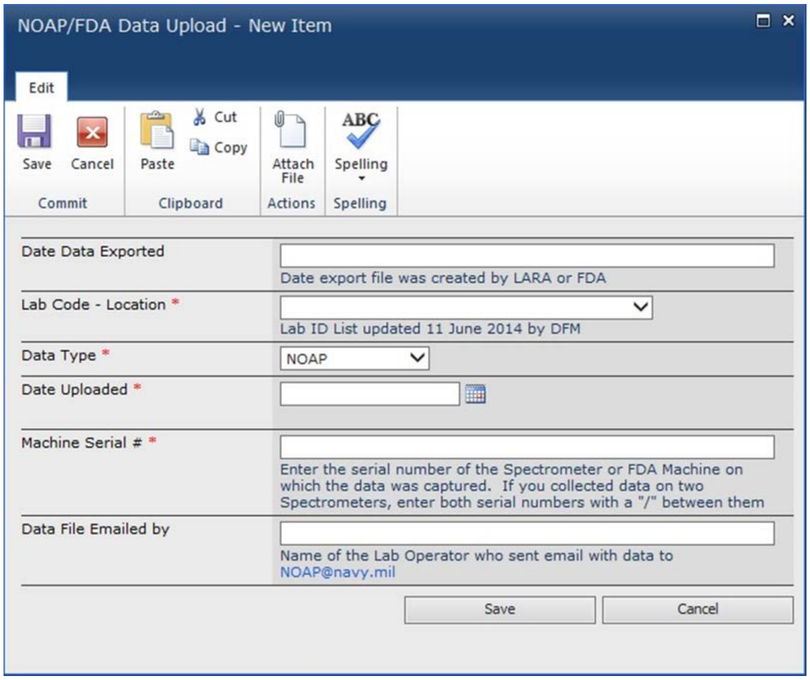
a. On an NMCI computer, navigate to the NOAP Laboratory Operators' WorkSpace website.

https://myteam.navair.navy.mil/air/44/nflcft/NOAP/NOAPLABS/SitePages/Home.aspx

b. Click the "NOAP/FDA Data Upload" link under the "Document Library/Lists" category at the right of the screen.

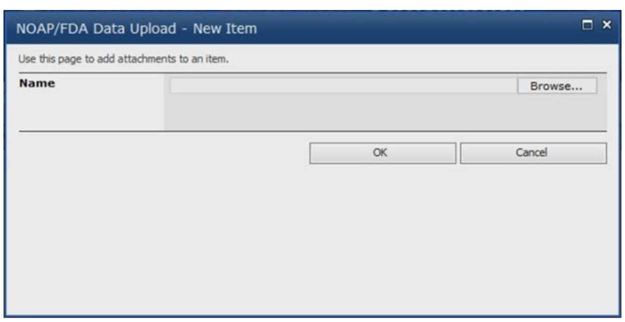


c. Click the “Add new item” link at the bottom of the list. The following screen will display.



c. Fill in all text boxes with appropriate information related to the upload.

d. Click the “Attach File” button at the top of the “NOAP/FDA Data Upload” screen. The following screen will display.

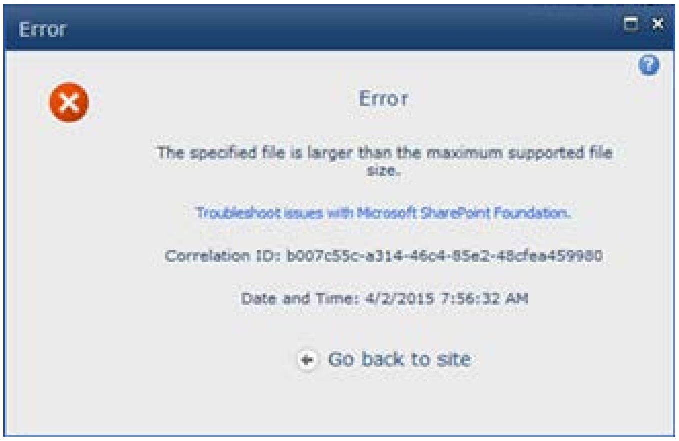


e. Click the “Browse” button and navigate to the Export file on the CD or External Hard Drive created in step 2 of the instruction above.

f. Click the “OK” button.

NOTE: It may take several minutes for the file to upload. While it is uploading to SharePoint, the screen above will not change.

If the file is too large (>100MB) the following screen will appear.



g. Click the “Save” button. The entry you created will be visible in the list.

4. Uploading a Backup File.

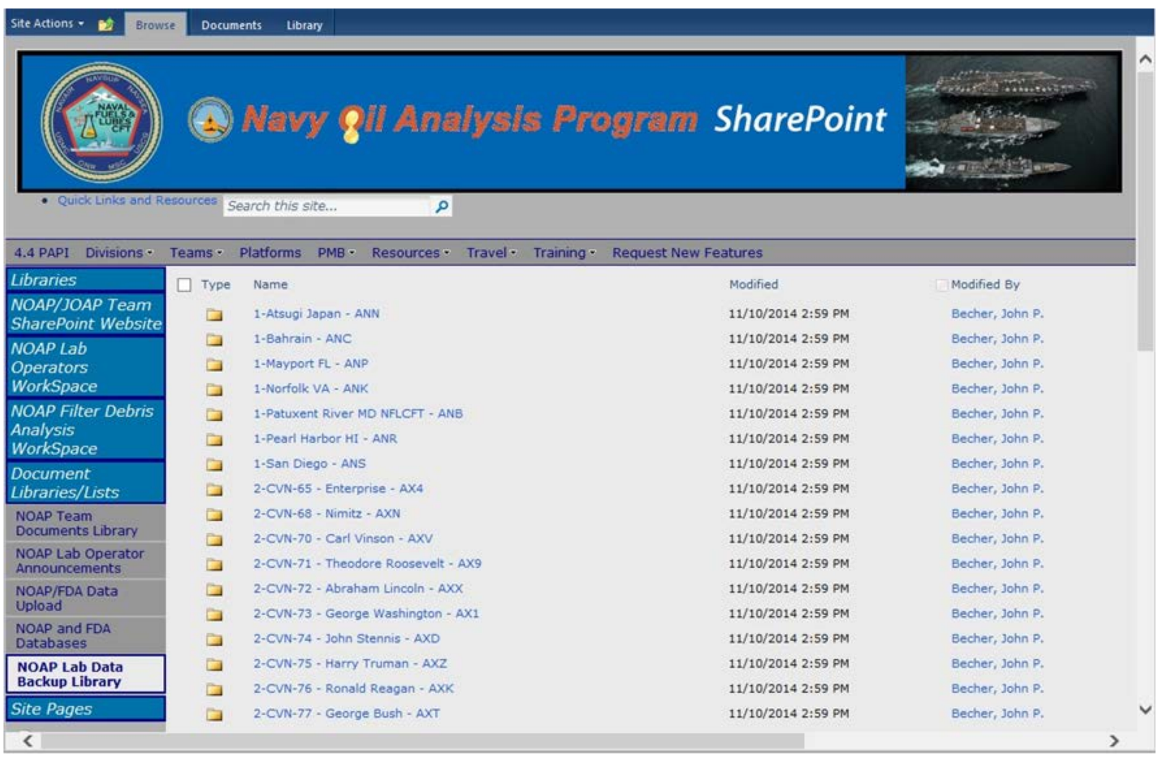
NOTE: Large files take longer to upload to the SharePoint. Please be patient and allow for a sufficient amount of time.

If you receive an error message during the upload of a backup file or are unable to upload a backup file then contact the NOAP Office at noap@navy.mil for further assistance.

a. On an NMCI computer, navigate to the NOAP Laboratory Operators' WorkSpace website.

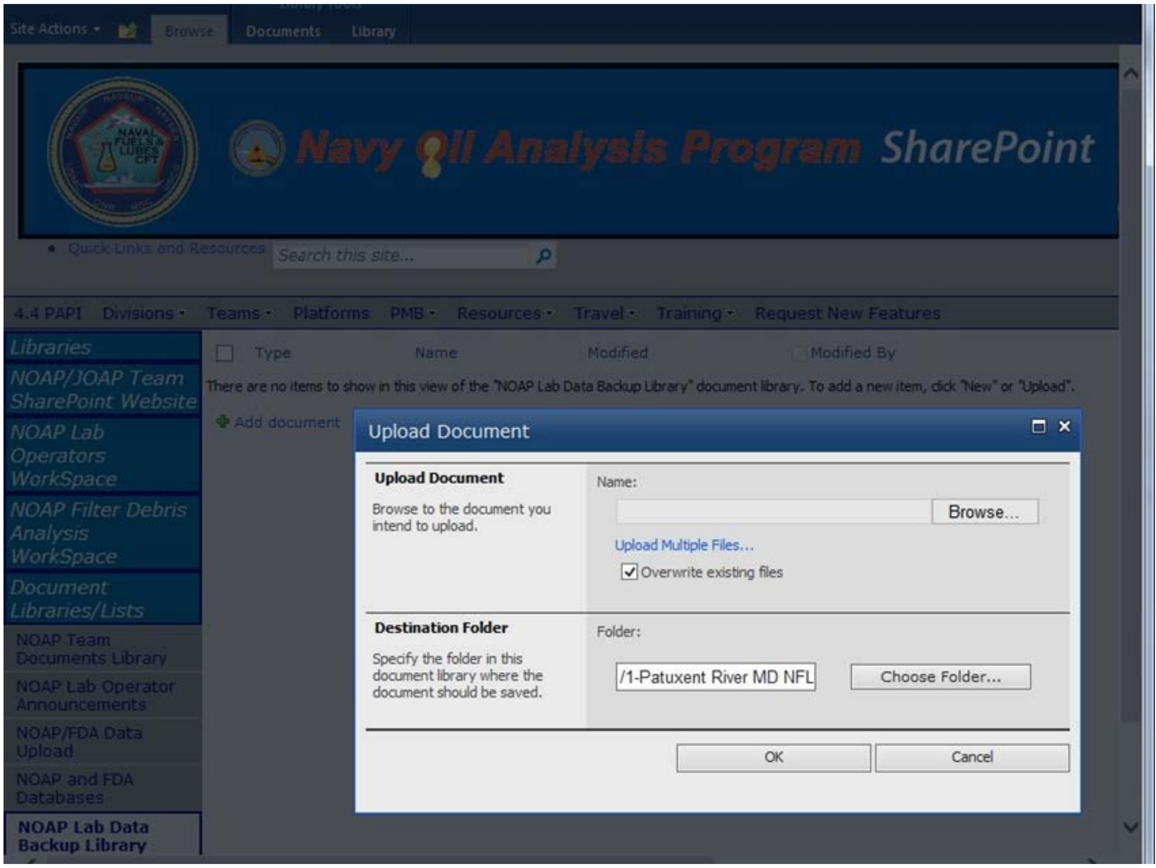
https://myteam.navair.navy.mil/air/44/nflcft/NOAP/NOAPLABS/SitePages/Home.aspx

b. Click the "NOAP LAB DATA BACKUP LIBRARY" link under the "Document Library/Lists" category at the right of the screen.



c. Navigate to your lab's folder. Click the yellow folder icon to enter the folder.

d. Click the “Add Document” link seen on the screen. The following screen will display.

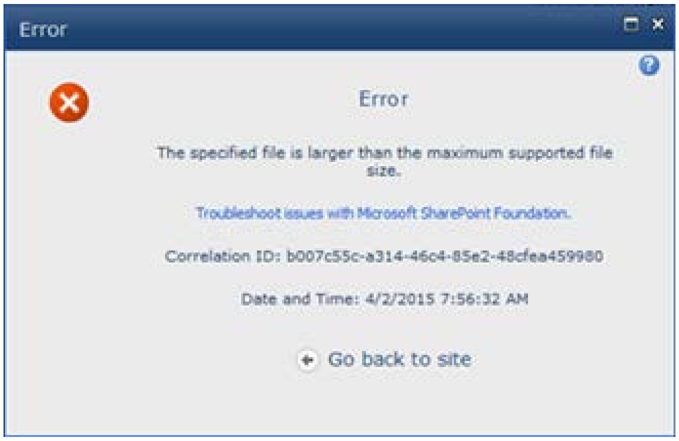


e. Click the “Browse” button and navigate to the Database Backup file on the CD or External Hard Drive created in step 5 of the instruction above.

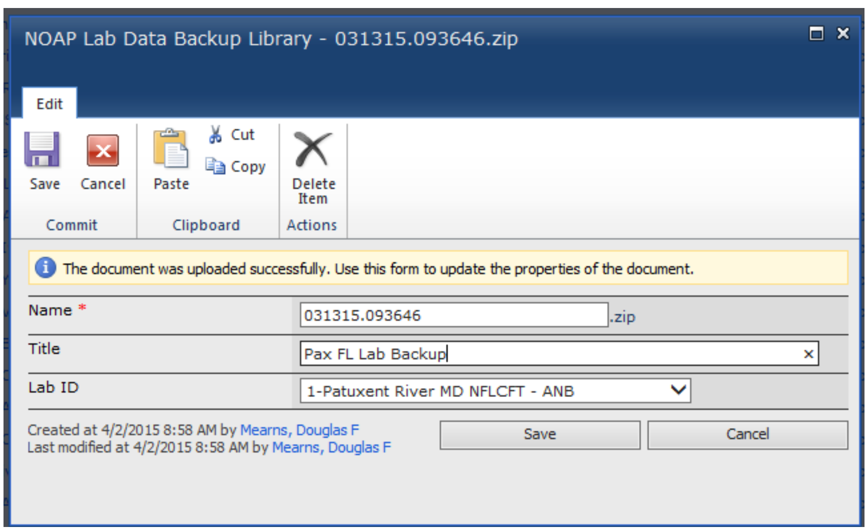
f. Click “OK” to upload the file.

NOTE: It may take several minutes for the file to upload. While it is uploading to SharePoint, the screen above will not change.

If the file is too large (>100MB) the following screen will appear.



g. Once the file uploads you will see the following screen



h. Enter a brief description of your file in the “Title” block and select your Lab ID from the dropdown list.

i. Click the “Save” button.

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 three 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

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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 Rev 005(AETC software) dated May 14. Installation of this software must be on an external computer with AF Standard Desktop Configuration (32 bit) and connected to the LAN.

   NOTE

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

   b. Backup AETC software on a weekly basis to an external device.

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

   d. Perform daily supervisor review using Tab F "View and Print Supervisory Review"

      (1) Supervisor will verify that all analysis performed for the day were correctly entered into the AETC software. Validate the DD Form 2026 and the information on the Supervisory Review match.

   e. Complete the AF OAP Annual Certification Checklist via AETC Rev 005 Tab C NLT 1 March of each year.

2. Rev 005 AETC software:

   The issue of data integrity and open loop feedback drove the requirement for the new AETC software CPIN 81E-OAP/EXTERNAL/US-F001-00A Rev 005, dated May 2014, which is the minimum revision required for all AF laboratories. The Rev 005 has many of the same features as the fielded Rev 003 software, with a significant difference in the front screen appearance. However, there are several internal changes that have occurred; the following is intended to assist users make the transition from previous revisions to the required Rev 005. Further information is available on the AF OAP Share Point site at https://cs1.eis.af.mil/sites/LPCS/OAP/SitePages/Home.aspx

   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. The engine serial number will be input as 6 numerical digits (ex. 204251). In the event the engine serial number contains alpha characters (T-1, and T-6 aircraft) enter the alpha characters in the remarks section (ex. ESN is JB0413, enter 000413 as the engine serial number and enter "JB" in the remarks section).

   d. 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).

e. 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).

f. 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.

g. If a printout of the monthly correlation is needed, simply enter your email address in the Cc block, upon receipt of the email print the attachment.

h. 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:

a. https://cs1.eis.af.mil/sites/LPCS/OAP/SitePages/Home.aspx can be accessed with a DoD CAC for OAP related information to include:

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

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. Normal samples. Air Force Oil Analysis Laboratories perform only wear metal analysis via rotrode atomic emission spectrometer. Volume II 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.

6. 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: Lynne Nelson (785-3100)
BLDG 490 AREA B
1790 LOOP ROAD N
WRIGHT PATTERSON AFB OH 45433-7103
DSN: 785-3100
Commercial: (937) 255-3100

7. 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

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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 technical order.

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Change 1 - 1 June 2015

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 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 AETC software Rev 005

   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 hard copy documents within OAP:

DD Form 2027	DD Form 2026	Correlation Printouts	Daily Calibration Printouts	Supervisory Review Printouts
12 months	3 months	3 months	1 month	1 month

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Change 1 - 1 June 2015

TOTAL ACID NUMBER (TAN) LABORATORY OPERATING PROCEDURES

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.

Description	Manufacturer	Part Number	NSN
Jencons Digitrate Pro - 50ml	Jencons	JENC182-026	
Toluene (ACS Reagent Grade)	Fisher Scientific	T-324-SK4 (4L)	6810-01-368-6710
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

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 1). The

factor of the spindle and fluid accuracy determines the total tolerance of the fluid. Table 2 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 1. 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 2. 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 3 below for the specific gravity of various oils used.

TABLE 3. 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 1). The factor of the spindle and fluid accuracy determines the total tolerance of the fluid. Table 2 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 4).

NOTE

Ensure the spindle speed is set at 60 RPM.

TABLE 4. 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 3 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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Change 1 - 1 June 2015

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.

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[2]	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	- -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 II 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 mm^2/s the measured value should be between 53.87 mm^2/s and 54.25 mm^2/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 1 and enter the density of the fluid being tested.

TABLE 1. Fluid Densities

NAVSEA Designation	DLA Designation	Specification	Density
MIL-PRF-2104 (15W-40)	MIL-PRF-2104	MIL-PRF-2104	0.88
9250 (MS9250)	LO6	MIL-PRF-9000	0.90
2190 TEP	LTL	MIL-PRF-17331	0.90
MIL-H-22072	MIL-H-22072	MIL-H-22072	1.04
MIL-PRF-23699	MIL-PRF-23699	MIL-PRF-23699	0.96
MIL-PRF-2105	SAE J2360	SAE J2360 (MIL-PRF-2105)	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.

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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.

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.

Change 1 - 1 June 2015

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 2, page 5, 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.

Description	Manufacturer	Part Number	NSN
AquaTest 2010	Photovolt		6630-01-293-4324
Grease, Sealing	Photovolt	2091001	9150-01-558-8043
Pyridine, Free Vessel	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 1 for proper fuse ratings for the selected voltage.

TABLE 1. 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 2

TABLE 2. 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.

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.

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.

73F H-83282 218

(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.

73F H-83282 218

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.

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.

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. Evaluation. 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. Recording Results. 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				
	Organic				
Non-Metallic, Amorphous					
Friction Polymers					
Fibers					
Other, Specify					

Considered Judgement of Wear Situation:

☐ Normal ☐ Caution ☐ Very High (Red Alert)

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: ____________________

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: ____________________

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.

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.

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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Change 1 - 1 June 2015

SPECTRO FUEL DILUTION METER (FUEL SNIFFER) MODEL Q600

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. Spectro, Inc manufactures the Fuel Sniffer.

Description	Manufacturer	Part Number	NSN
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.

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

.

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.

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.

Change 1 - 1 June 2015

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.

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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: $1.52 \times 10_8$ 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 $4 \times 10_{10}$ 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:

$P = R/K$
$R = PK = (4 \times 10_{10})\ (.0038) = 152{,}000{,}000$ 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.

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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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ANTON PARR 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

2. Summary of Method.

3. Equipment/Apparatus/Materials.

Description	Manufacturer	Part Number	NSN
Viscometer	Anton Paar	SVM3000	6630-01-564-6096
Maintenance Kit	Anton Paar	16864	
Kim Wipes	GSA		7920-00-721-8884
Paper Towels	GSA		7920-00-823-9773
Heptane	Fisher	H350-4	
Viscosity Standards	Cannon	N44	
Viscosity Standards	Cannon	N100	
Viscosity Standards	Cannon	N250	

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. Applicable Standards.
   a. ASTM D2270
   b. ISO 2909

5. Operation/Procedure. Consult the operating procedures manual supplied with the viscometer.

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Change 1 - 1 June 2015

TYPE EQUIPMENT CODES

Table of Contents

Table # | Title | Page

Table 1 – Aeronautical Type Equipment Codes - Sorted by End Item

END ITEM	COMPONENT	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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
H-46	T62T-l 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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
UH-1N	42/Int Gbx	GAIN
UH-1N	90/Tail Gbx	GATN
UH-1N	Eng Comb Gbx	GAEN
UH-1N	Hyd Sys	HAA4
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

END ITEM	COMPONENT	TEC
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
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
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	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
Oil Cart	PON-6	DRAA
A-4	CSD	DSAA

END ITEM	COMPONENT	TEC
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
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
C-140	J60-P-5	EHCA
T-37	J69-T-25	EKAA
U-2	J75-P-17	EMAB
U-2S	F118-GE-101	EMAC

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
CV-22	Mid-Wing Gbx	GVBC
MV-22	Mid-Wing Gbx	GVBM
CV-22	Prop Rotor Gbx	GVDC
MV-22	Prop Rotor Gbx	GVDM
CV-22	Tilt Axis Gbx	GVJC
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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
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
Predator	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

END ITEM	COMPONENT	TEC
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
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

END ITEM	COMPONENT	TEC
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

Table 3 – Non-Aeronautical Type Equipment Codes U.S. Marine Corps Components

Non-Aeronautical USMC TEC's		
EIMOD	**COMPMOD**	**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

Non-Aeronautical USMC TEC's		
EIMOD	**COMPMOD**	**TEC**
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

Non-Aeronautical USMC TEC's		
EIMOD	**COMPMOD**	**TEC**
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
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

Non-Aeronautical USMC TEC's		
EIMOD	**COMPMOD**	**TEC**
LAV-L-MC	DD6V53T	MWKA
LAV-L-MC	MT653DR	MWKG
LAV-M-MC	DD6V53T	MWLA
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

Non-Aeronautical USMC TEC's		
EIMOD	**COMPMOD**	**TEC**
M927-MC	NHC-250	MBHA
M928A1-MC	HYD SYS	MCJN
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

Non-Aeronautical USMC TEC's		
EIMOD	**COMPMOD**	**TEC**
MK-27	ENGINE	PBCA
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 TEC's		
EIMOD	**COMPMOD**	**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
4700	AT545	NA4G

Non-Aeronautical Army TEC's		
EIMOD	**COMPMOD**	**TEC**
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
621B	3406	EH3A
621B	7G2780	EH3G

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
AP308	FORD C-6	DXLG
APP-1	GTCP85-127	VAFC
ARTFT6	ALS 3331-1	DJCG

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
CAT-12	CAT-D333	EHKA
CAT-120ROPS	3R9859	EHKG
CAT-130G	5R6192	EHFG
CAT-130G	CAT-330DIT	EHFA

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
CAT-D5B	HYD SYS	TEKN
CAT-D7E	CAT-D333	EA3G
CAT-D7F	5R82	EA2G
CAT-D7F	CAT-3306	EA2A
CAT-D7F	CAT-6CYL638C	EA2B

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
D6	HYD SYS	TCMM
DV43	CAT-2408T	DJNA
DV43	CAT-3408	DJNB
DV43	CAT-3P9094	DJNH
DV43	CAT-5R3855	DJNG
DV43	HYD SYS	DJNN

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	**COMPMOD**	**TEC**
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
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

Non-Aeronautical Army TEC's		
EIMOD	**COMPMOD**	**TEC**
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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
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

Non-Aeronautical Army TEC's		
EIMOD	COMPMOD	TEC
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 Type Equipment Codes Army Corps of Engineers Components

Non-Aeronautical Army Corps TEC's		
EIMOD	**COMPMOD**	**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

Non-Aeronautical Army Corps TEC's		
EIMOD	**COMPMOD**	**TEC**
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
HODGE	DD8V92	89CA
HURON	DD453	817A

Non-Aeronautical Army Corps TEC's		
EIMOD	COMPMOD	TEC
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
MW24C	TT24211	871G
N CENTRAL	DD8V71	89FA
NI9752	DD671	83CA

Non-Aeronautical Army Corps TEC's		
EIMOD	COMPMOD	TEC
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
W-46	M20L	89AG
W-48	DD8V71	89AA
WHITEFISH	DD12V71	8D5A
XM93FOX	HP500 TYPE 6	559G

Non-Aeronautical Army Corps TEC's		
EIMOD	COMPMOD	TEC
XM93FOX	HYD SYS	559N
XM93FOX	OM402A	559A
YF-865	DD371	8E6A
YF-865	DD6V149	8E6B
YSD-22	DD12V71	8E3A
YSD-22	DD471	8E3B
YSD-59	DD12V71	8E5A
YSD-59	DD471	8E5B

Non-Aeronautical Army Corps TEC's		
EIMOD	COMPMOD	TEC
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	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	TEC
UH-60FS	Hydraulic Pump	HLAA
UH-1FS	Hydraulic Pump	HAA1
CH-47FS	Hydraulic Pump	HEAD
Oil Cart (PON-6)	MIL-PRF-83282	DRAA
Oil Servicing Cart/System	MIL-PRF-87257	DRBA
Oil Servicing Cart/System	MIL-PRF-23699	DRCA
Oil Servicing Cart/System	MIL-PRF-7808	DREA
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 TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
	ANCHORS	
ALL	ANCHOR HYDRAULIC	1A01
ALL	ANCHOR 80-90	1A02
	CRANES	
ALL	CRANE 80-90	2A01
ALL	CRANE HYDRAULIC	2A02
ALL	CRANE 9250	2A03
	HYDRAULIC EQUIPMENT	
ALL	HYDRAULIC POWER UNIT	3A01
	AIR CONDITIONING AND REFRIGERATION	
ALL	AIR CONDITIONING/REFRIGERATION SW 68	4001
ALL	AIR CONDITIONING/REFRIGERATION RC02	4002
ALL	AIR CONDITIONING/REFRIGERATION RC04	4003
ALL	AIR CONDITIONING/REFRIGERATION POE 48	4004
	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
	BLOWERS	
ALL	BLOWER 2190	6A0Y

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
	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
	CONTROLLABLE PITCH PROPELLERS	
AOE 6 Class	ROLLS ROYCE NAVY MARINES 245-6361975	C41M
ARS 50 Class	ROLLS ROYCE NAVY MARINES 7309	C50M
CG 47 Class	ROLLS ROYCE NAVY MARINES 115652102	C80M
CG 66 Class	ROLLS ROYCE NAVY MARINES 115652103	C8AM
DD 963 Class	ROLLS ROYCE NAVY MARINES 7309	CF0M
DDG 51 Class	ROLLS ROYCE NAVY MARINES 7309	CF1M
DDG 993 Class	ROLLS ROYCE NAVY MARINES 115657001	CF2M
FFG 7 Class	ROLLS ROYCE NAVY MARINES 7309	CG0M
LCAC Class	DOWDY CO. LTD.	CH0N
LHD 1 Class	ROLLS ROYCE NAVY MARINES 80-3S-CP	CI1M
LSD 41 Class	ROLLS ROYCE NAVY MARINES 112152001	CN0M
LSD 49 Class	ROLLS ROYCE NAVY MARINES 112157071	CP0M
LST 1179 Class	ROLLS ROYCE NAVY MARINES	
	DWG110251003PORT	CQ0M
MCM 1 Class	ROLLS ROYCE NAVY MARINES 7309	CR0M

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
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	
AE 26 Class	DETROIT DIESEL CORP. 7124-320212V71LC	E101
AE 26 Class	DETROIT DIESEL CORP. 7124-320212V71RC	E1A1
AGF 11 Class	COLTEC INDUSTRIES INC. 38F5 1/4	E213
AGF 3 Class	CATERPILLER INC. D334TA	E202
AGSS Class	EDG 555	E221
AO 177 Class	COLTEC INDUSTRIES INC. 6-38D8 1/8	E303
AO 177 Class	COLTEC INDUSTRIES INC. 6-38ND8 1/8	E3A3
AOE 1 Class	COLTEC INDUSTRIES INC. 38ND8 D3051/8	E403
AOE 1 Class	GENERAL MOTORS CORP. 16-567C	E408
AOE 1 Class	COLTEC INDUSTRIES INC. 38ND8-1/8	E4A3
AOE 6 Class	CATERPILLER INC. 3608	E412
ARDM 5 Class	ARDM 5 EDG	E510
AS 33 Class	COLTEC INDUSTRIES INC. 8-38D8 1/8	E603
AS 33 Class	GENERAL MOTORS CORP. 12-645E2	E608
AS 39 Class	COLTEC INDUSTRIES INC.38 D8 1/8AR3	E703
AS 39 Class	COLTEC INDUSTRIES INC. 38ND8 1/8	E7A3
CGN 36 Class	COLTEC INDUSTRIES INC. 38D8 1/8	E003
CGN 38 Class	COLTEC INDUSTRIES INC. 38D8 1/8	E9A3
CV 59 Class	COLTEC INDUSTRIES INC. 38ND8 1/8	EA03
CV 63 Class	COLTEC INDUSTRIES INC. 12-38D8 1/8	EB03
CV 63 Class	GENERAL MOTORS CORP. 16-567C	EB08
CV 63 Class	COOPER CAMERON CORP. FVAM8T	EB0L
CV 63 Class	COLTEC INDUSTRIES INC. 38ND8 1/8	EBA3
CVN 65 Class	GENERAL MOTORS CORP. 16-567C	ED08
CVN 68 Class	GENERAL MOTORS CORP. LL16-645E5	EE08

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
CVN 68 Class	GENERAL MOTORS CORP. LL16-645E5N	EEA8
LCC 19 Class	COLTEC INDUSTRIES INC. 6-38D8 1/8	EH13
LHA 1 Class	COLTEC INDUSRIES INC. 251C	EI03
LHD 1 Class	COLTEC INDUSTRIES INC. 251C	EI13
LPD 1 Class	COLTEC INDUSTRIES INC. 38F5 1/4	EJ03
LPD 14 Class	DETROIT DIESEL CORP. 7123-730012V71RC	EL01
LPD 7 Class	COLTEC INDUSTRIES INC. 38F5 1/4	EK03
LSD 36 Class	DETROIT DIESEL CORP. 7123-730012V71RC	EM01
MCM Class	MCM EDG	ER00
MCS 12 Class	COLTEC INDUSTRIES INC. 12-38D8 1/8	ER13
ALL	MISC EDG	EH50
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	
AOE 6 Class	GENERAL ELECTRIC CO LM2500	G41O
CG 47 Class	STEWART & STEVENSON SERVICES INC 139A200	G80J

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
CG 47 Class	GENERAL ELECTRIC CO LM2500	G80O
DD 963 Class	ROLLS ROYCE NAVY MARINES 501-K17	GF0M
DD 963 Class	GENERAL ELECTRIC CO LM2500	GF0O
DDG 51 Class	ROLLS ROYCE NAVY MARINES 501-K34	GF1M
DDG 51 Class	ALLIED SIGNAL GTCP 100-82	GF1P
DDG 993 Class	GENERAL ELECTRIC CO LM2500	GF2O
FFG 7 Class	GENERAL ELECTRIC CO LM2500	GG0O
LCAC Class	AVCO-LYCOMING TF40B	GH0Q
LCAC Class	SUNDSTRAND T-62T-40-7	GH0R
MCM 1 Class	SOLAR T-1000S-28AA	GR0B
MCM 1 Class	SOLAR T-1302S-28AA	GRAB
WHEC Class	WHEC GTE	GV0M
	GAS TURBINE GENERATORS	
AOE 6 Class	ALLISON 501 2190	H41Y
AOE 6 Class	ALLISON 501 23699	H41Z
CG 47 Class	ALLISON 501 2190	H80Y
CG 47 Class	ALLISON 501 23699	H80Z
DD 963 Class	ALLISON 501 2190	HF0Y
DD 963 Class	ALLISON 501 23699	HF0Z
DDG 51 Class	ALLISON 501 2190	HF1Y
DDG 51 Class	ALLISON 501 23699	HF1Z
DDG 993 Class	ALLISON 501 2190	HF2Y
DDG 993 Class	ALLISON 501 23699	HF2Z
FFG 7 Class	ALLISON 501 2190	HG0Y
FFG 7 Class	ALLISON 501 23699	HG0Z
LCAC Class	ALLISON 501 2190	HH0Y
LCAC Class	ALLISON 501 23699	HH0Z
MCM 1 Class	ALLISON 501 2190	HR0Y
MCM 1 Class	ALLISON 501 23699	HR0Z
WHEC	WHEC GTG	HV00
	FANS	
ALL	SCAVENGER FAN HYDRAULIC	I001
	GEARS	

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
ALL	GEARS 2190	J001
ALL	GEARS 80-90	J002
ALL	GEARS 23699	J003
ALL	GEARS HYDRAULIC	J004
ALL	GEARS 9250	J005
	ROCKER ARMS	
LSD 36 CLASS	COLTEC IND. INC. DIESEL ENG ROCKER ARMS	KM03
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
CV 63 CLASS	WESTINGHOUSE	LB07
CV 63 CLASS	JARED INDUSTRIES INC	LB0A
CV 63 CLASS	OTIS ELEVATOR CO	LB0D
CVN 65	WESTINGHOUSE	LD07
CVN 68 CLASS	JARED INDUSTRIES INC	LE0A
CVN 68 CLASS	RUCKER	LE0E
DD 963 CLASS	DD 963 ELEVATOR NON HYDRAULIC	LF00
FFG 7 CLASS	FFG7 ELEVATOR NON HYDRAULIC	LG00
LHA 1 CLASS	JARED INDUSTRIES INC	LI0A
LHA 1 CLASS	LHA1 ELEVATOR NON HYDRUALIC	LI00
LHD 1 CLASS	SCHINDLER ELEVATOR CORP	LI0S
LPD 7 CLASS	LPD 7 ELEVATOR-NON HYDRAULIC	LK00
MCS 12 CLASS	JARED INDUSTRIES INC	LR1A
	ELEVATORS HYDRAULIC	
CG 47 CLASS	CG 47 ELEVATOR HYDARULIC	L8A0
CV 63 CLASS	WESTINGHOUSE	LBA7
CV 63 CLASS	OTIS ELEVATOR CO	LBAA
CV 63 CLASS	JARED INDUSTRIED INC	LBAD
CVN 65	WESTINGHOUSE	LDA7
CVN 68 CLASS	RUCKER	LEAA

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
CVN 68 CLASS	JARED INDUSTRIED INC	LEAE
DD 963	DD 963 ELEVATOR HYDRAULI	LFA0
FFG 7	FFG 7 ELEVATOR HYDRAULIC	LGA0
LHA 1 CLASS	JARED INDUSTRIED INC	LIAA
LHD 1 CLASS	SCHINDLER ELEVATOR CORP	LIBS
LPD 7	LPD 7 ELEVATOR HYDRAULIC	LKA0
MSC 12	JARED INDUSTRIED INC	LRAS
	MAIN DIESEL ENGINES	
AE 26 CLASS	CATERPILLER INC. D398	M102
AGSS 555 CLASS	DETROIT DIESEL CORP. 7124-3202-12V71	M221
AOE 1 CLASS	AOE 1 MDE	M400
ARS 50 CLASS	CATERPILLER INC. D399B-TA	M502
CG 47 CLASS	CG 47 MDE	M800
DD 963 CLASS	DD 963 MDE	MF00
LCU CLASS	LCU MDE	MH20
LHA 1 CLASS	LHA 1 MDE	
LHD 1 CLASS	LHD 1 MDE	MI10
LPD 1 CLASS	LPD 1 MDE	MJ00
LPD 7 CLASS	LPD 7 MDE	MK00
LSD 36 CLASS	DETROIT DIESEL CORP. 7123-7305-12V71T	MM01
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
LST 1179 CLASS	ALCO PRODUCTS INC. 16-251C	MQ00
LST 1179 CLASS	ALCO PRODUCTS INC. 8-251E	MQA0
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

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
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
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 TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
	SMALL BOYS DIESEL ENGINES	
AE 26 CLASS	DETROIT DIESEL CORP. 5042-40004-53LD	O101
AE 26 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	O104
AE 26 CLASS	WESTERBEKE CORP. 108O-14088	O105
AE 26 CLASS	DETROIT DIESEL CORP. 5062-70006V53N	O1A1
AE 26 CLASS	WESTERBEKE CORP.4 –107	O1A5
AE 26 CLASS	DETROIT DIESEL CORP. 6087M-ALUM	O1B1
AE 26 CLASS	DETROIT DIESEL CORP. 6-71RD706087M	O1C1
AGF 11 CLASS	DETROIT DIESEL CORP. 6121T6-71LC	O211
AGF 11 CLASS	WESTERBEKE CORP. 108U-14088	O215
AGF 3 CLASS	DETROIT DIESEL CORP. 1062-7000	O201
AGF 3 CLASS	WESTERBEKE CORP. 108O-14088	O205
AGF 3 CLASS	DETROIT DIESEL CORP. 6072M6-71RC	O2A1
AGF 3 CLASS	DETROIT DIESEL CORP. 7082-7399	O2B1
AO 177 CLASS	DETROIT DIESEL CORP. 1062-7000	O301
AO 177 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	O304
AO 177 CLASS	VOLVO PENTA OF AMERICA INC AQAD41A-DP290A	O306
AO 177 CLASS	DETROIT DIESEL CORP. 6072M6-71RC	O3A1
AOE 1 CLASS	DETROIT DIESEL CORP. 1062-7000	O401
AOE 1 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	O404
AOE 1 CLASS	WESTERBEKE CORP. 108U-14088	O405
AOE 1 CLASS	DETROIT DIESEL CORP. 5062-70006V53N	O4A1
AOE 1 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	O4A4
AOE 1 CLASS	WESTERBEKE CORP. 14088 SPEC B	O4A5
AOE 1 CLASS	DETROIT DIESEL CORP. 64HN9HTEXCH	O4B1
AOE 1 CLASS	DETROIT DIESEL CORP. 64HN9KCLG	O4C1
AOE 6 CLASS	DETROIT DIESEL CORP. 1062-7000	O411
AOE 6 CLASS	CUMMINS ENGINE CO. INC. 4B3.9-M	O414
AOE 6 CLASS	VOLVO PENTA OF AMERICA INC AQAD41A-DP290A	O416
AOE 6 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	O4B4
AOE 6 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M2	O4C4
AOE 6 CLASS	DETROIT DIESEL CORP. 6072M6-71RC	O4D1
ARS 50 CLASS	DETROIT DIESEL CORP. 5042-40004-53LD	O501
ARS 50 CLASS	DETROIT DIESEL CORP. 5042-40004-53RB	O5A1
AS 33 CLASS	DETROIT DIESEL CORP. 1062-5000	O601
AS 33 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M2	O604

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
AS 33 CLASS	WESTERBEKE CORP. 4-107	O605
AS 33 CLASS	ONAN CORP. 1.5OMDJF4R4686D	O60C
AS 33 CLASS	DETROIT DIESEL CORP. 1062-5099	O6A1
AS 33 CLASS	ONAN CORP. 1.5OMDJF4R4686D	O6AC
AS 33 CLASS	DETROIT DIESEL CORP. 1062-7000	O6B1
AS 33 CLASS	DETROIT DIESEL CORP. 6072M6-71RC	O6C1
AS 33 CLASS	DETROIT DIESEL CORP. 64HN9HTEXCH	O6D1
AS 39 CLASS	DETROIT DIESEL CORP. 1043-7005	O701
AS 39 CLASS	COLTEC INDUSTRIES INC. 38D8 1/8AR3	O703
AS 39 CLASS	WESTERBEKE CORP. 14088 SPEC B	O705
AS 39 CLASS	DETROIT DIESEL CORP. 1043-7005-4-71N	O7A1
AS 39 CLASS	WESTERBEKE CORP. 4-107	O7A5
AS 39 CLASS	DETROIT DIESEL CORP. 1062-5099	O7B1
AS 39 CLASS	DETROIT DIESEL CORP. 1062-6001	O7C1
AS 39 CLASS	DETROIT DIESEL CORP. 5062-7000	O7D1
AS 39 CLASS	DETROIT DIESEL CORP. 5062-70006V53N	O7E1
AS 39 CLASS	DETROIT DIESEL CORP. 6072M6-71RC	O7F1
AS 39 CLASS	DETROIT DIESEL CORP. 6088M	O7G1
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
CGN 36 CLASS	DETROIT DIESEL CORP. 1062-7000	O901
CGN 36 CLASS	CUMMINS ENGINE CO. INC. 8BTA5.9-M	O904
CGN 36 CLASS	WESTERBEKE CORP. 108D-14088	O905
CGN 36 CLASS	DETROIT DIESEL CORP. 5062-70006V53N	O9A1
CGN 36 CLASS	WESTERBEKE CORP. 14088 SPEC B	O9A5
CGN 38 CLASS	DETROIT DIESEL CORP. 5042-3000	O001
CGN 38 CLASS	WESTERBEKE CORP. 4-107	O005
CGN 38 CLASS	DETROIT DIESEL CORP. 5042-40004-53LD	O0A1
CV 59 CLASS	DETROIT DIESEL CORP. 6087M-STBD	OA01
CV 59 CLASS	WESTERBEKE CORP. 108U-14088	OA05
CV 59 CLASS	VOLVO PENTA OF AMERICA INC AQAD41A-DP290A	OA06
CV 59 CLASS	DETROIT DIESEL CORP 6088M PORT	OAA1
CV 59 CLASS	WESTERBEKE CORP. 4-107	OAA5
CV 59 CLASS	DETROIT DIESEL CORP. 64HNTEXCH	OAB1
CV 59 CLASS	DETROIT DIESEL CORP. 6-71RA6071MB	OAC1
CV 63 CLASS	DETROIT DIESEL CORP. 1062-7000	OB01

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
CV 63 CLASS	WESTERBEKE CORP. 4-107	OB05
CV 63 CLASS	VOLVO PENTA OF AMERICA INC AQAD41A-DP290A	OB06
CV 63 CLASS	DETROIT DIESEL CORP. 5033-60023-53	OBA1
CV 63 CLASS	DETROIT DIESEL CORP. 6072M6-71LC	OBB1
CV 63 CLASS	DETROIT DIESEL CORP. 6072M6-71RA	OBC1
CV 63 CLASS	DETROIT DIESEL CORP. 6072M6-71RC	OBD1
CV 63 CLASS	DETROIT DIESEL CORP. 6088M-ALUM-6-71	OBE1
CV 63 CLASS	DETROIT DIESEL CORP. 6088MCI	OBF1
CV 63 CLASS	DETROIT DIESEL CORP. 6088MPORT	OBG1
CV 63 CLASS	DETROIT DIESEL CORP. 64HN9HTEXCH	OBH1
CV 63 CLASS	DETROIT DIESEL CORP. 6-71RD706087M	OBI1
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
DD 963 CLASS	DETROIT DIESEL CORP. 1062-6001	OF01
DD 963 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	OF04
DD 963 CLASS	WESTERBEKE CORP. 4-107	OF05
DD 963 CLASS	DETROIT DIESEL CORP. 5062-3000	OFA1
DD 963 CLASS	DETROIT DIESEL CORP. 5062-7000	OFB1
DD 963 CLASS	DETROIT DIESEL CORP. 5062-70006V53N	OFC1
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
FFG 7 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	OG04
FFG 7 CLASS	WESTERBEKE CORP. 108U-14088	OG05

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
FFG 7 CLASS	VOLVO PENTA OF AMERICA INC 6AQAD40-867734	OG06
FFG 7 CLASS	WESTERBEKE CORP. 4-107	OGA5
FFG 7 CLASS	VOLVO PENTA OF AMERICA INC AQAD41A-DP290A	OGA6
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
LHA 1 CLASS	DETROIT DIESEL CORP. 7082-7399-8V71TI	OI01
LHA 1 CLASS	DETROIT DIESEL CORP. 7082-7399RC-8V71TI	OIA1
LHA 1 CLASS	DETROIT DIESEL CORP. 7082-7399TI-8V71RC	OIB1
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
LPD 1 CLASS	DETROIT DIESEL CORP. 5042-40004-53LD	OJ01
LPD 1 CLASS	WESTERBEKE CORP. 108U-14088	OJ05
LPD 1 CLASS	DETROIT DIESEL CORP. 64HN9KCLG	OJA1
LPD 1 CLASS	WESTERBEKE CORP. 4-107	OJA5
LPD 1 CLASS	DETROIT DIESEL CORP. 6-71LC6121T	OJB1
LPD 1 CLASS	DETROIT DIESEL CORP. 7082-7399RC-8V71TI	OJC1
LPD 14 CLASS	WESTERBEKE CORP. 4-107	OL05
LPD 14 CLASS	DETROIT DIESEL CORP. 7082-7399-8V71TI	OL01
LPD 14 CLASS	CUMMINS ENGINE CO. INC. 6B5.9-M	OL04
LPD 14 CLASS	DETROIT DIESEL CORP. 7082-7399RC-8V71TI	OLA1
LPD 7	DETROIT DIESEL CORP. 5042-40004-53LD	OK01
LPD 7	CUMMINS ENGINE CO. INC. 6B5.9-M	OK04
LPD 7	WESTERBEKE CORP. 4-107	OK05
LPD 7	DETROIT DIESEL CORP. 4HN9KCLG	OKA1
LPD 7	DETROIT DIESEL CORP. 7082-7399RC-8V71TI	OKB1
LPD 7	DETROIT DIESEL CORP. 7082-7399TI-8V71RC	OKC1
LSD 36 CLASS	DETROIT DIESEL CORP. 64HN9KCLG	OM01
LSD 36 CLASS	DETROIT DIESEL CORP. 7082-30008V71	OMA1
LSD 36 CLASS	DETROIT DIESEL CORP. 7082-7399RC-8V71TI	OMB1
LSD 41 CLASS	DETROIT DIESEL CORP. 1062+D417-7000	ON01
LSD 41 CLASS	CUMMINS ENGINE CO. INC. 6BTA5.9-M	ON04

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
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
LST 1179 CLASS	DETROIT DIESEL CORP. 64HN9KCLG	OQ01
LST 1179 CLASS	DETROIT DIESEL CORP. 7082-7399RC-8V71TI	OQA1
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
	REDUCTION GEAR	
AGF 11 CLASS	REDUCTION GEAR 9250	R21W
AOE 6 CLASS	REDUCTION GEAR 2190	R41Y
ARS 50 CLASS	REDUCTION GEAR 9250	R50W
CG 47 CLASS	REDUCTION GEAR 2190	R80Y
CG 47 CLASS	REDUCTION GEAR 23699	R80Z
CV 63 CLASS	REDUCTION GEAR 9250	RB0W
CVN 65 CLASS	REDUCTION GEAR 2190	RD0Y
DD 963 CLASS	REDUCTION GEAR 2190	RF0Y
DD 963 CLASS	REDUCTION GEAR 23699	RF0Z
DDG 51 CLASS	REDUCTION GEAR 23699	RF1Z
DDG 993 CLASS	REDUCTION GEAR 2190	RF2Y
FFG 7 CLASS	REDUCTION GEAR 2190	RG0Y
FFG 7 CLASS	REDUCTION GEAR 23699	RG0Z
LCAC CLASS	REDUCTION GEAR 23699	RH0Z

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
LCC 19 CLASS	REDUCTION GEAR 2190	RH1Y
LCU CLASS	REDUCTION GEAR 9250	RH2W
LHA 1 CLASS	REDUCTION GEAR 2190	RI0Y
LHD 1 CLASS	REDUCTION GEAR 2190	RI1Y
LPD 1 CLASS	REDUCTION GEAR 2190	RJ0Y
LPD 7 CLASS	REDUCTION GEAR 2190	RK0Y
LSD 36 CLASS	REDUCTION GEAR 2190	RM0Y
LSD 41 CLASS	REDUCTION GEAR 2190	RN0Y
LSD 49 CLASS	REDUCTION GEAR 2190	RP0Y
LST 1179 CLASS	REDUCTION GEAR 9250	RQ0W
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	

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
AOE 6 CLASS	AOE 6 SSDG	S410
ARS 50 CLASS	CATERPILLER INC. D399-TA	S502
FFG 7 CLASS	STEWART & STEVENSON SERVICE 114D001	SG0J
LCC 19 CLASS	COLTEC INDUSTRIES INC. 6-38D8 1/8	SH13
LCU CLASS	LCU SSDG	SH20
LHD 1 CLASS	LHD1 SSDG	SI10
LSD 41 CLASS	COLTEC INDUSTRIES INC.38ND8 1/8	SN03
LST 1179 CLASS	ALCO PRODUCTS INC. 8-251-E	SQ00
MCM CLASS	MCM SSDG	SR00
TWR CLASS	CATERPILLAR INC. 3304	ST62
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

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
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
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
	STEAM TURBINE GENERATORS	
AE 26 CLASS	AE 26 STEAM TURBINE GENERATORS	Y101
AGF 11 CLASS	AGF 11 STEAM TURBINE GENERATORS	Y211
AO 177 CLASS	AO 177 STEAM TURBINE GENERATORS	Y301
AOE 1 CLASS	AOE 1 STEAM TURBINE GENERATORS	Y401
AS 33 CLASS	S33 STEAM TURBINE GENERATORS	Y601
AS 39 CLASS	AS 39 STEAM TURBINE GENERATORS	Y701
CGN 36 CLASS	CGN 36 STEAM TURBINE GENERATORS	Y901
CGN 38 CLASS	CG 38 STEAM TURBINE GENERATORS	Y001
CV 63 CLASS	CV 63 STEAM TURBINE GENERATORS	YB01
CVN 65	CV 65 STEAM TURBINE GENERATORS	YD00

Non-Aeronautical TEC's US Navy Ships Equipment		
End Item	**Component**	**TEC**
CVN 68 CLASS	CV68 STEAM TURBINE GENERATORS	YE01
LCC 19 CLASS	LCC 19 STEAM TURBINE GENERATORS	YH11
LHA 1 CLASS	LHA 1 STEAM TURBINE GENERATORS	YI01
LHD 1 CLASS	LHD 1 STEAM TURBINE GENERATORS	YI11
LPD 1 CLASS	LPD1 STEAM TURBINE GENERATORS	YJ01
LPD 7 CLASS	LPD7 STEAM TURBINE GENERATORS	YK01
LSD 36 CLASS	LSD 36 STEAM TURBINE GENERATORS	YM01
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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